U. S. DEPARTMENT OF COMMERCE

BUREAU OF FISHERIES

REPORT

OF THE

UNITED STATES COMMISSIONER OF FISHERIES

FOR THE FISCAL YEAR 1929

WITH

APPENDIXES

HENRY O'MALLEY
Commissioner

UNITED STATES
GOVERNMENT PRINTING OFFICE
WASHINGTON : 1930

National Oceanic and Atmospheric Administration

Report of the United States Commissioner of Fisheries

ERRATA NOTICE

One or more conditions of the original document may affect the quality of the image, such as:

Discolored pages
Faded or light ink
Binding intrudes into the text

This has been a co-operative project between the NOAA Central Library and the National Marine Fisheries Service (NOAA Fisheries). To view the original document, please contact the NOAA Central Library in Silver Spring, MD at (301) 713-2607 x124 or www.reference@nodc.noaa.gov.

LASON
Imaging Contractor
12200 Kiln Court
Beltsville, MD 20704-1387
November 19, 2004

ERRATA

Page 108, Table 5: There should be an X with a reference to footnote 1 in the miscellaneous column for Western Bank.

Page 191: The twenty-second page number in the table of contents should be *243* instead of *245*.

Page 332: The date in the heading to the table at the top of the page should be *1928* instead of *1998*.

Page 339, fourth line in second paragraph: *monopolizing* should read *mobilizing*.

Page 342, second line in fourth paragraph: *isg* should read *is*.

Page 374, Figure 2: The legend here belongs to Figure 3 on page 377.

Page 377, Figure 3: The legend here belongs to Figure 2 on page 374.

Page 637, fourth line in second paragraph: *townet* should read *tow-net*.

CONTENTS

DEPARTMENT OF COMMERCE

BUREAU OF FISHERIES

HEADQUARTERS STAFF, 1928-29

Commissioner

HENRY O'MALLEY

Deputy Commissioner.—LEWIS RADCLIFFE.
Assistants in Charge of Divisions:
- *Office.*—IRVING H. DUNLAP.
- *Fish Culture.*—GLEN C. LEACH.
- *Inquiry Respecting Food Fishes.*—ELMER HIGGINS.
- *Fishery Industries.*—OSCAR E. SETTE.
- *Alaska Service.*—WARD T. BOWER.

Architect and Engineer.—GEORGE A. SCHNEIDER.
Accountant.—CHARLES W. SCUDDER.
Editor.—ANNA B. BROWN.

REPORT OF THE COMMISSIONER OF FISHERIES[1]

CONTENTS

[1] Bureau of Fisheries Document No. 1051.

DEPARTMENT OF COMMERCE,
BUREAU OF FISHERIES,
Washington, July 1, 1929.

The honorable the SECRETARY OF COMMERCE.

DEAR MR. SECRETARY: I have the honor to submit the following summary of the work of the Bureau of Fisheries during the fiscal year ended June 30, 1929.

Fisheries, like agriculture, are divided into a large number of small operating units, largely lacking in capital to conduct fundamental technical research, which has been the basis for the huge profitable expansion in the industrial field. These conditions have retarded the development of the fisheries at home and abroad and made them a subject for national concern and aid. It is especially noteworthy that in this country our fisheries industries are now rapidly developing improvements in handling, manufacturing, and merchandising. It is believed that the bureau is entitled to an appreciable share of the credit for this condition because of the technical assistance it has given in solving the problems of the fisheries and through the training of skilled technologists, who have graduated into the fisheries industries for solving the problems of their employers.

These developments have improved the quality of the products offered the consumers and greatly increased the demand for aquatic products. The intensity of fishing effort has been increased to fill this growing demand and threatens the future supply in places. As a result there is growing concern for the future of our fisheries, resulting in greatly increasing the demands upon the bureau for accurate knowledge regarding the condition of each important fishery and the restrictions that may be necessary to insure a continuance of large-scale operations.

Fishery administration is involved. Many important species are of wide range and migratory habit. The fisheries are prosecuted in State, interstate, and international boundary waters and on the high seas. While each State makes its own laws governing the fisheries within its boundaries, the State authorities and those engaged in the fisheries generally look to the Bureau of Fisheries to make the investigations necessary to determine the condition and trend of each important fishery and to recommend the restrictions needful for maintenance of supply.

Because of land deficiencies of elements important to the health of man and his domestic animals and the losses of fertility through erosion and other factors, and because the seas through the ages have been absorbing these losses, it is desirable that man draw as fully as practicable on the resources of the seas of the earth. This policy not only involves the wise use of existing resources but the development of the science of aquiculture or water farming.

At the present time statistics collected by the bureau reveal that our annual harvest of fishery products approximates 3,000,000,000 pounds, for which our 127,000 fishermen receive $113,000,000. The pack of canned fishery products in 1928 exceeded 617,000,000 pounds, valued at nearly $96,000,000. Fishery by-products to the value of $14.880,000 were produced. The quantities of fish frozen exceeded 113,600,000 pounds—the largest on record. Over 65,000,000 pounds of packaged fresh and frozen fish, or three and one-half times the production of 1926, valued at nearly $10,000,000, were marketed. In 1928 our imports of fishery products were valued at nearly $59,000,000 and our exports at $21,000.000.

The output of fish and eggs from the bureau's stations during the fiscal year amounted to 7,060,000,000, slightly exceeding the record output of 1928. There is continued growth in the number of fish nurseries cooperating with the bureau, from 55 in 1927 to 86 in 1928 and to 114 in the current year, with the result that many waters are now being adequately stocked with fish.

The wisdom of the White law of 1924, broadening the powers of the Secretary of Commerce over the fisheries of Alaska, is evidenced by the improvements in the runs of salmon, the commercial catch of which in 1928 exceeded 517,000,000 pounds, and by the stabilization of the industry.

Under the bureau's program of husbandry the fur-seal herd has been built up to more than 900,000 animals, or more than five times the combined total of all other fur-seal herds in the world. With this growth it has been possible to increase the take of skins from surplus bulls to more than 30,000 per annum. The herd is increasing at the rate of over 5 per cent annually.

The importance of the bureau's international relations on fishery matters is increasing, and rapid strides are being made in the solution of these problems under the most amicable circumstances.

Tribute should be paid to the efficiency of the bureau's personnel, without which the achievements recorded in these pages would not have been possible.

INTERNATIONAL RELATIONS

NORTHERN PACIFIC HALIBUT CONVENTION

The International Fisheries Commission has continued to follow the condition of the halibut fishery through the collection of biological statistics, as is required of it by the terms of the present treaty. These statistics show a continued decline in abundance despite the closed season now in force. However, the work of the commission has been hampered by lack of power to collect complete statistics. This power it requested in its first report.

Vessel operations for the study of the early biological stages were carried on from October 26 to December 10, for the study of the eggs and larvæ from January 10 to April 12, and for the extension of the study of commercial sizes on banks farther west from April 12 to May 18. Halibut were tagged and material was collected for the study of growth, spawning, and migrations off the Shumagin Islands. For the remainder of the time the scientific staff was engaged upon the preparation for publication of scientific reports embodying the results of the statistical work, the tagging operations, and various other phases of the life-history investigations. Several of these reports are ready and should be issued during the coming year.

The continued observation of the fishery has emphasized the necessity for action upon the recommendations of the commission as submitted in its first report. New and more adequate regulations must be adopted to halt the continued decline; and more reasonable powers for the collection of statistical information must be granted the commission if the observation of the fishery is to be continued as carefully as the terms of the present treaty require.

TREATY REGARDING SOCKEYE-SALMON FISHERIES

On March 27, 1929, at Washington, the Secretary of State and the Canadian Minister signed a treaty for the preservation and extension of the sockeye-salmon fisheries of the Fraser River System, which includes the waters contiguous to the State of Washington and the Province of British Columbia.

The treaty includes provision for the establishment of an international fisheries commission of six members, one of the three United States commissioners to be the Commissioner of Fisheries of the United States. The commission is charged with the duty of making a thorough investigation into the natural history of the sockeye salmon and is given the power to maintain hatcheries and develop the fisheries. The commission is also given the power to establish a closed season, when fishing for sockeye salmon will be prohibited, between the 1st day of June and the 20th day of August in each year, and to regulate the character and size of fishing gear that may be used during the open fishing season. The convention is concluded for a period of 16 years, after which it is subject to termination on notice of one year given by the Government of either the United States or Canada.

Formerly the most productive sockeye-salmon fishery engaged in by Americans and Canadians, in recent years the pack has shrunk to such a low figure as to be a cause for real alarm. It is the hope of those interested in the restoration of this fishery to its former greatness that the treaty will be ratified and adequate measures taken to provide for an escapement of fish sufficient to seed the beds properly.

INTERNATIONAL PACIFIC SALMON FEDERATION

This federation was established in the spring of 1925 as an informal organization of the leading fishery executives of the United States, Canada, the Pacific States, British Columbia, and Alaska for the purpose of conducting and systematizing the work of salmon research according to a comprehensive unified program. A meeting was held at Vancouver, British Columbia, April 5, 1929, at which the entire field of salmon research was discussed. With all of the Pacific coast biologists engaged in salmon studies working under a unified program with definite objectives, results are being achieved much more rapidly than would be possible otherwise.

GREAT LAKES FISHERIES SITUATION

On December 5, 1928, the third meeting of the International Fisheries Conservation Council of the Great Lakes was held at Lansing, Mich. With some slight modifications, recommendations made at previous meetings relative to legal sizes of fish and size of mesh of gill nets were reaffirmed. Resolutions were adopted urging (1) the saving of the original statistical records now being collected to insure their accessibility for further study; (2) the adoption of the principle that in all fisheries legislation each species of fish be afforded such protection as will make certain that only fish that have spawned at least once shall be included in the commercial catch; and (3) that in the adoption of closed seasons these shall be seasons closed to commercial fishing, and that the several States, the Province of Ontario, and the United States Bureau of Fisheries shall undertake the collection of spawn for the hatcheries, limiting fishing strictly to the needs of the Federal, Provincial, and State hatcheries.

During the past two years the bureau has taken an active part in (1) the unification and coordination of the scientific work on Lake Erie; (2) the inauguration of a new system of fishery statistics suitable to the need of the biologist; (3) the codification and revision of the commercial fishing laws of Michigan, Indiana, and Ohio, and in cooperating more closely with State authorities and fishermen's organizations to secure specific and uniform laws for each lake; and (4) the inauguration of a series of studies (*a*) on the effect of gear on the fish population, (*b*) fish populations instead of individual species, (*c*) fluctuations in the fisheries, and (*d*) life histories of nine important market species.

To the credit of several of the States, Michigan in particular, it should be said that the fisheries have been the subject of much closer study and important legislative action than for many years before. Until all of the governments bordering each of the lakes work in closer harmony in enacting needful legislation, the seriousness of the situation can not be considered as having been relieved.

NORTH AMERICAN COMMITTEE ON FISHERY INVESTIGATIONS

The fifteenth meeting of this committee was held at the University of Toronto, Toronto, Canada, on October 22, 1928. The committee viewed with particular concern the increasing intensity of the fishing for haddock and urged the respective Governments to make at once every effort to investigate the situation thoroughly. As nearly as can be ascertained, the catch of haddock by United States and Canadian fishermen has increased from 100,000,000 pounds in 1921 to 280,000,000 pounds in 1928. Because of the possible interrelationship of the stock of haddock on the grounds off the coast of Canada with that off our own coast, the problem has international aspects, which may necessitate international accord and action. The meetings of the committee have resulted in a coordination of fisheries investigations of the several governments, a standardization of method, and the initiation of scientific research bearing directly on the economic problems of the fisheries.

PROTECTION OF GUADALUPE FUR SEALS

Recently attention has been directed toward the preservation of the Guadalupe fur seal (*Arctocephalus townsendi*). Formerly abundant on certain islands off the coast of California and Lower California, they were subsequently practically exterminated. Recently rediscovered, the matter has been brought to the attention of the Mexican Government, which is in complete accord with the idea of preserving these seals, with the result that the outlook is promising that the remnant of the herd may become the nucleus for the restoration of these animals to greater abundance.

STATISTICAL SURVEYS

According to the most recent statistics available, the commercial fisheries of the United States are in a sounder position than at any time in their history. They now employ nearly 127,000 fishermen, and the annual catch amounts to nearly 3,000,000,000 pounds, valued at about $113,000,000. For transporting these products from the fishing grounds to market or from port to port over 4,000 persons are engaged aboard transporting vessels.

The statistical work of the bureau in 1928, as in former years, included the furnishing of statistics on the catch of fishery products, the gear employed in making the catch, and statistics of related fishery industries.

That fishery statistics, both biological and trade, are becoming more generally appreciated by those interested in our fisheries is evidenced by the generous cooperation given the bureau by fishermen, fish wholesalers, those in related fishery industries, State fisheries agencies, and others. The bureau appreciates this cooperation and wishes to take this opportunity to thank such persons for their support during the past year in an effort to give the fishing industry a statistical record upon which to base its activities. In this connection the bureau urges those in the industry to offer criticisms and suggestions for the betterment of statistics now being collected.

During 1928 unusual progress was made in the collection of statistics of the catch of fishery products in the United States. This was occasioned by greater cooperation with State fishery agencies and by the use of automobiles by agents, which enabled them to canvass a larger territory than formerly when travel was performed mainly by train. As a result, catch statistics for 1927 were obtained of the fisheries in the South Atlantic, Gulf, Pacific Coast, and Great Lakes States and for the State of Connecticut.

CANNED FISHERY-PRODUCTS AND BY-PRODUCTS TRADE

Four hundred and eighty-one establishments were engaged in canning fishery products in 1928, the total production being 15,629,980 standard cases, or 617,327,527 pounds, net weight, valued at $95,871,855, to which may be added the value of by-products, $14,880,956, making a total of $110,752,811. This was an increase of 18 per cent in the value of canned products and 16 per cent in the value of by-products when compared with the respective values of the previous year. Alaska contributed 43 per cent, California 22 per cent, and Maine 9 per cent of the total value.

FROZEN-FISH TRADE

In 1928 there were 155 public freezers and cold-storage warehouses in the United States and Alaska devoted wholly or in part to the storage of frozen and cured fishery products. The average monthly holdings during the past few years have increased, amounting to 53,925,000 pounds in 1928, or 10 per cent more than in 1927 and 22 per cent more than the 5-year average. The quantity of fish frozen, amounting to 113,637,898 pounds, is greater than the amount in any other year for which there are records.

PACKAGED FRESH AND FROZEN FISH TRADE

Packaged fresh and frozen fish were produced in 85 plants operated in 12 States in 1928. The output amounted to 65,245,376 pounds, valued at $9,790,024. Haddock accounted for 87 per cent of the total quantity prepared. Other species packaged to a considerable extent were cod, squeteague, hake, and croaker. Massachusetts accounted for 65 per cent of the production, and Connecticut and New York also packed important quantities. Of the total production, fillets accounted for 89 per cent; the rest consisted of dressed fish, pan-dressed fish, sticks, steaks, and tenderloins.

GOLDFISH INDUSTRY

The American output of goldfish, produced in some 770 acres of ponds, mainly in Maryland, Ohio, and Indiana, in 1928 amounted to 21,500,000 fish, having a value to the breeders of about $942,000. Of this number, 17,000,000 were common goldfish, valued at $573,000, and 4,500,000 were fancy goldfish, valued at $369,000.

FOREIGN FISHERY TRADE

The value of the United States' foreign trade in fishery products during 1928 amounted to $80,028,683, of which $58,854,938 represents the value of those imported for consumption and $21,173,745 the value of exports of domestic fishery products. Compared with the previous year, this is an increase of 8 per cent in the value of the total trade, 6 per cent in imports, and 13 per cent in exports.

Imports consisted of 360,767,010 pounds of edible products (including fresh, frozen, cured, and canned fishery products), valued at $37,391,079, and nonedible products (comprising mainly fish and marine-animal oils, pearls, and imitation pearls), valued at $21,463,859.

Exports consisted of 170,817,414 pounds of edible products, valued at $20,786,353, and nonedible products valued at $387,392.

69501—29——2

NEW ENGLAND STATES

As the latest general canvass of the catch of fishery products for Maine, New Hampshire, Massachusetts, Rhode Island, and Connecticut was made for 1924, no later data on general conditions in this section are available. However, the trend is revealed by statistics collected for 1928 on various phases of the fisheries in this section.

Vessel fisheries.—In 1928 landings of fish by American vessels at Boston and Gloucester, Mass., and Portland, Me., amounted to 277,981,691 pounds, as landed, valued at $10,849,145, and were larger than in any year for which there are records; the value also was greater, due largely to the demand by the filleting trade. Of this amount, over 155,000,000 pounds were haddock. While Boston, Gloucester, and Portland continue to receive most of the fish brought in by these vessels, larger quantities are being landed at other New England ports, especially at Vinal Haven, Me., and Groton, Conn.

Mackerel fishery.—In 1928 the mackerel fishery resembled that of the previous year, with heavy southern and Block Island runs in the spring, followed by a slack season in the Gulf of Maine during the summer and autumn. An unusual run of large mackerel appeared off Cape Ann and lasted well into December. Altogether, the season's catch, amounting to nearly 31,000,000 pounds, was about 25 per cent below that of the previous year.

Packaged-fish trade.—The packaged-fish trade in New England, centering at Boston and Groton, Conn., is now on a sounder basis, and methods used at the packing plants are being modernized. The output of packaged fresh and frozen fish in New England increased perceptibly over 1927, the production in 1928 being valued at over $9,000,000. To supply the demand for raw fish by the packers, more vessels fishing with otter trawls were added to the fleet, so that now 288 vessels of over 5 net tons are outfitted with this gear and operate from the three principal ports.

Canned sardines.—Sardine canning, conducted only in Maine in the New England section, recovered from the slump of 1927 with a production valued at over $8,000,000.

MIDDLE ATLANTIC STATES

According to the latest statistics (1926) of the fisheries of New York, Pennsylvania, New Jersey, and Delaware, the situation is not encouraging. The production of many of the staple fish showed a tremendous decline in 1926 as compared with 1921. Notable examples are the bluefish, which declined 72 per cent; scup, 37 per cent; and squeteague or weakfish, 36 per cent.

At New York City and Groton, Conn., the landings of fresh fish by vessels of over 5 net tons amounted to about 71,000,000 pounds in 1928, which is considerably better than in 1927. As with Boston, the landings consisted largely of haddock, which are in demand by packing plants in those two cities. The menhaden industry of this section recovered very slightly in 1928.

Shad fishery.—On the Hudson River the shad fishery was carried on by 293 fishermen and yielded 79,029 fish, which weighed 246,231 pounds, valued at $43,149 to the fishermen. This represents a decrease of 31 per cent in weight, as compared with the weight of the catch in 1927, but was nearly equal to the catch in 1926.

CHESAPEAKE BAY STATES

The last general canvass of the catch of fishery products for this region (Maryland and Virginia) was made for 1925. However, later statistics of the canning and by-products industries and certain other industries are available. The menhaden industry again suffered a poor year in 1928, the total value of the products manufactured being one of the lowest on record. The existence of this situation should encourage those in this industry to improve methods in an effort to reduce overhead and to produce a quality product. The diversion of a greater amount of menhaden meal to feedstuffs should result in a better price for this product. To produce such a product would require but little additional expenditure in improving manufacturing methods.

In 1928 greater activity was evidenced in the alewife-canning industry, the value of the products being the highest on record. The oyster industry has regained its previous level, although retail sales have not kept pace in some localities of the country. The crab industry recovered entirely from its previous poor years, and, according to reports of persons in the trade, the production was one of the largest on record. This section is rapidly becoming a factor in the production of packaged fish, especially croaker and sea trout.

Shad fishery.—In 1928 the shad and alewife fishery on the Potomac River was prosecuted by 754 fishermen. It yielded 716,420 shad that weighed 2,077,622 pounds, valued at $214,687 to the fishermen, and 14,783,655 alewives with a weight of 5,903,062 pounds, valued at $58,297 to the fishermen. The catch of shad was larger than in any one of the past 29 years, except 1922. The catch of alewives was larger than in any year since 1909, except 1924.

SOUTH ATLANTIC STATES

In 1927 the fisheries of North Carolina, South Carolina, Georgia, and the east coast of Florida employed 11,527 fishermen, or 14 per cent more than in 1923. The catch amounted to 260,668,693 pounds, valued at $5,695,887, which is an increase of 14 per cent in quantity and 12 per cent in value when compared with 1923.

The fisheries of this region are conducted largely alongshore with small operating units. For this reason the trade is confined chiefly to marketing primary products, except for canned shrimp and oysters. The production of canned shrimp in 1928 showed little change over the previous year, while there was a considerable increase in the production of oysters. The output of menhaden products increased substantially.

GULF STATES

The fisheries of the west coast of Florida, Alabama, Mississippi, Louisiana, and Texas were more productive in 1927 than in any year for which there are records since 1880. They employed 15,133 fishermen, or 43 per cent more than in 1923, and the catch amounted to 195,705,355 pounds, valued at $9,965,775, which is an increase of 22 per cent in quantity and 23 per cent in value when compared with 1923. This was due chiefly to larger catches of shrimp and oysters.

The production of canned shrimp was greater than in the previous year, although the market value did not increase accordingly. The production of canned oysters was about the same as in 1927.

Florida sponge fishery.—In 1928 the quantity of sponges sold on the sponge exchange at Tarpon Springs, Fla., amounted to 413,198 pounds, valued at $729,918. Of this amount, 232,208 pounds, valued at $623,776, were large wool; 33,744 pounds, valued at $50,616, small wool; 61,358 pounds, valued at $28,633, yellow; 74,698 pounds, valued at $20,925, grass; and 11,190 pounds, valued at $5,968, wire.

PACIFIC COAST STATES

In 1927 the fisheries of Washington, Oregon, and California produced 651,196,982 pounds of products valued at $22,306,576, which is an increase of 25 per cent in quantity and 18 per cent in value over 1926, and is the largest catch on record. This was due mainly to larger catches of pilchards, tuna, and tunalike fishes. There were 20,514 fishermen engaged in making this catch.

In 1928 the pack of salmon was 44 per cent less than in the previous year. This was due to smaller packs of pink and humpback salmon on Puget Sound, 1928 being an off year. Compared with the previous off year, 1926, there was an increase of about 1 per cent.

The pack of sardines was the largest on record both in volume and value. The production of canned tuna was less than in 1927, but the value was greater, being slightly below the highest value on record.

Unusual developments occurred in the mackerel-canning industry of California in 1928, the production being valued at about $1,600,000. In 1927 the production was so small that it was included in the statistics with other canned fish. Now mackerel is finding favor in the export trade with the Philippines.

Halibut fishery.—The halibut fishery of the Pacific coast, which is prosecuted by American and Canadian vessels, ranks as one of the foremost fisheries of that section. In 1928 the total weight of the catch, as landed, by vessels of both nationalities amounted to 54,915,000 pounds, valued at $5,673,000. This is virtually the same as in 1927, and a little more than for 1925 and 1926, in spite of the depleted condition of the fishery. Of the total landings, 79 per cent was taken by American craft and 21 per cent by Canadian craft.

LAKE STATES

In 1927 the lake fisheries (Lakes Ontario, Erie, Huron, Michigan, Superior, and Namakan, Lake of the Woods, and Rainy Lake) of the United States and Canada produced 111,952,531 pounds of fish. Of the total the United States accounted for 81,326,550 pounds, valued at $6,794,891. This is about the same as in the previous year, although there was a slight decline from the 10-year average. The average is being held up by greater catches of some of the less-favored species, while decreases are apparent in some of the choice species, such as the cisco of Lake Erie, which shows a decline of 81 per cent compared with the 10-year average. Larger catches were made on every lake in 1927 than in 1926 except Lake Ontario, Lake Erie, and the international lakes of Minnesota. The Canadian catch amounted to 30,625,981 pounds, an increase of 11 per cent over the previous year.

MISSISSIPPI RIVER AND TRIBUTARIES

No general statistical canvass has been made for this section since 1922, therefore recent developments can not be determined. A special canvass of the fisheries of Lakes Pepin and Keokuk for 1928 reveals a smaller catch than for 1927.

TECHNOLOGICAL INVESTIGATIONS

During the past year the bureau operated the Reedville laboratory the entire year for the study of problems of the menhaden industry; a temporary summer laboratory at Erie, Pa., for the study of net preservation; another at Brunswick, Ga., to study the utilization of shrimp waste; and continued the investigation on the handling of fresh fish at Boston, Mass., throughout the year. The Washington laboratory was used mainly for the conduct of chemical and technological research. In addition, one of the bureau's technologists studied the South Atlantic and Gulf States fisheries in an effort to acquaint those in the fisheries with better handling methods. The bureau received the active cooperation of Johns Hopkins University and the University of Wisconsin in research on two important fisheries problems.

NET PRESERVATION

Work upon the perfection of a treatment for use upon cotton nets in salt water was continued, an attempt being made to ascertain the most economical treatment. It is estimated that by following the procedure outlined by the bureau the cost of preserving trap gear may be cut to about one-third the cost of the best commercial treatments employed.

The investigators at the Erie (Pa.) laboratory discovered that the deterioration of gill nets was due to bacteria alone. These are cellulose-digesting organisms, which attack the cotton fiber. In combating these destructive organisms the bureau's trap-net treatment proved effective. Formerly there was prejudice to this treatment as it darkened the nets and was believed to decrease their fishing efficiency. However, practical tests in Lake Erie raised doubts as to the soundness of this conclusion except as to the incidental catch of whitefish.

BY-PRODUCTS

Menhaden.—In the study of by-products problems special attention has been accorded the menhaden industry, not only because of the urgent need for improvement in this industry, but also because of its similarity to the herring and sardine industries in the reduction of accumulated waste. To date two main sources of loss are apparent, namely, losses of protein and oil in the waste liquors and nitrogen loss through oxidation in the flame driers now in use. Two small-scale commercial driers were tested. One showed promise, so that a slightly altered type will be tested next year; the other showed excellent results and will be run again next season, as the supply of fish last year was not regular enough to allow the technologists to gather sufficient data upon cost and efficiency.

It is equally as important to save oil and to improve its quality as to improve meal, for both represent nearly equal portions of the profits of the menhaden industry. The presence of free fatty acid detracts from the usefulness of oil, and if present in too great quantity actually changes the channel of trade into which the oil may enter. Preliminary experiments have shown conclusively that water increases the free fatty acid content of oil in storage tanks, and that sun and rain do not improve the quality of fish oils.

Ground fish and waste fish.—As a result of the increasing demand for packaged fish large quantities of waste accumulate at central points. In addition, large quantities of trash fish are taken in the nets of otter trawls fishing for ground fish. Further, small amounts of fish waste accumulate in isolated localities or city fish markets. All of these factors make profitable utilization more feasible than in former times. The majority of this waste comes from nonoily fish having a high glue content, which renders reduction extremely difficult. Experiments looking toward the solution of this problem are now under way, special consideration being given to the development of plants suitable for installation on board fishing vessels. Larger fishing vessels now being built have space for such equipment.

Shrimp.—Through research upon the utilization of shrimp waste it has been found that fertilizer material or shrimp meal (a material particularly valuable for its mineral constituents) can be prepared by four relatively inexpensive and simple methods applicable to those localities in which the industry is small and the season short. The fertilizer stock is excellent for treating soils, and the meal promises the same favorable results that have been secured from using steam-dried shrimp meal in animal nutrition. Through the adoption of such processes it is expected that a good deal of the material now discarded will be utilized.

NUTRITIVE VALUE OF FISHERY PRODUCTS

Fishery products are by nature rich in many important food factors, as the sea lacks the deficiencies common to many land areas. Therefore these products are a most valuable adjunct to the citizens' dietary and to the farmers' list of feeds. In general, these products are particularly valuable for their mineral constituents, vitamin potency, and availability of protein. The researches of the bureau's investigators at Johns Hopkins University have added materially to this knowledge. To further increase this knowledge, the bureau has arranged cooperative feeding tests with the United States Department of Agriculture, State experiment stations, various private agencies, and independent investigators.

IMPROVED HANDLING OF FRESH FISH

The bureau's technologist on the Boston Fish Pier has done much to promote the adoption of improved practices and methods of handling fish on the pier and aboard vessels, and also is aiding the industry to draw up plans for unloading vessels more expeditiously.

The technologist working in the Southern States has been demonstrating improved methods of handling and distributing fishery products, including methods of precooling the product. During one phase of this study a chilling tank was installed at the fish freezer of a cooperating dealer in South Carolina to demonstrate possibilities along this line. Cooperation along similar lines was extended to dealers in other Southern States, particularly in Louisiana and Texas. This work has been conducted in cooperation with the fisheries association of that territory.

ALASKA FISHERIES SERVICE

ADMINISTRATION OF FISHERY LAWS AND REGULATIONS

Since the passage of the act of June 6, 1924, giving the Secretary of Commerce broad powers in regard to the time, place, and manner of conducting commercial fishing in Alaska, distinct progress has been made in restoring runs of salmon depleted in earlier years by overfishing, and in consequence there has been a healthful stabilization of the fisheries, Alaska's most important industry. The beneficial and progressive results thus achieved clearly reflect the wisdom of the constructive policy that, since the passage of the new law in 1924, has been pursued in conserving this great natural resource. The constant purpose and aim is to so conserve the fisheries that there may be a maximum use without impairment of the future supply.

The salmon fishery of Alaska extends for more than 2,000 miles along the coast, from the southerly extremity to north of the Arctic Circle. In this great region the distinct differences in geographic and other features naturally result in considerable variation in the time and extent of the runs of salmon from the sea for reproductive purposes. This, in turn, means a corresponding variation in the character and extent of fishing operations in the different regions.

The regulations issued each year are framed carefully to meet the varying conservation requirements in the 12 fishing areas created by the Secretary of Commerce, but it occasionally happens during the progress of the season that modification of the regulations becomes advisable to meet conditions arising in a particular section. The Commissioner of Fisheries was in Alaska several weeks during the active salmon-fishing season and was able to initiate immediately any such necessary changes in the regulations.

A patrol for the enforcement of the fishery laws and regulations was carried on actively throughout the season. Eleven statutory and two hundred and one temporary employees were engaged in the work, in addition to the crews of the 14 vessels of the bureau and 8 chartered boats. A number of launches were also used in the patrol. Violations of the fishery laws and regulations occurred chiefly in southeastern Alaska and were primarily failures to comply with restrictions as to closed periods and closed areas. These cases were disposed of through the courts in the usual manner.

In the general revision of the regulations issued under date of December 18, 1928, to be effective in the following season, some further restrictions were imposed in certain areas where the intensity of fishing had been too great, and various other changes were made for the purpose of preventing any marked expansion of operations. An important feature of the revised regulations was the redistricting of the southeastern Alaska area into eight divisions, instead of six as formerly. Various modifications of the regulations made by supplementary orders in the spring of 1929 included the extension northward of the boundary of the Yukon-Kuskokwim area and restrictions on commercial fishing for herring therein.

On February 28, 1929, an act was approved amending section 7 of the Alaska fisheries act of June 26, 1906, in regard to the utilization of salmon after removal from the water. Formerly it was provided that salmon must not be canned or salted for sale for food more than 48 hours after being killed, but this has now been extended to include icing, freezing, smoking, and drying for human consumption.

ALASKA SALMON HATCHERIES

At the Government hatcheries at Afognak and on McDonald Lake 44,478,925 red-salmon eggs were collected in 1928, as well as 4,429,000 pink-salmon eggs. Shipments of 2,493,000 red-salmon eggs and 3,888,550 pink-salmon eggs in the eyed stage were forwarded to Seattle in October. At the privately owned hatchery operated under the provisions of the Alaska fisheries act of June 26, 1906, 20,310,000 red-salmon eggs were collected.

SPECIAL STUDIES AND INVESTIGATIONS

Fourteen weirs for counting salmon ascending streams to spawn were maintained in 1928, as follows: Anan Creek, Olive Cove, Eagle Creek, and Situk River in southeastern Alaska; Karluk River, Chignik River, two streams tributary to Olga Bay, Uganik River, Morzhovoi Bay, Thin Point Lagoon, Chinik Creek, and English Bay in central Alaska; and Ugashik River in western Alaska. The collection of accurate data on the spawning population in a salmon stream over a period of years is an important factor in the study of the salmon to determine the size of the future run that may be expected from a known escapement. A general survey of the escapement of salmon also was made in all districts.

Extensive collections of salmon scales were made in several localities for life-history study of the salmon, and a tagging experiment was conducted on the Alaska Peninsula to develop further information concerning migration routes, 463 red salmon being tagged and released from a trap at Nicholaski Spit. Studies of the herring and clam fisheries were continued.

PRODUCTS OF THE FISHERIES

The output of Alaska fishery products in 1928 showed a decided increase, the total value representing a gain of 35.8 per cent over the preceding year and ranking third in the history of the industry, being exceeded only by the value of products in 1918 and 1926.

More canneries were operated than in any previous year, and the production of canned salmon increased from 3,572,128 cases in 1927 to 6,083,903 cases in 1928, or approximately 70 per cent. The pack of cohos increased about 18 per cent, chums 96 per cent, pinks 96 per cent, and reds 48 per cent, while kings decreased about 23 per cent. As compared with the average for the five years from 1923 to 1927, inclusive, there was an increase in the pack of every species, the gains aggregating nearly 22 per cent for the entire pack. This greater output was attributable in large measure to the extraordinarily heavy run of red salmon in the western district and to the greatly improved condition of the pink-salmon run in southeastern Alaska.

The total value of the fishery products of Alaska in 1928 was $54,545,588, as against $40,163,300 in 1927. In addition to canned-salmon products valued at $45,383,885, salmon were mild-cured, pickled, fresh, frozen, and otherwise utilized, in the value of $2,103,878. Other important fishery products were valued as follows: Herring, $3,098,457; halibut, $3,094,000; whaling, $454,274; shrimp, $202,165; clams, $107,046; crabs, $51,477; cod, $28,979; and miscellaneous products, $21,427. The value of the catch to the fishermen was approximately $17,343,000, or $3,531,000 greater than in the preceding year. There were 31,086 persons employed in the various branches of the industry, as compared with 28,872 in 1927.

The extent and condition of the Alaska fisheries in 1928 and of the activities of the bureau under the laws and regulations for the protection of the fisheries are covered in detail in the annual report of the Alaska service for that year.

ALASKA FUR-SEAL SERVICE

GENERAL ACTIVITIES

Computations made in 1928 indicate that the numerical strength of the Pribilof Islands fur-seal herd was seven times as great as in 1911, when the North Pacific Sealing Convention for the protection and preservation of the fur seals was ratified. The increase in the size of the herd has been reflected in larger takes of sealskins in successive years.

Sealing activities at the islands in the season of 1928 included the marking and reserving of an adequate number of 3-year-old male seals for future breeding stock, the taking and curing of sealskins, and the operation of the by-products plant on St. Paul Island for a brief period to supply food for foxes. Incidental to sealing operations, attention was given to the management of the fox herds and to the taking of fox skins.

In 1928 several new buildings, principally houses for natives, were erected on St. Paul and St. George Islands, and a medical building on the latter island was partly completed. Satisfactory progress was made in the extension of improved roads on both islands.

A staff of employees at the Pribilofs directs the work performed by resident natives and by temporary native workmen from the Aleutian Islands and the mainland, who assist with the work in the summer. The temporary labor is employed at a specified wage, but the Pribilof natives are compensated by food, fuel, shelter, and educational and medical facilities furnished the entire native population, which at the close of the year 1928 numbered 368 persons. Additional compensation is paid Pribilof natives in cash at the rate of 75 cents for each sealskin and $5 for each fox skin taken, and certain other small cash payments are made for special services.

The annual supplies for the Pribilof Islands were transported from Seattle, Wash., on the U. S. S. *Vega*, through the cooperation of the Navy Department. On its return to Seattle, the vessel carried the annual shipment of sealskins and fox skins, as well as a number of passengers. Assistance also was rendered by the United States Coast Guard in patrolling waters frequented by the fur-seal herd.

SEAL HERD

Computations showed a total of 871,513 fur seals in the Pribilof Islands herd on August 10, 1928, an increase of 62,643 animals, or 7.74 per cent, over the corresponding figure for 1927.

TAKE OF SEALSKINS

In the calendar year 1928 there were taken on the Pribilof Islands 31,099 fur-seal skins, of which 23,003 were from St. Paul Island and 8,096 from St. George Island. This was an increase of 6,157 over the number taken in 1927.

MARKING RESERVED SEALS

In 1928 there were marked 8,852 3-year-old male seals to be reserved for future breeding stock, of which 6,900 were on St. Paul Island and 1,952 on St. George Island. The marking was done by shearing a patch of fur, and in addition on St. Paul Island 200 of the animals so marked were also iron branded for special observation in future years. In addition to the seals marked, there remained also the 3-year-old males that were not taken up in driving operations.

SALE OF SEALSKINS

In the fiscal year 1929 two public-auction sales of fur-seal skins taken on the Pribilof Islands were held at St. Louis, Mo. The first was on October 15, 1928, when 7,174 black dyed, 5,623 logwood-brown dyed, 647 golden-chestnut dyed, and 16 miscellaneous (dressed and raw salted) skins, a total of 13,460, were sold at a gross price of $414,103.10. At the same time 161 Japanese fur-seal skins were sold for $1,686.70, of which 123 were dyed black, 21 dyed logwood brown, 1 washed and dried, and 16 raw salted. These 161 skins were the United States Government's share of sealskins taken by the Japanese Government in 1927 on Robben Island. There were sold also 1 confiscated skin dyed logwood brown and 4 confiscated skins washed and dried for $35.80.

At the second sale, held on April 8, 1929, 5,334 black dyed, 9,884 logwood-brown dyed, 1 golden-chestnut dyed, and 5 miscellaneous skins, a total of 15,224, were sold at a gross price of $469,442.50.

Special sales of sealskins, authorized by the Acting Secretary of Commerce, in the fiscal year 1929 consisted of 245 logwood-brown dyed skins at a gross price of $12,834.87. All were taken at the Pribilof Islands.

FOXES

The feeding and trapping of foxes on the Pribilof Islands afford employment and special compensation to the natives in the winter, when sealing activities are at a minimum, and the sale of the fox skins brings considerable revenue to the Government.

There were sold at public auction on October 15, 1928, at St. Louis, Mo., 278 blue and 15 white fox skins taken on the Pribilof Islands in the season of 1927–28. The gross price realized was $21,290.

Foxing operations in the winter of 1928–29 resulted in a take of 79 blue and 8 white fox pelts on St. Paul Island and 465 blue pelts and 1 white pelt on St. George Island, a total of 553. During the season 24 foxes on St. Paul Island and 281 on St. George were trapped, marked, and released for breeding purposes. The actual breeding reserve naturally was much greater, as many of the foxes are not caught in the traps.

FUR-SEAL SKINS TAKEN BY NATIVES

By the provisions of the North Pacific Sealing Convention of July 7, 1911, natives of the Pacific coast may, under certain restricted conditions, take fur seals at sea. The resulting skins must be authenticated as having been taken lawfully before they can enter into commerce. One thousand four hundred and eighty-one sealskins taken in 1928 have been authenticated by the Government, 773 of which were taken in the offshore waters of southeastern Alaska and 708 in waters off the coast of Washington. Through the courtesy of the Interior Department the latter skins were authenticated by the superintendent of the Neah Bay Indian Agency. An official report states that 2,421 fur-seal skins were taken by natives of British Columbia in 1928.

FUR-SEAL PATROL

A patrol of the waters frequented by the Pribilof Islands fur-seal herd was again maintained by vessels of the United States Coast Guard. Three vessels of the Bureau of Fisheries also assisted in the work—the *Widgeon* and *Auklet* in southeastern Alaska and the *Brant* off the coast of Washington.

PROTECTION OF SEA OTTERS, WALRUSES, AND SEA LIONS

Regulations previously issued for the protection of sea otters, walruses, and sea lions were not changed during the year. The killing of sea otters is prohibited at all times. There is a closed season at all times on walruses and sea lions, although certain limited killing is permitted under specified conditions.

PROPAGATION AND DISTRIBUTION OF FOOD AND GAME FISHES

While the output in various fields and at various stations fluctuated, the aggregate output was substantially the same as that of the previous year, the total of 7,060,369,500 eggs, fry, and fingerlings representing an increase of 24,052,300 over 1928. Decreases occurring in the production of certain species were balanced by material increases in the numbers of other forms. One of the most serious shortages occurred in connection with the rescue work on the upper Mississippi River, where water conditions were such that virtually no applications could be filled from this source. Offsetting the decline, however, was the increased shad output of the Potomac River, which had been exceeded in only three years since 1900. Increases were registered in the aggregate production of the Atlantic coast marine species—cod, haddock, pollock, and winter flounder—as well as the usual quadrennial gain for the commercially important sockeye salmon. A decline was noted in the production of whitefish, lake trout, and pike perch. There follows a summary of the output classified according to the natural grouping of the propagation activities.

SUMMARY OF OUTPUT

Warm-water species:	
Basses	3, 243, 900
Sunfish	2, 154, 000
Crappie	1, 898, 900
Yellow perch	193, 111, 500
Other	121, 050
Cold-water species:	
Trouts—	
Brook	16, 855, 200
Rainbow	12, 728, 200
Loch Leven	9, 214, 700
Black-spotted	19, 084, 000
Grayling	1, 765, 000
Landlocked salmon	668, 700
Anadromous species:	
Shad	71, 351, 000
Glut herring	11, 500, 000
Salmon—	
Atlantic	917, 200
Pacific	152, 529, 100
Striped bass	9, 661, 000
Commercial species (Great Lakes and interior waters):	
Whitefish	97, 295, 000
Cisco	132, 200, 000
Lake trout	30, 335, 000
Pike perch	80, 750, 400
Carp	26, 831, 000
Marine species:	
Cod	2, 502, 155, 000
Haddock	351, 442, 000
Winter flounder	2, 918, 583, 000
Pollock	358, 442, 000
Mackerel	2, 778, 000
Miscellaneous fishes	52, 754, 650
Total	7, 060, 369, 500

New substations were placed on an operating basis at Fort Worth, Tex., and Crawford, Nebr., although the latter had not been finally completed by the close of the year. The transfer of the Potomac

River shad station from Bryans Point, Md., to Fort Humphreys, Va., was under way at the opening of the fiscal year and was completed in time to permit the gratifying hatch mentioned above. The change gives the bureau a model plant for this work. Construction work at the large new pond station at Valdosta, Ga., continued throughout the year, but was retarded by difficulties encountered in sinking wells to provide subterranean drainage. Prospects indicate that this obstacle will be overcome within a short time. Title to the sites for new pond-cultural substations at Reagan, Okla., and Creede, Colo., has been cleared and construction is scheduled to begin immediately.

Car distribution was somewhat hampered by the retirement of car No. 4 from service, but a contract has been awarded for and construction begun on a modern steel car to replace it. A large hatchery building of rustic log design has been under construction in Yellowstone Park, and rearing pools have been completed at Mammoth Hot Springs within the park. Arrangements have been made with the National Park Service whereby the bureau will furnish an investigator to study fishing conditions in the parks and direct fish-cultural operations. Attention will be given to other Federal areas, such as the national forests, and an employee will be in charge of the bureau's stations in the intermountain area.

COOPERATIVE ACTIVITIES

The bureau's relations with outside agencies, such as the States and sportsmen's organizations, have been extended. The fish-nursery system, whereby sportsmen furnish pools and ponds and rear to fingerling or adult size fish received from Federal hatcheries, has expanded, so that 114 units were in operation, which received 4,070,268 fish of various species as well as over 900,000 eggs. These enterprises have developed to an extent that has placed a severe strain upon the bureau's ability to supply fish, but it is believed that the results attained from the planting of larger fish justify extraordinary efforts. The State of Virginia inaugurated a series of such units, which were stocked with several hundred thousand trout from the bureau's Wytheville (Va.) station. Plans have been laid to fill the bureau's applications for local waters from the output of these nurseries.

There have been many other instances of mutually helpful cooperation with the States. The bureau has detailed an employee to undertake the propagation of shad in Florida and to resume the propagation of spiny lobsters, which was started last season. The usual cooperative arrangement with Pennsylvania and Vermont for the operation of the pike-perch station on Lake Champlain was continued, although extreme weather conditions seriously reduced the output of fry. The bureau has continued to assist the State of West Virginia by incubating a million trout eggs at the White Sulphur Springs (W. Va.) station for distribution within the State. The practice of assigning trout eggs to such States as desire them has been continued as far as the available supply would permit. An employee was detailed throughout the greater part of the year to supervise the construction of a hatchery for the State of Arkansas.

One of the large fishing companies requested that an experiment be made regarding the possibility of planting fertilized cod and haddock eggs taken by steam trawlers operating on the offshore banks, such as Georges. Two men were detailed on this work for about six weeks during the spring, but weather conditions prevented a full realization of all the possibilities of the undertaking. The bureau has continued the operation of a striped-bass hatchery in cooperation with the State of North Carolina. Fish-cultural activities are being expanded in Glacier National Park, the park service assisting in the initiation of egg-taking operations and in the construction of rearing pools. A limited distribution of bass and other pondfishes was obtained from a large pond at Miles City, Mont., constructed by the State and operated by this bureau on Government-owned land.

PROPAGATION OF PACIFIC SALMONS

The aggregate output in this field was 152,529,100, about 12,000,000 in excess of the previous year. The gain was entirely accounted for by an increase in the production of sockeye salmon. All other species handled showed a decline in the number distributed. As the sockeye is the most valuable form commercially, it is gratifying to note that operations with this variety were so successful. A very satisfactory season at the Alaska stations was largely responsible for this situation. A small decline in the output of chinook salmon is attributable to limitations in the collections in the Columbia River, from which field the bureau derives its main supply of this species. As usual, due to the limited capacity of the Puget Sound stations, it was necessary to discontinue the taking of chum-salmon eggs while a supply was still available. A number of the stations have been increasing their rearing-pond equipment with the object of distributing a larger proportion of the output as fingerlings.

MARINE SPECIES OF THE ATLANTIC COAST

These stations handle four species only—the cod, haddock, pollock, and winter flounder, which are distributed as fry or fertilized eggs. For the first time the output exceeded 6,000,000,000—several hundred million over that of the previous year. The increase is confined to the latter three species, the output of cod remaining virtually equivalent to that of last year. Experiments in fertilizing immense numbers of cod and haddock eggs taken in conjunction with operations of steam trawlers working out of New York City and planting them on the offshore fishing grounds were undertaken. Two employees of the Woods Hole (Mass.) station were detailed to accompany the vessels, but practical difficulties in handling the fish prevented achieving the expected results. Shore cod fisheries in the vicinity of the Boothbay Harbor (Me.) station yielded a considerable quantity of eggs for this work, however. It is interesting to note that an employee of this station was lent to the State of Florida to supervise the hatching of spiny lobsters or crawfish at Key West. This constituted the only instance in which the artificial propagation of this form has been conducted on a practical basis. The augmenting of the output of haddock was deemed especially desirable, since this species has enjoyed a rapidly increasing demand for filleting.

ANADROMOUS SPECIES OF THE ATLANTIC COAST

One of the most satisfactory features of the operations conducted by the division of fish culture was the marked increase in the production of shad at the Potomac River station. The new station at Fort Humphreys, Va., operating for its first season, handled over 78,000,000 eggs. The total distribution of over 71,250,000 shad, which included a limited number produced at the Edenton (N. C.) station, indicates a high percentage of hatch. A hatch of yellow perch almost equaling earlier records also was obtained at Fort Humphreys. Two consecutive successful seasons with the shad give reason to hope that, on the Potomac River at least, the runs can be maintained on a plane of high productivity. The Edenton (N. C.) station enjoyed average success in its shad work, but the output of glut herring was negligible in comparison with that of last year. The Craig Brook (Me.) station, obtaining its supply of Atlantic-salmon eggs from Canada, handled 500,000 less than in the previous year. A program of rearing these fish to larger size before distribution may be developed to offset any possible future decline in the numbers handled. The bureau again enjoyed the cooperation of the State of North Carolina in propagating striped bass on the Roanoke River.

COMMERCIAL SPECIES OF INTERIOR WATERS

The main activity in this field is the propagation of whitefish, cisco or lake herring, and lake trout at the Great Lakes stations. With regard to the whitefish, the reduction in the number of eggs collected, which has become so evident during the past five or six years, continued, and the output for the past year dropped below 100,000,000 fry. As the egg take and consequent distribution of fish reflect the condition of the fishery to a considerable degree, the present situation can not be viewed complacently. Virtually all of the stations handling this species reported inability to secure an adequate supply of eggs. The fluctuations that mark the cisco operations, however, brought the output up to 35,000,000 more than in the previous year.

Inability to operate on spawning grounds in Canadian waters contributed to the reduction in whitefish output at the Cape Vincent (N. Y.) station. The production of lake trout in this field was approximately 30,000,000, or 7,000,000 under last year's figures. The decline apparently was not traceable to a shortage in fish so much as to adverse weather conditions and other factors. An attempt to net and pen lake trout at Cape Vincent awaiting the maturity of the eggs failed to give the successful results that rewarded the previous season's attempt.

Operations with buffalo fish, carp, and yellow perch in interior waters were attended by average results, but there was a noticeable decline in the production of pike perch, the output totaling about one-third that of the previous year. This was due to the virtual failure of the Lake Champlain field, which is usually responsible for the bulk of the output. Rigorous weather conditions accompanying an extremely late spring proved to be a very serious handicap to egg collections. The Great Lakes stations that handle this form enjoyed a reasonably successful season.

GAME FISHES OF INTERIOR WATERS

The strictly game fishes include the trouts and pondfishes, such as bass, sunfish, and crappie, propagated at the bureau's stations in the Southern States. The only species of trout showing an increase in abundance was the black-spotted or native cut-throat of the Rocky Mountain section. The main field for work with this species in the Yellowstone National Park yielded an egg collection of well over 20,000,000. The Meadow Creek (Mont.) substation of the Bozeman (Mont.) station, one of the most important of the Loch Leven and rainbow-trout egg-collecting fields, turned in a total within 1,826,000 of its previous high record. A new rainbow egg-collecting station yielding a half million eggs was developed at Williams Lake, Idaho, in connection with the salmon work in that territory. The Craig Brook (Me.) station increased its take of brook-trout eggs from the station brood stock to a new record, and its substation at Grand Lake Stream, Me., handled almost a million landlocked salmon.

Development of the brook-trout egg-producing unit at York Pond, N. H., has continued, with a yield of nearly 3,000,000 eggs for the past season. In brief, the bureau has augmented its collections of trout eggs at the above-named stations and at others in New England, the Middle Atlantic and Middle West sections, Utah, Wyoming, and Colorado so as to become virtually independent of outside egg sources, making up any deficiencies by the exchange of surplus rainbow, Loch Leven, and other eggs for eggs of needed varieties. The bureau has likewise deliberately reduced its numerical output of trout by retaining the fish longer before planting, with consequent diminution of output. This plan, together with the distribution of larger numbers of advanced fry and small fingerlings to private rearing pools conducted by groups of sportsmen, probably will result in more efficient restocking in spite of the smaller number handled.

While the aggregate number of warm-water pondfish distributed shows a material decline from the previous year, this has been due to an absence of distribution from the rescue field on the upper Mississippi River. The output of large-mouth and small-mouth bass, which are mainly derived from the hatcheries, was about the same as the previous year, the small-mouth distribution being somewhat in excess of the previous season. Without citing the records of the individual stations, it may be said that most of them produced an average yield of bass, sunfish, and similar fishes. Development at Orangeburg, S. C., permitted a much greater distribution from that point, but the San Marcos (Tex.) station, normally of high productivity, was visited by floods, which injured the spring hatch.

RESCUE OPERATIONS

The salvaging of fishes stranded in the landlocked sloughs along the Mississippi River was an activity of no importance during the past year, the continued high stage of the river rendering such work unnecessary. Virtually no fish were seined and returned to parental waters, and no general distribution to other waters could be made. Inasmuch as the bureau can not cover the full area in which rescue work is possible in a normal year, the situation during the past season will prove beneficial, in that the river itself, serving as a reservoir, will be amply restocked.

BIOLOGICAL INVESTIGATIONS

The chief function of the division of scientific inquiry is to provide fishery administrators, both State and Federal, with sound and practical scientific information that can be applied, either immediately or ultimately, to the conservation of the fisheries. The investigations of the bureau's biologists contribute year after year to the upbuilding of a coherent body of scientific knowledge, which ultimately will become as important in the development and conservation of the aquatic food supply as have the associated branches of agricultural sciences become in the production of land crops.

Satisfying progress has been made in solving the fundamental problems encountered in the major fisheries of the entire country. In the marine fisheries of the Atlantic coast attention has been centered upon variations in the yield and the natural forces that determine abundance. In the salmon fisheries of the Pacific coast and Alaska predictions of future runs in the important areas are now becoming feasible; and the yield, at least in Alaska, is being so regulated, through protection of an adequate spawning escapement, that an abundant future supply is assured. In the Great Lakes the question of the cause of the decline of the fisheries has been investigated, and a study of fishing gear to determine the most effective and at the same time the least destructive types has resulted in definite recommendations for legislation to the various State governments. In the field of aquiculture studies on greater productivity of waste areas have been particularly successful. Hatchery methods have been improved through studies of fish diet, and the control of disease and fish production in ponds and swamp areas likewise has been increased. Through an extension of precise knowledge of the habits and physiology of shellfishes, important improvements in cultural or farming methods have been furnished the shellfish industries.

Mention has been made in previous reports of the growing public appreciation of the results of scientific investigation of the fisheries; and the greater interest, manifested by more liberal financial support, has been continued through the past year without abatement. Despite the handicap of too few permanent investigators, the activities carried on by an increasing number of temporary employees have expanded. The scientific work is now organized under three distinct heads—commercial fishery investigations, shellfish investigations, and fish-cultural investigations. Cooperation in research by State and private agencies has continued to be a material factor in increasing its extent and effectiveness.

COMMERCIAL FISHERY INVESTIGATIONS

North and Middle Atlantic States.—In the North Atlantic area data have been obtained concerning the life history and migrations of the Nantucket Shoals cod, a fish of peculiar importance to the American fishery because of its availability throughout the year. Studies on the migrations of cod have been extended southward to the shores of New Jersey and to the mouth of Chesapeake Bay, where during the past spring unexpectedly large quantities of larvæ and eggs were taken for the first time west of Rhode Island.

Investigations of the mackerel fishery were continued on a large scale. This fishery is subject to extreme fluctuations, a study of which reveals the success or failure of a spawning year as the chief cause, rather than migration, which previously had been held responsible. With the object of perfecting a system of prediction concerning the probable abundance of future year's runs of mackerel, observations on the commercial catch are being continued at the chief ports of landing, and, in addition, oceanographic investigations (referred to later) and quantitative collections of eggs and larvæ have been undertaken in order to discover not only the occurrence of a successful spawning year at the earliest possible moment but also the natural causes that favor survival. Such predictions, which already have attained practical accuracy, not only will afford material benefit to the producer, the distributor, and cold-storage interests, but may warn of depletion, should it occur, and indicate the extent to which the mackerel fishery may be prosecuted with safety.

Fishery investigations in the Middle Atlantic States, begun during the last fiscal year, have been continued, primary attention being given to the squeteague or weakfish, which is the most important species in this region. Observations also were made on the scup and butterfish as well as other minor species taken in the shore fisheries conducted largely with pound nets.

Historical records of the pound-net fishery of Long Island and New Jersey have been analyzed in order to trace the character of fluctuations in yield. Biological observations in the major fishing centers are being made to ascertain the essential features of the life history of the fish, their spawning and growth, their feeding and migrations; and continued collection of detailed statistics is expected to provide dependable evidence on the question of depletion. In addition to the observations on the Long Island and New Jersey coasts, similar studies have been made of the commercial fisheries of lower Chesapeake Bay.

Oceanographical studies have been initiated during the present year for the purpose of discovering the causes of variations in abundance of the important fishes depending upon physical environment, such as temperatures, currents, chemical composition of the sea water, and the contained microscopic life that constitutes the food for the schools of fish. The fisheries steamer *Albatross II* has furnished the means for making these studies in the waters of the Middle Atlantic region.

In addition to the collection of eggs and larvæ of the cod, mackerel, weakfish, and other shore species, studies on the movements and distribution of the plankton organisms, upon which the mackerel directly and other fishes indirecly feed, have been undertaken. Such studies give promise of explaining the apparently erratic movements of the mackerel and other plankton-feeding fishes. All of the investigations in this area have been furthered by the facilities of the fisheries biological laboratory at Woods Hole, Mass., which for most of the year serves as a base for field operations.

The final report on the biology of the New England smelt is now in process of completion, in which the details of the life history of both marine and fresh-water races are presented and further constructive recommendations for the conservation of a depleted fishery are offered.

South Atlantic and Gulf States.—Except for important oyster investigations throughout the South, investigations of the commercial fisheries of the South Atlantic and Gulf States have centered at the fisheries biological laboratory at Beaufort, N. C., during the past fiscal year. Due to changes in the method of conducting fishery research, which lessened the usefulness of the Key West station (authorized by an act of Congress on March 1, 1911, but never completed), authorization was obtained from Congress on April 29, 1929, to return the property to the original owners. Investigations of the Texas shore fisheries were completed early in the year, and an extensive report, outlining the biology of the important species and containing constructive recommendations for fishery legislation, was published.

At the Beaufort laboratory extensive repairs and alterations to the station buildings and grounds to fit them for year-round investigations have been under way. The larval and postlarval development of the important fishes is the least understood field in fishery biology, and the peculiar advantages of situation and equipment at this laborotary have been utilized throughout the year in this important research.

With the completion of a new nursery house for the raising of the animals under controlled conditions, terrapin culture at the Beaufort station again became an active field for investigation. Although practical methods have been developed and production on a commercial scale has been carried on with the cooperation of the North Carolina conservation department, the relatively high mortality of winter-fed young terrapin has proved to be a serious obstacle. The occurrence of certain diseases was investigated; and although the nature of the diseases still remains unsolved, experiments on feeding were again undertaken with considerable success.

Pacific coast and Alaska.—One of the most important problems in the administration of the salmon fishery of Alaska is to determine, as accurately as possible, the product in terms of adult commercially valuable fish of known escapements to the spawning grounds in order that the salmon runs may be maintained at their maximum productivity. Special attention has been given during 1929 to a study of the production from known spawning escapements in the Karluk and Chignik Rivers. As the mature fish return to spawn at different ages several years are required to assemble the data for a single generation. These are now complete for the escapements of 1921 and 1922. Studies at Karluk of the number of seaward migrants leaving the stream each year are being made as a further step in determining the proper relation that should be maintained between the catch and spawning escapement. The relative fluctuations in the rate of mortality of the young fish in fresh waters and in the ocean can then be determined, in the hope that accurate forecasts of future runs may be made.

A detailed study of the statistics of the salmon fishery of Alaska, begun in 1925, has been continued during the past fiscal year. The results are proving to be of value in detecting depletion, and doubtless will be of still greater value in future years as a means of determining the effect of such regulations as have been and will be imposed. The first report of a series dealing with the statistics of Bristol Bay and the Alaska Peninsula was published during the year.

Adding to the considerable list of tagging experiments already completed to determine the routes of migration of the spawning fish in the sea, one new experiment was conducted in the Alaska Peninsula region to determine the distribution of red salmon taken in a locality previously unfished. A report on this experiment is nearing completion.

Since 1916 an extensive series of experiments involving the marking of young salmon liberated from the hatcheries has been conducted on the Columbia River. The chief problem has been to discover the relative value of various methods and procedures of hatchery practice. A report was completed and published during the year, dealing with experiments in which young chinook salmon were marked. Another report, dealing with experiments in which young sockeye were marked, is well along toward completion.

The herring fishery is second in importance among the fisheries of Alaska, being exceeded in yield only by the salmon fishery. The rapid development of this fishery and indications that depletion has already taken place make it important to study the biology of the fish and the changes in abundance in each locality in order that proper regulations may be drawn up. This study, begun in 1925, has been continued, and an extensive report has been completed for publication.

For years the great salmon industry of the northwest has suffered from the loss that occurs when young fish, on their migration to the sea, enter irrigation and power-diversion canals and are destroyed. Further loss of fish life is occasioned when the mature fish, journeying upstream to spawn, encounter obstacles to their progress, such as dams and the tailraces of power houses, over or around which adequate fishways have not been built. Congress provided a special appropriation at the end of the fiscal year 1928 for an investigation of means for reducing this loss by devising and erecting suitable screens, stops, or diverters at the mouths of such canals or tailraces, and by devising suitable fishways over dams. Gratifying progress in this work has been made during the past year. The entire area in which such irrigation canals are operated has been surveyed, experiments were made with types of screens at present in use, and detailed studies of the use of an electrical field in stopping or diverting fish from the entrances of such canals were made, with the result that an approved type of electrical fish screen was selected, and several installations on Government irrigation projects have been made.

Inland waters.—The most important commercial fisheries of inland waters are supported by the Great Lakes; but in certain of the lakes, particularly in Lake Erie, depletion of the more valuable species is becoming acute. During 1928 a general survey of Lake Erie fisheries was completed. On the basis of data collected for these studies, the bureau has been able to assist intelligently and effectively in the recodification of the major part of the commercial fishery laws in Michigan, Ohio, and Indiana. Similar assistance has also been given New York and Wisconsin in an effort to establish uniform regulations governing the commercial fishery activities on each of the Great Lakes.

The bureau has received extensive cooperation in fisheries investigations of Lake Erie from the States of New York, Ohio, and Pennsylvania, the Province of Ontario, the Buffalo Museum of Science, and the Buffalo Health Department. Fundamental studies of the productivity of the lake, and especially environmental conditions affecting fish life, are being given chief attention by this group of investigators.

The usual cooperation with the Wisconsin Geological and Natural History Survey in limnological studies of lakes in northern Wisconsin has been continued. Notable contributions to fishery science have been made during the year by the publication of two reports covering work of several years past, one dealing with the taxonomy of the whitefishes of the Great Lakes system and the other with the life history of the herring of Lake Huron.

SHELLFISH INVESTIGATIONS

Oysters.—In the field of practical oyster culture, studies on the production of seed oysters were continued at Milford, Conn., and Onset, Mass., developing to greater effectiveness the method of catching oyster seed on shells contained in wire bags planted in the water at varying depths. In the Long Island Sound region a method has been evolved whereby the time of spawning and setting can be predicted one month in advance, so that oyster farmers are enabled to take advantage of best setting conditions by planting the cultch at the proper time of year.

Experiments in oyster farming were continued in the waters of Georgia and begun in Texas, with the cooperation, in both cases, of the State commissions. Various methods employed in northern waters are being adapted to local conditions in the South, with the expectation of demonstrating and popularizing this important form of water farming. Experimental work has been undertaken, also, to determine the factors that control the development of eggs and sperm in the oyster, which, in turn, influence the abundance of the new crop. It is expected that such detailed studies will provide a scientific basis for the development of better methods of oyster culture.

At the request of the Maryland fish commissioner, a survey was made of the natural oyster bottoms of the Potomac River. The bottoms were found to be in a deplorable state of depletion, and recommendations were made for their rehabilitation. A second survey of oyster bottoms in Mobile Bay, Ala., was made at the request of the conservation department and the Mobile Chamber of Commerce. It was found that oysters of that region were very generally destroyed by unusual flood conditions, and a program of rehabilitation was outlined.

During the fall of 1928 a general survey of the oyster problems of the Pacific coast was made, and a complete analysis of the situation was submitted for publication. Special attention was directed to the importation of the Japanese oyster, together with possible pests that might have a serious effect upon native oysters, and a program of field and laboratory investigations to increase and improve Pacific coast oyster production has been undertaken in the Puget Sound area.

Further studies on the control of the oyster drill, which has proved to be a serious pest in lower Chesapeake Bay, were undertaken at the Beaufort (N. C.) laboratory. A complete report on this investigation has been submitted for publication, outlining the biology of the organism and recommending means of control.

Fresh-water mussels.—The pearl-button industry of America depends upon an adequate natural supply of fresh-water mussels, a mollusk that formerly grew abundantly throughout the bottom areas of the Mississippi River. Crude methods of artificial propagation employed by the bureau until the present time have been unable to maintain a natural supply sufficient to meet the growing demand. Experimental methods of propagating the fresh-water mussels recently developed at the Fairport (Iowa) laboratory, in which the parasitic larval stage in the development of the mussel is eliminated by means of culture in nutrient solutions, have been perfected during the present year and are now ready for large-scale application.

One of the first obstacles, however, to restocking the depleted mussel beds is the increasing menace of pollution in the Mississippi and tributary rivers. In many extensive areas pollution has been found to be so severe that juvenile mussels produced by artificial propagation were unable to withstand the unfavorable conditions when planted in areas that were otherwise favorable. At the end of the fiscal year detailed surveys of the various streams flowing into the Mississippi River and the Gulf were being undertaken in order to discover localities more suitable for producing abundant supplies of mussel shells. At the same time additional experiments to perfect minor points of technique are being conducted, and mussel propagation is being carried on at the Fairport laboratory on a semilarge-scale basis, the product to be planted in the few areas known to be suitable.

FISH-CULTURAL INVESTIGATIONS

All of the major projects of investigation pertaining to fish-cultural operations mentioned in the report for 1928 have been continued in the past fiscal year.

Experimental work at the Pittsford (Vt.) experimental hatchery during 1928 was concerned chiefly with feeding of fingerling and yearling trout. The primary object was to investigate the feasibility of using various substitutes for fresh meat as a food for trout. Our experiments have shown that a number of dry products are available which can be successfully substituted to replace approximately 50 per cent of the fresh meat at a very considerable reduction in cost.

The experiments on the propagation and rearing of bass and other pondfishes at the Fairport station have given very encouraging results and have shown conclusively that young bass can be reared in nursery ponds during the summer with comparatively small losses.

In the upper Mississippi wild life and fish refuge detailed studies on the natural fauna in the various sloughs, ponds, and creeks of the Mississippi River bottom were made as a basis for undertaking fish culture on a large-scale, semicontrolled basis. The relation of the food eaten by the fish to the total amount of food available in a number of representative sloughs of the refuge was investigated carefully and a report submitted during the past spring. A number of sloughs have been cleared of brush and vegetation and seined to remove predatory fish in preparation for active fish-cultural experiments. Bass and other important game fishes will be reared and distributed or allowed to disseminate naturally through the adjacent water areas.

Investigations at the Pittsford station on diseases of trout have shown that the disease commonly known as fin rot is due to a bacterial infection, and methods of controlling it have been devised. The bureau's pathologist has rendered valuable services at the various State and Federal hatcheries throughout the year by making diagnosis and recommending treatments where epidemics of disease have occurred.

VESSEL NOTES

From July 1 to November 28 the steamer *Albatross II* was engaged in fish-tagging and other fishery investigations on the fishing banks from Cholera Bank off New York to Roseway Bank off Nova Scotia, and during this period 4,257 fish were tagged and liberated. From December 1 until February 18 the vessel was at the Boston Navy Yard undergoing necessary repairs and having a new radio outfit installed. During the remainder of the year mackerel investigations were continued and one fish-tagging cruise was made. During the year 165 oceanographic stations were made and four lines of drift bottles were run out. The vessel cruised 11,341 miles.

The steamer *Phalarope* was employed as a tender for the Woods Hole biological station and on the Potomac River in connection with shad propagation. The steamer *Shearwater* was engaged in fishery investigations on Lake Erie, besides her fish-cultural work at the Put-in-Bay (Ohio) station.

Fifteen vessels of the Alaska service cruised more than 120,000 nautical miles in the fiscal year 1929, as compared with about 90,000 miles covered by 14 vessels in the previous year. The *Brant* and *Eider* each covered approximately 14,000 miles, and the *Crane* about 13,000 miles.

An addition to the Alaska fleet was the *Coot*, a vessel 50 feet in length and 11 feet in breadth, constructed at Bellingham, Wash., in the spring of 1929 and shipped by commercial steamer to St. Michael, Alaska. It is to replace the *Tern* on the Yukon River, the sale of which vessel has been authorized.

The *Eider* continued as local tender for the Pribilof Islands, with base at Unalaska. Before the close of another season it is expected that this vessel will have been replaced by a new and larger vessel, to be named *Penguin*, which is to be constructed soon at Seattle.

The *Widgeon*, *Murre*, *Auklet*, and *Petrel* were engaged in fishery protective work in southeastern Alaska throughout the season. Other vessels employed in that district for a time in the fall, after the close of fishing operations to the westward, were the *Crane*, which had been on duty in the Alaska Peninsula following its initial voyage to

Bristol Bay with bureau employees and supplies; the *Teal*, which had patrolled waters of the Cook Inlet area during the summer; and the *Kittiwake*, engaged in the Seward-Katalla district until the end of August. The *Blue Wing* and *Red Wing* were engaged in patrol work in the Kodiak-Afognak district; the *Merganser* in the Ikatan-Shumagin region; the *Ibis* at Chignik; the *Tern* on the Yukon River; and the *Scoter* on Bristol Bay.

The *Brant* was used in southeastern Alaska during much of the season, chiefly in connection with general supervisory work by Commissioner O'Malley. One cruise was made westward as far as Kodiak in July. Secretary of Agriculture Jardine and Solicitor General Mitchell were aboard the *Brant* during part of August.

In addition to work in connection with the conservation of the fisheries in Alaska, the *Brant* was engaged for several weeks in the spring in patrolling waters of Neah Bay, Wash., and vicinity to enforce the laws for the protection of the fur-seal herd during its migration northward. The *Auklet* performed similar duty off the coast of southeastern Alaska.

During the winter several of the Alaska vessels were given a general overhauling, the work being done at Seattle and at other ports in the Pacific Coast States and Alaska. The *Scoter*, which has been employed in the Bristol Bay area for a number of years, proceeded to Seattle at the close of the 1928 fishing season and was extensively remodeled. The *Red Wing*, used in the Kodiak region, was equipped with a 3-cylinder gas engine and new tanks were installed.

On June 30 the floating equipment of the bureau consisted of 4 steamers, 4 auxiliary schooners, and 76 motor vessels ranged in size from 101 to 20 feet in length.

APPROPRIATIONS

Appropriations for the bureau for the fiscal year aggregated $2,092,108, as follows:

Salaries	$803, 708
Miscellaneous expenses:	
Administration	4, 400
Propagation of food fishes	503, 000
Maintenance of vessels	152, 500
Inquiry respecting food fishes	108, 000
Fishery industries	55, 000
Protecting sponge fisheries	2, 500
Protecting seal and salmon fisheries of Alaska	367, 000
Upper Mississippi wild life and fish refuge	25, 000
Repairs and improvements:	
Fish hatchery, Saratoga, Wyo	18, 000
Fish hatchery, Northville, Mich	25, 000
Fish hatchery, Bryans Point, Md., transfer to Fort Humphreys, Va	8, 000
Biological station, Beaufort, N. C	20, 000
	2, 092, 108

Very truly yours,

HENRY O'MALLEY,
Commissioner of Fisheries.

○

SHRIMP FISHERY OF SOUTHEAST ALASKA[1]

By Frank W. Hynes

Warden, Alaska Fisheries Service, U. S. Bureau of Fisheries

CONTENTS

DEVELOPMENT OF THE SHRIMP FISHERY

So far as is known, no attempt to utilize the Alaskan shrimp commercially had ever been made prior to 1915. In that year a man named Gardner, backed by Chinese capital, commenced drying shrimp at Thomas Bay, a short distance from Petersburg. The enterprise was not successful, however, and was soon discontinued. Unfortunately, no data are available regarding the details of the venture.

In 1916 the two men that are now at the head of the industry, E. N. Ohmer and Karl I. Sifferman, entered the field. They brought a small beam trawler from Puget Sound and began pickling shrimp at Petersburg under the firm name of Alaskan Glacier Sea Food Co. For two years this was the only concern in Alaska engaged in the business of packing shrimp. Higher labor and transportation costs made it exceedingly difficult to meet competition from other shrimp-producing sections of the United States having the advantages of unlimited cheap labor and long-established markets, and except for the excellent quality of the Alaska product the enterprise must surely have met with failure. Operations during this period were necessarily conducted on a very small scale, the market for the product being limited, as were also the finances of the company. Gross re-

[1] Appendix I to the Report of the U. S. Commissioner of Fisheries for 1929. B. F. Doc. No. 1052

turns from the sale of meat and by-products exported during 1916 and 1917 were a little less than $8,000.

The industry began to expand in 1918, three new concerns having commenced operations. These were the Glacier Fish Co. at Scow Bay, the Ripley Fish Co. at Petersburg, and H. Van Vlack & Co. at Thomas Bay. The combined output of all the plants for the year was valued at $14,000. The era of expansion was short-lived, however, market conditions in Pacific coast cities and the keen competition from southern waters combining to discourage the new packers, with the result that all of them discontinued operations, leaving the field to the Alaskan Glacier Sea Food Co. during 1919 and 1920. In 1919 the latter company was still operating the one original trawler, but, owing to increased efficiency both in trawling and preparing the product for market, receipts reached a total of $21,000. The year 1920 proved to be even better; three additional trawlers were employed, and the product for the year was valued at $49,000. A greater demand for Alaska shrimp meat was manifested in the cities of the Pacific coast, and the fishery seemed to be firmly established at last.

The growing prosperity of the Alaskan Glacier Sea Food Co. resulted in bringing three new competitors into the industry in 1921—the Petersburg Sea Products Co. and the Ness Fish Co. began packing shrimp meat at Petersburg, and the Olympic Fisheries Co. commenced operations at Wrangell, using a floating plant. Five trawlers were employed. The product of all the plants for the year was valued at $132,000. The Petersburg Sea Products Co. did not operate in 1922, but the other plants nearly equaled the 1921 production, exporting meat to the value of $126,000, after sustaining losses totaling more than $7,000 because of inadequate shipping facilities.

Production in 1923 exceeded that of any previous year. In addition to the three canneries operating in 1922, a new plant, called the Wrangell Shell Fish Co., was built at Wrangell. This company began exporting shrimp meat early in the year but encountered difficulty in marketing and did not pack during the summer months. The Olympic Fisheries Co. discontinued business in November, selling its floating plant to the Alaskan Glacier Sea Food Co. The value of the product for the year was in excess of $178,000. In 1924 the Alaskan Glacier Sea Food Co. operated its shore plant in Petersburg and the floating cannery at Wrangell; the Wrangell Shell Fish Co. also continued packing in the latter place. The value of the product exceeded that of 1923 by approximately $50,000. These two concerns continued operations through 1925. The floating plant was towed to the Haines district in Lynn Canal, where shrimp had been found in considerable quantities; but, owing to unusually bad weather, the trawlers accompanying the plant could not catch sufficient shrimp to keep it in operation. This failure resulted in a decrease of about $20,000 in the value of the year's production as compared with 1924.

During the first months of 1926 the Alaskan Glacier Sea Food Co. was alone in the field once more, operating only its shore plant at Petersburg. The Wrangell Shell Fish Co. again met with difficulty in marketing and did not pack for several months, finally selling two-thirds of its capital stock to the Alaskan Glacier Sea Food Co., under whose management the plant resumed operations in August. A new cannery, called the Reliance Shrimp Co., was built at Wrangell and commenced packing in June. This is the smallest of those now in operation. The total value of the product for the year was $195,000.

Owing to the continued weak market, the Alaskan Glacier Sea Food Co. operated only the Petersburg plant during 1927, its floating plant and the Wrangell Shell Fish Co. both being idle throughout the year. The Reliance Shrimp Co. continued packing at Wrangell. In 1927 employment was given to 172 persons, and products consisted of 491,825 pounds of shrimp meat, valued at $196,732.

Shrimp were unusually plentiful in 1927, and, had it not been for the poor market, this would probably have been the year of greatest production since the beginning of the industry.

The following table shows the progress of the fishery from its beginning in 1916 to 1927, giving the increase in men employed and investment, total yield, and value of products. It is compiled from data collected yearly by the Bureau of Fisheries.

Investment, persons engaged, and products of the southeast Alaska shrimp fishery, 1916 to 1927

Year	Investment	Persons engaged	Form of product	Pounds	Value
1916	(1)	(1)	In brine	68,845	$2,770
			Dried	3,060	831
			Meat	100	35
			Shells	3,880	114
1917	(1)	(1)	In brine	65,000	3,400
1918	(1)	(1)	Fresh	48,204	--->
			Canned	[2] 524	14,006
1919	$41,776	17	Fresh	60,000	21,000
1920	105,700	40	do	112,045	49,123
1921	147,814	111	do	344,986	132,077
1922	168,111	118	do	336,380	126,690
1923	268,565	243	do	460,560	178,474
1924	326,683	173	do	528,432	227,979
1925	318,353	146	do	519,535	207,315
1926	315,752	163	do	490,185	195,828
1927	303,396	172	do	491,825	196,732

[1] No statistical data available. Investment covers value of plants, boats, gear, and wages paid.
[2] Cases.

FISHING METHODS

Motor vessels equipped with beam trawls are used exclusively in the Alaska shrimp fishery. These are of three types—the Puget Sound purse seiner, the halibut schooner, and a nondescript model that is a sort of combination of the others but, because of its small size, probably more nearly resembles the salmon troller than any other. At present 11 boats devote full time to the capture of shrimp, and 3 others engage in the fishery at irregular intervals, depending upon the condition of the market.

The halibut schooners are the largest, between 60 and 70 feet in length, and are used in handling the huge 60-foot trawls. The salmon-troller type, which are from 35 to 40 feet in length, are equipped with the lightest gear, having beams measuring 20 feet or less. It is in the intermediate-sized trawls, however, that most of the catch is taken—those with beams measuring from 25 to 40 feet. Here the purse seiner excels the others; it is easier to handle and more economical than the halibut schooner and can be used virtually anywhere that the salmon-troller type can be operated, taking nearly twice as many shrimp with but little additional expense, as the number of men required is the same in each case. For the above reasons and because more than half the fleet are purse seiners, the description that follows deals only with this type. In any case, the gear used on all the boats is essentially the same, with the exception of a few minor details in arrangement.

The shrimp trawlers average more than 50 feet in length and are strongly built, seaworthy vessels. A few are sheathed in ironbark below the water line to protect them from floating ice—a constant source of danger on fishing grounds that are adjacent to live glaciers. They are powered with heavy-duty engines of standard makes burning gasoline or distillate and developing from 50 to 60 horsepower. These boats are built more for general utility than for speed, and few of them will make more than 8 knots. Usually the engine is

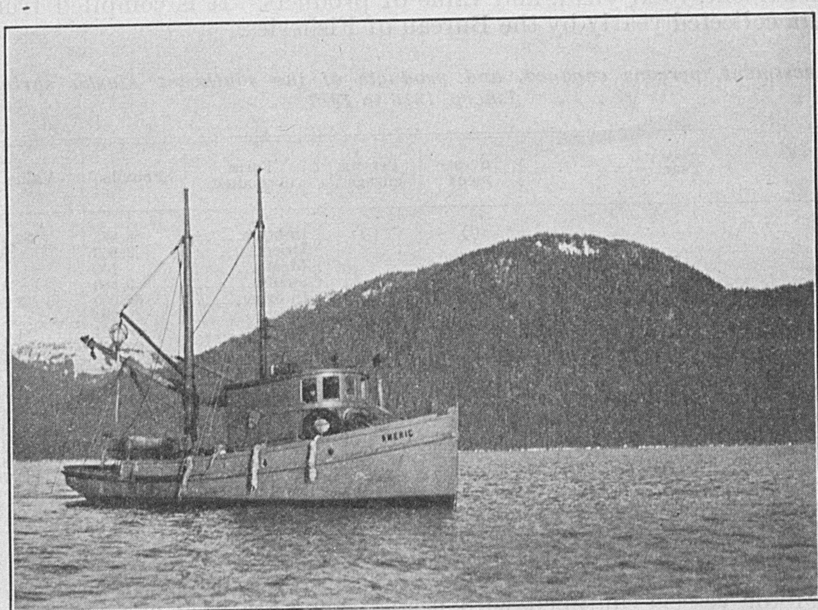


FIG. 1.—Typical Alaska shrimp trawler

controlled from the pilot house, thus dispensing with the services of an engineer. The pilot house, engine room, and living quarters are in the fore part of the boat, leaving the greater portion of the deck space free for handling the fishing gear. Under the main deck and aft of the engine room is a large hold in which extra drums of fuel and spare gear may be carried. Most of the trawlers have two masts, much stronger and heavier than are usually found in boats of the same size used for other purposes. Each mast supports a boom and hoisting tackle and is strongly braced with fore-and-aft and port-and-starboard stays in addition to a heavy steel cable or bar, which runs between them just below the mastheads. These braces are necessary because at times tremendous loads of mud or rock must be lifted to free the trawl, and without them the strain on the mast would be too great.

The hoist for lifting the trawl is located amidships, just aft of the deck house. It is driven by a chain or gears from the engine and is usually set so that the cable runs straight from the drum to the stern of the boat. Various sizes of cable are used, depending upon the weight of the trawl, but the average is about seven-sixteenths of an inch in diameter. The trawl cable leads from the drum to a block fastened to the main mast about 8 feet above the deck, and thence along the main boom, through another block near its outer end, to the hauling ring of the trawl. This boom is very heavy, since it must bear, more or less directly, the weight of the trawl and whatever may be in it. It is fastened to the mast with a strong iron collar and clevis, which allows it to be swung in a wide arc about the stern of the boat. Further support is rendered by ropes that pass through blocks near the outer end of the boom to others near the masthead. There is also the usual arrangement for holding the boom in any desired position—blocks and cleats fastened to the deck on each side of the stern, with lines running through other blocks on the boom.

Considerable ingenuity has been displayed by the shrimp fishermen in the specialization of the gear so that it can be handled efficiently by two men. All of the operations required in handling the trawl, brailing the shrimp from the bag, and unloading the catch at the cannery are performed by power transmitted from the engine through cleverly arranged gears, pulleys, and blocks.

FISHING APPLIANCES

The beam trawl, for a great many years identified with the ground fisheries of other parts of the world, is the only appliance used in the capture of shrimp in Alaskan waters. It has been modified to some extent to meet conditions not encountered elsewhere, but the principle remains the same. Various sizes are used, ranging from 16 to 60 feet in beam, but except in the matter of size all are constructed on exactly the same lines. The dimensions of the trawl carried by the *Charles T.*, a boat of the purse-seine type owned by the Alaskan Glacier Sea Food Co., are as follows: Beam 36 feet in length, 7 inches in diameter at the middle, and tapering to 5½ inches at the ends; bottom line, 7-inch manila 41 feet long; hauling cable, ½-inch woven wire; shoes, or runners, ½ by 6 inch black iron; bag, heavy tarred hemp web 1¼-inch mesh, 200 meshes deep.

The shoes, or runners, upon which the trawl slides along the bottom, are in the form of half circles about 4 feet in height and are fastened to each end of the beam by iron collars. Braces running from the highest point of the shoe to about midway of the beam serve to prevent the shoes being knocked off when the trawl slides sideways down a declivity on the bottom. The top of the bag is fastened to the beam by a series of lashings about 1 foot apart, and the bottom is fastened to the ground line. This line hangs loosely between the shoes and forms an opening into the bag as long as the beam and as wide as the shoes are high. Owing to the rapidity with which the bag and ground line wear out when dragged over rough bottoms, it is the practice to protect them with old pieces of web or canvas. However, care is taken not to use any material on the trawl that might prove stronger than the hoisting cable; for, in the event of fouling on a reef or bowlder, this might break and result in the loss of the entire trawl. Losing a trawl is a serious matter, as they are expensive. The smaller rigs, complete—gears, winch, cable, beam, and web—cost about $800; the largest—those with 50 and 60 foot beams—cost from $1,000 to $1,200.

A few years ago one of the shrimp packers experimented with the otter trawl, believing that with its advantage in spread over the beam rig it would catch more shrimp. It was not successful, however, as the fishermen were unable to regulate it to the variety of bottom conditions encountered. The Chinese bag nets and traps, so successful in the San Francisco Bay shrimp fishery, can not be used on the Alaska grounds owing to the great depths from which most of the catch is taken, and this circumstance also prevents the use of cast nets and seines. On the whole, even though the beam trawl is

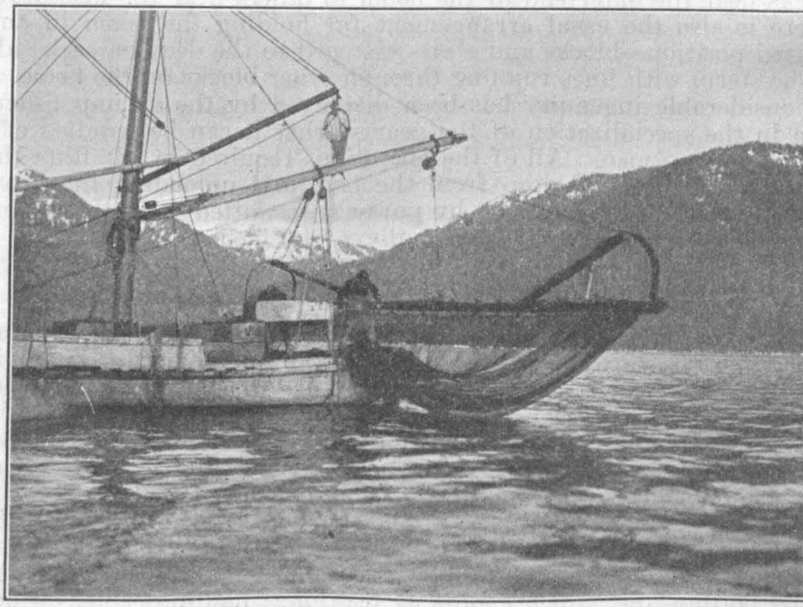


FIG. 2.—Preparing to drop the trawl

regarded as an antiquated appliance by shrimp fishermen in other localities, it comes nearer to meeting the requirements of the Alaskan fishery than any equipment thus far devised.

TRAWLING

The shrimp trawler leaves the cannery early in the morning, usually before 6 o'clock, and proceeds to some locality where the captain thinks he can make a good catch. Upon arrival at the grounds the engine is reduced to half speed, the trawl is hoisted from its place on the deck, swung around over the stern, and dropped. When it reaches the bottom the brake on the hoist is set, and the boat, retarded by the dragging trawl, travels slowly ahead at speeds ranging from ½ mile to 1½ miles an hour, depending upon the depth of the water and the character of the bottom.

On grounds with which the fishermen are familiar, regular courses are followed so as to avoid reefs and ledges where the trawls have been fouled at some previous time. Hauls of various lengths are made, depending upon the area of the shrimp bed and the amount of débris collected. If no difficulty is encountered, such as fouling the trawl or having it fill with mud or rocks, as it frequently does, the boat may continue on one haul for an hour or more. When the captain thinks the trawl is sufficiently full the boat is stopped and the net hoisted to the surface of the water. If the haul has been made on soft bottom, the trawler goes ahead again at full speed, dragging the bag through the water until it is thoroughly washed. The clutch is then thrown out, and as the boat loses headway the men

FIG. 3.—Getting ready to brail the catch from the bag

haul in the slack of the bag until the contents are all in one small section of the web.

Then, with the aid of the power brailer (a dip net worked by one of the winch pulleys), the catch is transferred to the cleaning table and all undesirable material, such as sticks, rocks, seaweeds, shells, and unmarketable fish, is thrown overboard. As the shrimp are cleaned they are raked by hand from the table into heavy wooden boxes, each of which holds about 200 pounds of shrimp. No effort is made to segregate the various species. If there are any salable crabs in the catch, they are taken to the cannery along with the shrimp and sold to the crab canners or fish dealers. As soon as the last of the catch is brailed from the trawl, it is dropped again and a new haul begun. After each haul the decks are thoroughly washed, and water is poured through the boxes of shrimp to wash out any mud or other foreign substance that may be clinging to the shells.

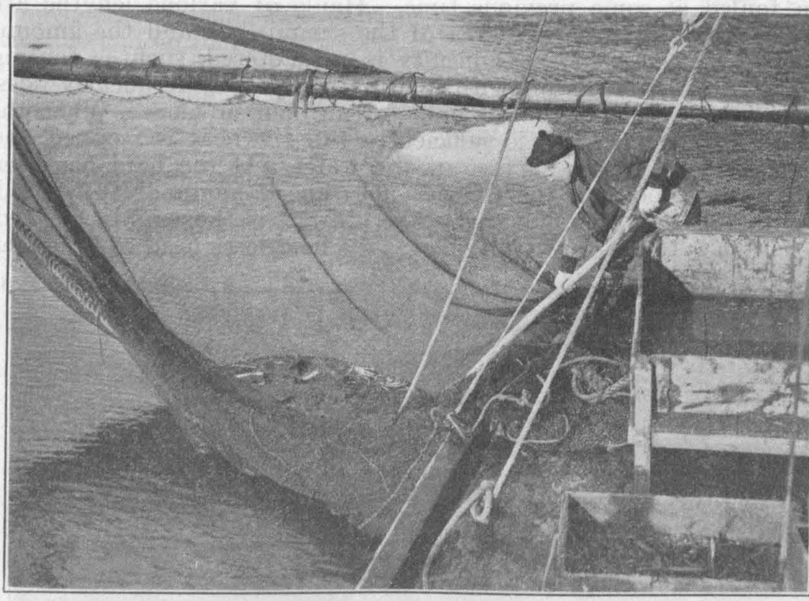


FIG. 4.—Method of handling the brail

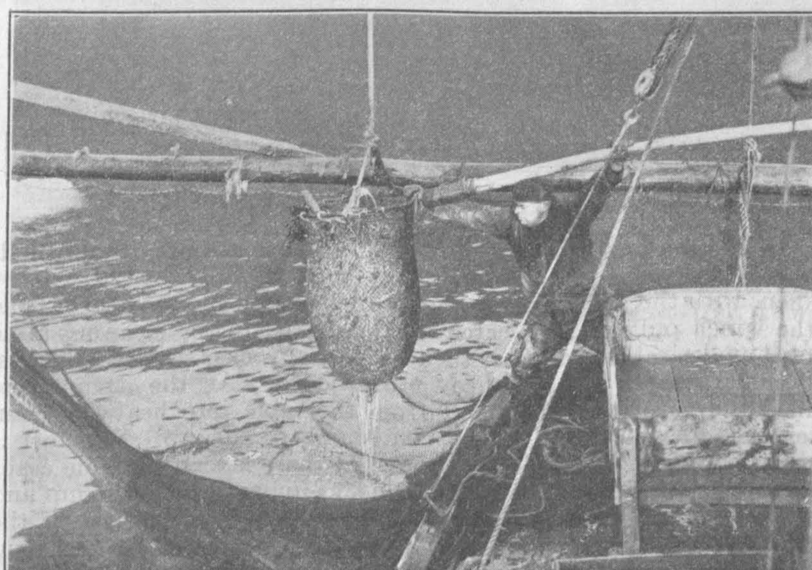


FIG. 5.—Brailing the shrimp from the trawl

Ten 200-pound boxes constitute a good day's catch for a boat, though sometimes that amount may be taken in one drag of the trawl. On the other hand, many hauls may be made on grounds that have yielded large quantities of shrimp a day or two earlier and catch virtually nothing. It is more or less a matter of luck, as in any kind of fishing, some of the boats making good catches consistently while others on the same grounds are making mediocre hauls.

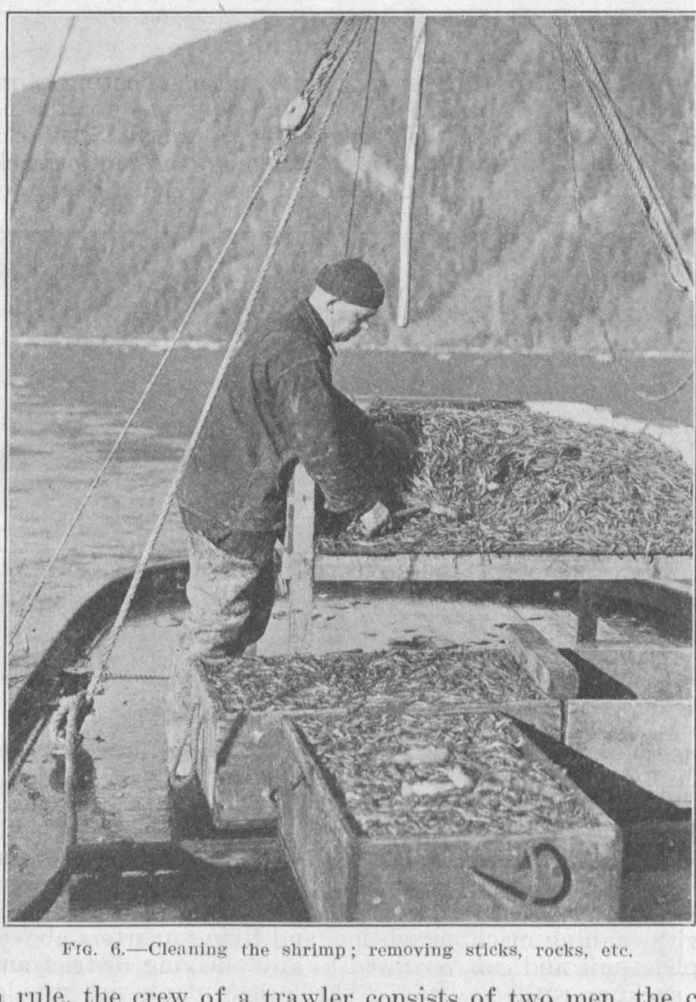


FIG. 6.—Cleaning the shrimp; removing sticks, rocks, etc.

As a rule, the crew of a trawler consists of two men, the captain and a cook, who is also general assistant. They take turns at steering, looking after the engine, and handling the brailer. The work is arduous and the hours long, but the pay is good and the food provided by the canneries is the best. At times, when market conditions are good and no catch limit is set by the canneries, the fishermen receive a bonus of $1 a box for all over 10 in the day's catch. This is divided equally between them and sometimes amounts to $20 or $25 a month for each.

In connection with trawling, it has been frequently asserted by persons engaged in the other ground fisheries that the trawls destroy large quantities of young food fish. The observations of the writer, however, have been that very few fish other than flounders, tomcod, and sculpins are ever taken in the trawls, and in most cases these are returned to the water uninjured except when sold as fox food or crab bait. Virtually none of the more alert ground fishes are caught, as the trawl moves along the bottom so slowly they have ample time to escape.

PLANTS AND PROCESSES

At present there are three shore plants and one floating cannery in southeast Alaska that have been built and equipped for the packing of shrimp meat. Two of the former (the Wrangell Shell Fish Co. and the Reliance Shrimp Co.) are located on the McCormack dock at Wrangell; one shore plant (the Alaskan Glacier Sea Food Co.,

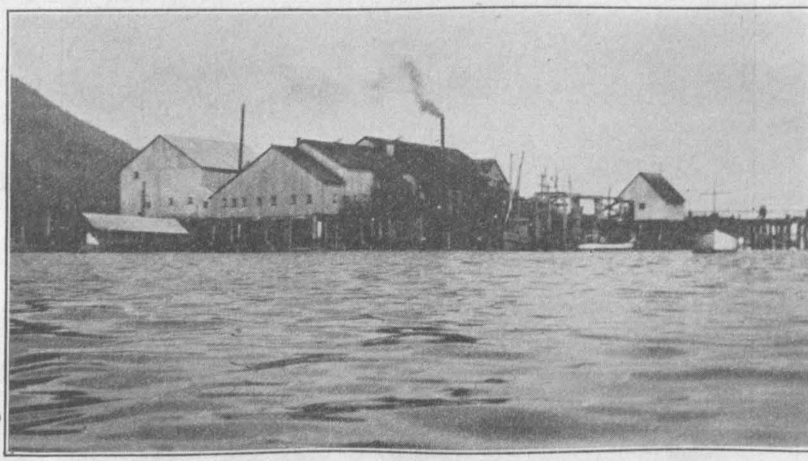


FIG. 7.—Shrimp cannery, Petersburg, Alaska

which is the largest of those now in operation) occupies a part of the steamship dock at Petersburg. The floating cannery, which is also owned by the Alaskan Glacier Sea Food Co., has been tied up at Petersburg for the past three years, during which time it has seldom been operated. The shore plants are all frame buildings, inexpensively constructed of rough lumber, the dock planking serving as floors and the roofs being of tar paper. The floating plant is a large scow with canning machinery below and living quarters above. It is a complete unit and can be towed to any outlying district and commence packing without delay. The larger plants are divided into five sections—a platform where the trawlers unload, a large room where the meat is cooked, weighed, and packed, and a picking room, cold room, and office. Very little machinery is needed in packing the product by the process now in use, the only requirements being a boiler with a few short steam lines, a retort, seamer, fanning machine, and scales. The arrangement of this machinery is optional, as each step in the process requires hand labor.

When the shrimp are unloaded from the boats they are immediately immersed in open wooden tanks of fresh water kept at the boiling point by injections of live steam, where they are cooked for 4 or 5 minutes, or until air spaces develop inside the shells and the shrimp

FIG. 8.—Weighing and packing the shrimp meat

rise to the surface. After this cooking (which greatly facilitates picking, as it frees the meat from the shell), the shrimp are dipped from the tanks into small wooden trays with wire-screen bottoms, which are set in racks until the shrimp are dry and cool (usualiy overnight), after which they go to the picking room.

The picking room is usually the best in the plant—well lighted and warm, to insure the comfort of the pickers. The equipment consists of rows of wooden tables divided into sections, with a stool, upon which the picker sits, before each section. Every picker brings his own supply of shrimp from the drying racks to the tables. In picking the shrimp, the cephalothorax, or "head," is first broken or twisted off, the picker's finger thrust between the swimmerets and a piece of the shell torn off; a slight squeeze on the end of the abdomen, or "tail," is then sufficient to force the meat from the shell, and it is dropped into a container. At present, no commercial use is made of the shells, and unless they are taken by the townspeople to be used as fertilizer they are thrown into the water through a hole in the cannery floor. Most of the pickers are Alaska native women or orientals, though occasionally white men and women are seen at the tables. They receive 10 cents a pound for picking, and an average worker will earn about $3 a day.

When the meat leaves the picking room it is thoroughly washed in clean water and placed in a saturated brine solution for 3 minutes, after which it goes to the retort and is cooked for 3 minutes at a temperature of 320° F.. After leaving the retort it is again put into the trays and left until the next day to dry, when it is put through the fanning machine and all bits of shell and antennæ (the "feelers") are blown out. The meat is then hand packed in 5-pound tin cans lined with parchment paper, which are single-seamed and packed in crushed ice for shipment. The product is known as "fresh shrimp" and is as good in every way as the freshly cooked article, even after months in storage. It is an excellent food substance, rich in protein, and every effort is made by the packers to see that it reaches the consumer in a clean, wholesome condition.

Marketing is done through brokers in Seattle, and most of the meat goes to the hotel and restaurant trade in cities west of the Rocky Mountains, though at present an effort is being made to introduce it in middle western and Atlantic coast cities in competition with the Atlantic and Gulf States product from the south. The packers receive about 40 cents a pound, on an average, and this price, if it were not for the limited demand, would enable them to make a very fair profit. However, the retail price is necessarily so high that the product is classed as a luxury and is beyond the buying power of most families, which no doubt accounts for the frequent periods of depression and slow expansion of the industry as compared with the other Alaska fisheries.

FISHING GROUNDS

Since the beginning of the shrimp-packing industry in southeast Alaska it has been centered at Petersburg and Wrangell, and, with the exception of a short period during the summer of 1925, when the floating plant of the Alaskan Glacier Sea Food Co. operated in the Haines district, all the shrimp exported from the Territory have been taken from the waters adjacent to these towns. During the first two years of the fishery, when only one small plant was in operation, the grounds in the immediate vicinity of Thomas Bay produced all the shrimp needed, but with the beginning of expansion in 1918 and consequent increase in the number of trawlers it became necessary to find new grounds.

The boats began prospecting in hitherto untried sections of Frederick Sound and neighboring waters with the result that many very

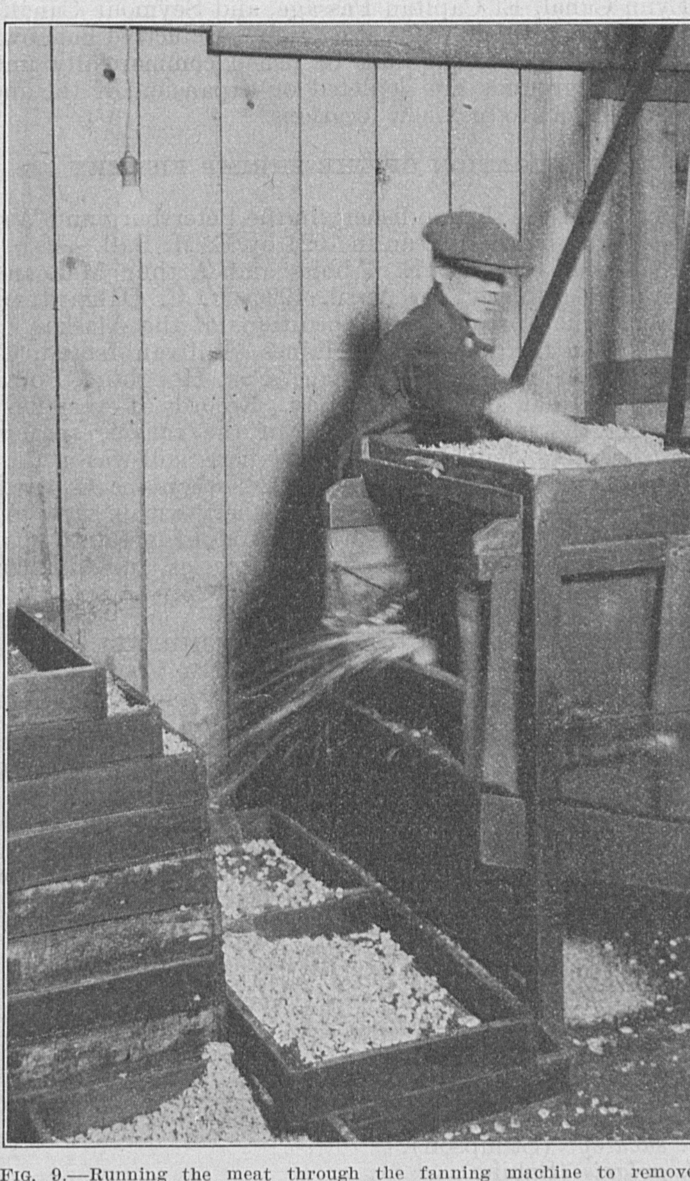


FIG. 9.—Running the meat through the fanning machine to remove pieces of shell and antennæ

productive areas were found; good catches were made in Farragut Bay, along the mainland shore from Wood Point to the Stikine Flats, and on the northeast side of Mitkof Island from Ideal Cove to the north end of Wrangell Narrows. Subsequently, excellent shrimp grounds were found in Duncan Canal, Sumner Strait, and the Eastern Passage. These grounds are all within a radius of about 25 miles from the packing centers and constitute the areas from which the entire catch is taken at present. Other sections, notably Keku Strait, Lynn Canal, El Capitan Passage, and Seymour Canal, all of which were prospected in 1925, are fairly productive but, owing to their isolation, will probably not be fished commercially until the more accessible grounds are depleted or expansion of the industry forces the operators to seek new locations.

INVESTIGATION OF THE SHRIMP FISHERY

Investigation of the shrimp fishery in the Petersburg and Wrangell region was begun by the bureau in 1924 by E. M. Ball. Also, in the fall of that year, Charles E. Tibbits and Arthur McLean made inquiries on the subject. In April, 1925, P. C. Dalgard and the writer accompanied prospecting expeditions of the Alaskan Glacier Sea Food Co. in the vicinity of Haines, Sullivan Island, Chilkat Inlet, Keku Strait, El Capitan Passage, Port Houghton, Port Beauclerc, Seymour Canal, and Gambier Bay. Records of every haul were kept, showing the relative abundance of the various species, percentage of spawners, depth, and vicinity where haul was made. Further investigation was deferred until 1926, when the writer undertook a more comprehensive study of the fishery with a view to determining as definitely as possible the season of greatest spawning activity, relative abundance of the various species, and whether there was evidence of overfishing.

NATURAL HISTORY OF THE SHRIMP

SPECIES

A number of species of shrimp are found in Alaskan waters, 13 having been identified during this investigation, which covered only a comparatively small area. All of these species and many more from other sections of Alaska are described by M. J. Rathbun in volume 10 of the report of the Harriman Alaska Expedition. The work of identifying these species, which are listed below, was done by Dr. Waldo Schmitt, curator of marine invertebrates at the National Museum, Washington, D. C.

Pandalus borealis Krøyer.
P. hypsinotus Brandt.
P. platyceros Brandt.
P. goniurus Stimpson.
P. gurneyi (Stimpson).
Pandalopsis dispar Rathbun.
Spirontocaris grœnlandicus (Fabricius).
S. suckleyi (Stimpson).
S. polaris (Sabine).
Crago communis (Rathbun).
C. franciscorum angustimana (Rathbun).
C. franciscorum (Stimpson).
Nectocrangon dentata Rathbun.

No study of the life history of any of the Alaska shrimps has been made, nor is there any satisfactory knowledge of any of the European or other more familiar species on which such work might be based. That such a study will be difficult is indicated by the work of G. O. Sars, who found in *Pandalus borealis* no less than eight larval stages. Accordingly, all possible data bearing on the economically more valuable species, *Pandalus borealis* ("pink") and *Pandalopsis dispar* ("side stripe"), have been preserved. Although these data indicate something of the habits, the approximate duration of the spawning season, and other important questions, and will form the basis of future studies on life history, they are as yet too fragmentary to be presented.

DISTRIBUTION

These species are found on all of the Alaskan grounds where trawling is carried on, some of them being very abundant while others are exceedingly rare. That they are by no means confined to these waters, however, is proved by the *Albatross* investigations, in the report of which Rathbun gives their distribution as follows:

Pandalus borealis.—Circumpolar. Bering Sea and North Pacific, southward on American coast to the Columbia River, 29½ to 350 fathoms. On the Atlantic coast of North America from Greenland to Massachusetts Bay, 40 to 160 fathoms. Scandinavia.

Pandalus hypsinotus.—Bering Sea to Strait of Juan de Fuca and Kurile Islands, 3 to 20 fathoms. Unalaska (Brandt).

Pandalus platyceros.—From Unalaska (Brandt) to off San Diego, Calif.; Strait of Juan de Fuca, Wash. (Dana). The specimens from north of the Strait of Juan de Fuca were found in shallow water, while in the strait and along the coast of California the species occurred in considerable depths—from 48 to 266 fathoms.

Pandalus goniurus.—Closely allied to *borealis;* ranges from the Arctic coast of Alaska southward to Okhotsk Sea on the one side and Puget Sound on the other in 3 to 100 fathoms. Its occurrence below 50 fathoms is exceptional, however.

Pandalus gurneyi.—Southern California, 9 to 55 fathoms (rare). Taken at Monterey Bay, 9 fathoms; off Santa Barbara, 21 fathoms; off Santa Cruz Island, 30 fathoms; off Santa Rosa Island, 52 fathoms.

Pandalopsis dispar.—From Bering Sea to Washington, 53 to 351 fathoms.

Spirontocaris grœnlandicus.—Arctic coast of America; Bering Sea to Puget Sound; Kamchatka; Okhotsk Sea. Atlantic coast of North America from Greenland to Narragansett Bay; Rhode Island; from 1 to 72 fathoms.

Spirontocaris suckleyi.—From Arctic coast of Alaska southward to Washington, 6 to 156 fathoms.

Spirontocaris polaris.—Circumpolar. Atlantic coast of North America southward to Cape Cod, 10 to 218 fathoms. Northern Europe; Bering Sea; Aleutian Islands eastward to Kodiak to a depth of 283 fathoms.

Crangon communis.—From Bering Sea to San Diego, Calif., including Puget Sound and Strait of Juan de Fuca, 20 to 309 fathoms; more abundant in the northern localities than in the southern.

Crangon franciscorum.—From Tomales Bay, Calif., to Sitka, Alaska.

Crangon franciscorum angustimana.—From Bering Sea southward to Sitka and southeast coast of Kamchatka, 96 fathoms; Aleutian Islands and Siberia.

Nectocrangon dentata.—From Bering Sea southward to Sitka and southeast coast of Kamchatka, 96 fathoms; Aleutian Islands and Siberia.

RELATIVE ABUNDANCE OF SPECIES

From a commercial standpoint only five species of the Alaska shrimp are of importance. These are *Pandalus borealis*, *Pandalopsis dispar*, *Pandalus goniurus*, *Crangon franciscorum angustimana*, and *Pandalus platyceros*. Twelve samples were taken during the months of July and August, 1926, and twice a month from May to November, 1927, to determine the relative abundance of these species. During both periods, *Pandalus borealis* was found to be the most abundant, 60 per cent of the catch being of this species. *Pandalopsis dispar* ranked next, making up 22 per cent of the take, and the others were as follows: *Pandalus goniurus*, 8 per cent; *Crangon franciscorum angustimana*, 6 per cent; and *Pandalus platyceros*, 4 per cent. The other eight species listed were found in such small numbers as to compose no more than a fraction of 1 per cent of the catch. In sampling the catch the following method was employed: A few specimens were taken from various portions of each box of shrimp in the day's take, without regard to species or size, until 10 pounds was secured. The various species composing the sample were then counted and weighed separately and the resulting amounts compared with the weight of the entire sample to ascertain the percentage of each species in the catch.

SIZE AND NUMBER OF EGGS

Measurements were made of a number of specimens of each species, their eggs were counted, and notes were kept regarding the development of the spawn, while analyzing the samples and at other times as opportunity offered. Size-frequency records of *Pandalus borealis* and *Pandalopsis dispar* were compiled during 1927, 300 specimens of each being measured twice a month from May to November.

All specimens were measured, to the nearest millimeter, from the outer edge of the last joint of the abdomen to the eye stalk, the long, slender spine projecting forward from the head, and the antennæ not being included for the reason that these vary in length, even in individuals that are otherwise of about the same size. The eggs were counted by separating them from the body of the shrimp and placing them in a warm oven for a few minutes to harden, after which they were rolled on a flat surface until separated from each other. The mass of eggs was then crowded together, one deep, squared and measured. It was then divided into equal sections; the eggs in one or two sections were counted individually, after which it was only necessary to multiply the number of eggs in one section by the number of sections to get a close estimate of the number of eggs carried by the specimen under examination.

The following table gives a preliminary determination of the average length of each of the 13 species identified, number of specimens measured, egg count, and number of specimens from which eggs were counted.

Size and egg production of commercial species of shrimp in Alaska

Species	Number measured	Average length, centimeters	Number of eggs	Number of specimens counted
Pandalus borealis	4,500	7.5	2,150	25
Pandalopsis dispar	4,500	9.1	4,150	25
Pandalus goniurus	50	7.0	2,000	5
Crangon franciscorum angustimana	50	7.6	2,100	5
Pandalus platyceros	50	10.5	3,900	5
Pandalus hypsinotus	50	8.9	4,000	5
Pandalus gurneyi	50	6.2	1,900	5
Spirontocaris suckleyi	50	5.7	1,450	5
Spirontocaris grœnlandicus	50	5.1	1,300	5
Spirontocaris polaris	4	5.3		
Crangon communis	50	6.3	1,600	5
Crangon franciscorum	50	5.9	1,200	5
Nectocrangon dentata	15	6.9	1,850	1

SEASONAL VARIATIONS IN ABUNDANCE

As far as the available evidence shows, there is little, if any, seasonal variation in the abundance of the commercially important species, the catches being as large at one season of the year as at another, weather conditions being equal. The shrimp do, however, move from one portion of the grounds to another very rapidly, as is proved by the fact that a trawler may catch nothing to-day on grounds that yesterday produced record hauls; the reverse is also true. These movements are not seasonal in character, as they do not occur in regular cycles, but possibly are occasioned by the exhaustion of the food supply in one area and its abundance in another, usually not far removed.

CONSERVATION PROBLEMS

The question of depletion has been raised from time to time during the past three years, generally by persons not engaged in the shrimp fishery and prompted more by a desire to prevent depletion before it actually becomes imminent than because of any indication that the shrimp are less numerous now than formerly. Unfortunately, no records are available showing the catch per boat since the beginning of the industry, areas from which the catch was taken, or periods during which the boats were operated on a limit basis. Without these data it is not possible to show, in statistical form, whether greater catches were made per unit of gear during the earlier days of the fishery than are being made at present over the same grounds. However, fishermen and packers alike are unanimous in the belief that shrimp are as numerous now as they have ever been, claiming that the trawlers have no more difficulty to-day than they had in the beginning in securing a load on grounds that have been fished for 10 years.

REGULATION OF FISHERY

Under the existing regulations commercial shrimp fishing is prohibited in Alaskan waters between March 15 and April 30 each year. This period has been proven to be the season of greatest spawning activity for the important species on all grounds where trawling is carried on at present. As this regulation has only been in effect for three years and was promulgated as a precautionary measure, its effectiveness can not be measured as yet.

PROPAGATION OF PONDFISHES [1]

By M. C. James,[2] *U. S. Bureau of Fisheries*

CONTENTS

INTRODUCTION

The propagation of fish [3] on farms in artificially constructed ponds or in natural ponds of limited area is perfectly feasible, and with proper management such ponds will afford a convenient and economical food supply that will justify the expense of their construction or preparation and maintenance. The interest exhibited by sportsmen's organizations in rearing game fish for stocking public waters also makes it desirable to emphasize the possibilities inherent in lands frequently unsuited for any purpose other than fish culture. Areas otherwise unproductive except by recourse to expensive drainage operations may be made to provide material returns as a source of food and game fish.

It is the purpose of this report to point out briefly the essential features to be considered in the location of a site, the construction of the pond and its operation, and the care of the fish contained therein. This information has reference exclusively to the rearing of the spiny-rayed or warm-water fishes, which are especially adapted to culture in ponds, and which can not be propagated by the artificial methods applicable to the trouts and salmons.

---

[1] Appendix II to the Report of the U. S. Commissioner of Fisheries for 1929. B. F. Doc. No. 1056.

[2] This document is a revision of Bureau of Fisheries Document No. 826, Fish Ponds on Farms, by Robert S. Johnson and M. F. Stapleton, which was Appendix II to the Report of the U. S. Commissioner of Fisheries for 1915 and was issued on December 15, 1915.

[3] This document covers the propagation of the basses, sunfish, and catfish only. Information concerning the propagation of carp, buffalo fish, trout and salmon, shad, whitefish, grayling, lake trout, pike perch, and yellow perch is obtainable from other publications on sale by the Superintendent of Documents, Government Printing Office, Washington, D. C. Information concerning these other forms will be furnished upon application to the Bureau of Fisheries, Washington, D. C.

It is not purposed to discuss minor technical details applicable only to the hatcheries conducted by the State and Federal Governments. The object is rather to outline in a broad way the methods whereby the culture of fish can be carried on as an adjunct to farming or as an activity of groups of sportsmen.

COMMERCIAL VALUE OF PONDFISHES

The value of fish in the human diet is so well attested by an impressive array of data that it is unnecessary to dwell upon this phase here. In spite of recent improvements in the marketing of fish, permitting delivery of the frozen product far from the point of catching, there are many sections of the country that are not able to enjoy a regular supply of fresh fish in any form. Fortunately, such areas frequently furnish exceptional facilities for the construction of farm fishponds and the occasional supply of fresh fish thus obtained is highly welcome. Many correspondents intimate that there would be a ready local sale for fish so raised in the semiarid regions, and there is likewise a fairly steady demand for bass and bluegill sunfish for stocking purposes. Prices vary, but fingerling bass generally sell at from $20 per thousand upward, according to size, while the sunfish and other varieties command a lower price.

The bureau is in frequent receipt of requests for an opinion as to the monetary profit to be reasonably expected from a commercial hatchery for pondfish. The bureau is unable to offer any suggestions on this point as there are no authentic published records of financial returns that may be expected from the pursuit of pondfish culture on a commercial basis. Many theories have been advanced on this point, but, as in other undertakings of importance, the efficiency necessary in order to conduct such a business profitably can be gained only by repeated efforts and actual experience. Furthermore, in order to arrive at an estimate of any value one would have to take into consideration such important factors as the topographical features of the site, the character and quantity of the water supply available, the extent of the enterprise, and the location of the plant with reference to market and transportation facilities. Taking all these facts into consideration, one can readily see the futility of attempting to forecast in a general treatise the financial returns that may be expected from any given pond area devoted to commercial fish culture.

All this, however, detracts in no way from the argument favoring the construction of ponds with the view to providing a food supply for private use. The feasibility of pondfish culture on this basis has been demonstrated fully, and ample quantities of fish for home use are to-day being propagated in established ponds on farms, proving the value of such an undertaking for that purpose alone.

With regard to the rearing of the game varieties for angling, it is generally true that sportsmen can propagate the bass, sunfish, crappie, and similar fish at less cost than purchasing them and, furthermore, can be assured of a supply when State and Federal hatcheries are unable to furnish them, as is frequently the case.

UTILIZATION OF WASTE LANDS

The bureau aims especially to influence the utilization of the natural and favorable water areas existing on countless farms, which at the present time are being put to no use, many of them constituting unsightly waste spaces that detract from the value of the land. The presence of springs, lakes, flowing wells, or adjacent streams are all leading incentives to a fishery project, and suitable sites for the construction of ponds, especially if at present unremunerative, should make their use for such a purpose desirable to the thrifty husbandman after a full comprehension of their possibilities in a fish-cultural way.

Ponds intended primarily for the cultivation of fish may be conveniently located for the watering of stock, or the overflow therefrom may be utilized for the irrigation of land. In many sections of the United States artificial ponds on farms are an absolute necessity to serve one or both these latter purposes, and by a merely nominal expenditure such water areas may be utilized advantageously for the growing of fish without interfering in any way with the original uses for which they were intended.

There are many cases in which the drainage of marshy or flooded areas would not return an income commensurate with the cost of the work, and in such instances the lands might be made productive by utilizing them for the production of fish or fur-bearing animals.

At the outset the main object of the amateur farmer fish-culturist should be the production of a food supply for home consumption.

After gaining the required experience and knowledge of the subject as a result of conducting work for several years on a limited scale, the farmer will be well qualified to judge as to the practicability of extending his operations and can then, if he so chooses, increase his facilities with the view of raising fish for the market.

Frequent inquiries are received by the Bureau of Fisheries regarding the use of natural ponds, lakes, and streams for the raising of fish. With respect to such water areas it may be stated that if drainage is provided for, the pond bed cleared of débris, the site protected against the inflow of surface water—if, in short, complete control is affected—natural water areas will possess many adventages over artificial constructions. There is objection, however, to any body of water not under complete control.

WATER SUPPLY—VOLUME, QUALITY, AND TEMPERATURE

In a brood pond a constant water level should be maintained at all times, especially during the breeding season. The required flow, which will vary with the character of the soil, must be sufficient to replace loss by evaporation and seepage. An amount just short of overflowing the pond is the ideal to be attained, as it is desirable to avoid a current. A surplus of water is preferable to a shortage, as any excess may be easily diverted through waste channels or held as an emergency reserve.

For a 1-acre pond, where the sides and bottom are of clay or rich loam, a flow of from 30 to 50 gallons per minute should be sufficient to maintain a proper water level at all times, while sandy or gravel soil untreated may require double that amount. A practical method of measuring the flow of water from any source is as follows:

Select a stretch on the stream or ditch affording as straight and uniform a course as possible. If the water at any point is carried in a flume, it will be better to measure at that point. Lay off a distance of, say, from 10 to 50 feet; measure the width of flowing water at about six different places in this distance and obtain its average width. Likewise, at these same points measure the depth of water at three or four places across the stream and obtain its average depth. Then drop a float in the water and note the number of seconds it takes to traverse the given distance. The product obtained by multiplying the average width in feet by the average depth in feet by the velocity (expressed in number of feet per second) will give the flow of the stream in cubic feet per second. From the figures so obtained it is advisable to deduct about 20 per cent, as the surface velocity of water is in excess of the actual average velocity.

High temperatures in season are necessary in brood and rearing ponds. If the water is cold at the source, the fault must be corrected by reducing the inflow to the lowest quantity that will maintain a uniform level, thus allowing the maximum absorption of warmth from the sun and air. Water that does not fall below 60° F. in the brood pond during the spawning season is desirable.

SOURCES OF WATER SUPPLY FOR PONDS

Springs are the most dependable of all the sources of water supply, requiring the minimum expenditure in preparation and being the least subject to outside influence. The presence of injurious mineral substances usually can be detected without expert analysis, but the amateur fish-culturist may be surprised to learn that so-called pure water often carries abnormal proportions of oxygen or nitrogen gases in quantities inimical to fish life. This may be due either to subaeration or superaeration, and the results following the use of such water will be as disastrous in the one case as in the other.

This contingency and the requisite of high temperature make precarious the embodiment of springs and wells within the pond bed. In the absence of thoroughly demonstrated fitness, the more prudent course will be to provide an independent water-supply reservoir, apportioning its area to the volume of the spring. While being held in this reservoir the gaseous contents of the water will be corrected and its temperature seasonably modified.

The flow from many springs is so obstructed through the trampling of stock or from other causes that they emit only a small portion of the water available near the surface. In such cases the supply usually may be increased materially by sinking 2-foot lengths of terra-cotta pipe over the bubble and removing the incased earth. Several such pipes in a promising area often will result in an astonishing increase in flow. Where the cost is not prohibitive, however, the better course will be to excavate the site and wall it in with rock and concrete.

In profusely watered sections—notably in the States bordering the Great Lakes—there are many tracts of marshy characteristics, some of them hundreds of acres in extent, promiscuously interlaced with tiny rivulets that combine to form streams of considerable size. Seemingly inexhaustible quantities of water lie close to the surface in many such places, and by driving pipes only a few feet into the ground flowing wells are obtained.

Where the volume of water is a matter of concern the overflow level of spring reservoirs, sunken tiling, or driven pipes should be kept as low as possible consistent with the object in view, as the flow will naturally decrease with the elevation of the head against which it works.

A brood pond contiguous to a spring reservoir may be fed through a spillway directly into the stock pond. Where a reservoir is impracticable, at least partial correction of any abnormal condition of the water may be brought about by conducting it to the pond through open ditches or raceways of wood or concrete, the choice of material being determined by adaptability of the soil and the comparative expenditure involved.

The chief objection to creek or river water as a supply for fishponds is the great quantity of mud and débris carried during freshets and the excessive cost of effective measures to prevent its introduction into the ponds. Streams subject to extremely high water are totally impracticable as a source of supply, while those of lesser floods can be utilized only after a considerable initial expenditure, and much vigilance will be entailed in their use, as large and continuous deposits of mud in breeding ponds will ruin any eggs present and invariably kill recently hatched fry. Furthermore, protracted roily water will retard and sometimes prevent growth of the aquatic vegetation so essential to pond fish-cultural operations. It is also imperative that undesirable and predacious fishes be rigorously excluded from the ponds, and it will be impossible to accomplish this if the water supply is beyond control during certain periods.

From the foregoing it can readily be seen that if a stream is subject to appreciable changes as a result of storms or drainage from local watersheds it will be unwise to establish a pond therein by the construction of dams, as is often contemplated. It will be entirely feasible, however, to conduct water from such a stream to ponds adjacently located, provided the intake is adequately screened, the supply arranged so that it can be cut off during times of excessive turbidity, and measures are taken to prevent the inundation of the pond site in high-water periods.

It may be necessary to erect a dam in the channel of the stream to provide the required head of water for a gravity flow to the pond, in which case it may be of a simple type designed merely to accomplish the end in view. The intake from the stream should be wide and deep, thus presenting a large screen surface to obviate the complete stoppage of the water supply in the absence of the caretaker. It should be covered by a series of screens graduated in size, the first to consist of coarse hog wire, or wooden racks with like openings, to catch the largest objects. The intermediate screen (of 2-inch mesh) will intercept vegetation, while the inner one must be fine enough to exclude smaller débris and the fry of undesirable fishes. Immediately below the screens, gates should be provided so that the water may be shut off at will and diverted into a storm channel when it becomes too roily for use.

Where the source of supply is a lake the difficulties referred to above are not encountered, lake water seldom being roily and demanding less attention to screens owing to absence of currents.

Uncontaminated open waters have many advantages. Their temperatures are seasonal; usually there are no abnormal gaseous constituents to be corrected; the plankton or pelagic animal and plant life contained therein forms a valuable addition to the natural food supply in the pond; and were it not for the difficulty of control and occasional roilyness, such waters would be preferable to springs and wells as a source of supply to fishponds.

Wells, both flowing and power lifted, are successfully used in some sections for the cultivation of fish. Before incurring the expense of constructing ponds to be supplied from such a source, however, it will be advisable to test the water thoroughly in order to demonstrate its fitness for fish culture. This can be done best by fitting up a running-water supply in a retaining reservoir and holding therein, for an extended period, a number of specimens of the species of fish it is desired to propagate. If they thrive, it may be assumed that the water is free from injurious gases or mineral substances and is adapted to the work it is proposed to undertake.

Rain water (surface drainage).—Another class of ponds available for the propagation of fish, known as "sky ponds," embraces those wholly or partly dependent upon local precipitation for their supply of water. Such ponds are invariably profuse in the production of fish food, and for this reason would be ideal were there an auxiliary water supply adequate to maintain constant surface levels during the critical nesting season and a fair depth throughout the remainder of the year. In the absence of this reserve many such ponds become virtually dry during periods of drought or freeze to the bottom in the winter months. Where ponds are subjected to such conditions fish-cultural operations are impracticable.

Ponds dependent entirely upon precipitation and surface drainage for their water supply must necessarily be located at a low elevation in order that the surface drainage from surrounding lands may be taken advantage of. Land depressions, ravines protected from floods, or swamp lands are desirable sites for such ponds.

Catfishes only can be recommended for the best of "sky ponds," strictly speaking, and the results even with them will be very uncertain.

DESIRABLE SITES FOR THE LOCATION OF PONDS

If a gravity flow of water is contemplated, the fishpond must, of course, be located below the level of the source of supply. Porous soils are to be avoided, if possible, not only because of the large volume of water required to replace loss from seepage but because they are usually sterile. Swamp lands, old watercourses, and catch basins of years' standing are the best and most productive soils as they possess the required fertility and contain seeds and spores for the early development of profuse vegetation and animalcula. Ponds located in such soil will maintain their water levels with a minimum inflow.

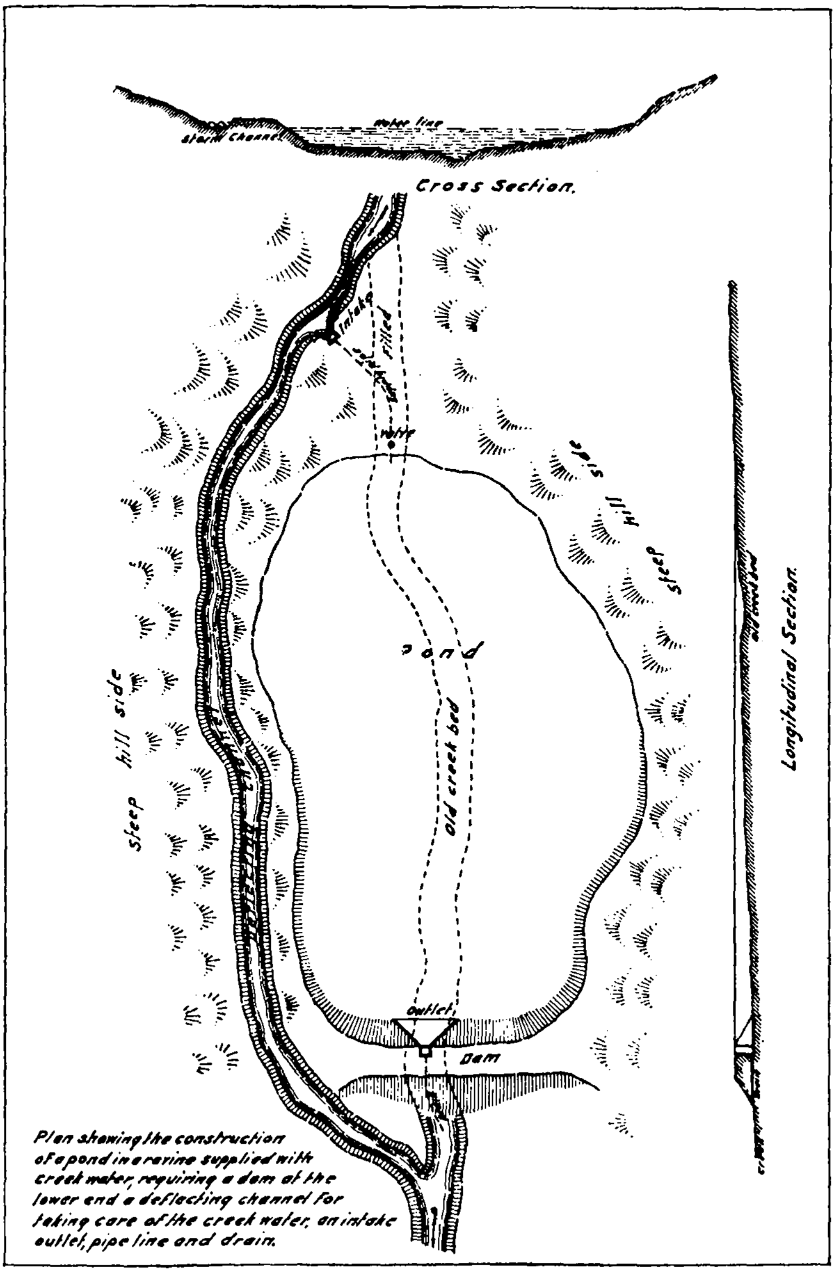

water line
storm channel
Cross Section.
intake
filled
valve
pond
old creek bed
steep hill side
steep hill side
outlet
Dam
Longitudinal Section.
Plan showing the construction of a pond in a ravine supplied with creek water, requiring a dam at the lower end a deflecting channel for taking care of the creek water, an intake outlet, pipe line and drain.

FIGURE 1

Satisfaction may be had from ponds less favorably located, however, if good sense is employed in their preparation and maintenance. Aside from the ideal lands of alluvial deposits, clay loams are a first choice, being most nearly impervious to water and quickly responsive to efforts made to establish their fertility. Sandy loam, being the most prevalent, is probably the most general soil in use for pond construction. While some difficulty may at first be experienced in making it retain water, this is overcome in time by the accumulation of decayed vegetation. Its fertility is good, and, in general, it produces a sufficient supply of natural food. Even clear sand and gravel mixtures may be made to hold water and brought to fair productivity by increased expenditures in construction and by the application of fertilizers in a manner to be explained later.

It is very desirable and also essential for a marked degree of success that ponds be so located and constructed that they may be entirely emptied of water at certain seasons. To this end there should be accessible a natural dry run or watercourse lower than the bottom of the proposed pond, to which drain pipes may be conducted.

Ponds are drained for the purpose of assorting fish, removing objectionable species, reducing the stock, and killing excessive vegetation. Complete drainage can not be effected, of course, unless there are adjacent waters to which the fish can be removed during this process. A number of small auxiliary ponds will always be found advantageous in fish-cultural work.

Where the primary purpose is other than fish culture, the selection of the site must depend upon the more important object in view. Fish culture will yield very satisfactory returns as a secondary enterprise, but the site selected for the work should by all means be the best available consistent with the general scheme of farming operations.

POND CONSTRUCTION

The exact mode of construction must depend largely upon local conditions, such as the presence or absence of favorable land contour, the nature of the soil, proximity to storm channels, and the area of the ground to be worked. Even with these features specified, lesser local characteristics and the exigencies of individual circumstances will vary the application of any approved general method. Where practicable, ponds should be not less than 1 acre in surface area. Those of smaller extent will produce fish and add an interesting feature to farm life, but they will not yield adult food fishes of the larger species in quantities sufficient for the requirement of the average farmer's table.

Natural draws or ravines involve the least expenditure in their adaptation to fishponds, as two and frequently three sides are already formed, so that an earthen embankment connecting them will complete the inclosure. Such locations must be surrounded by ditches to divert surface water where that is likely to roil the pond, and effective waste channels should be provided if the site covers the natural course of flood waters.

If flat land of an elevation only slightly lower than that of the source of water supply is selected, it will be necessary to excavate the ponds in whole or in part to the required depth to insure a water

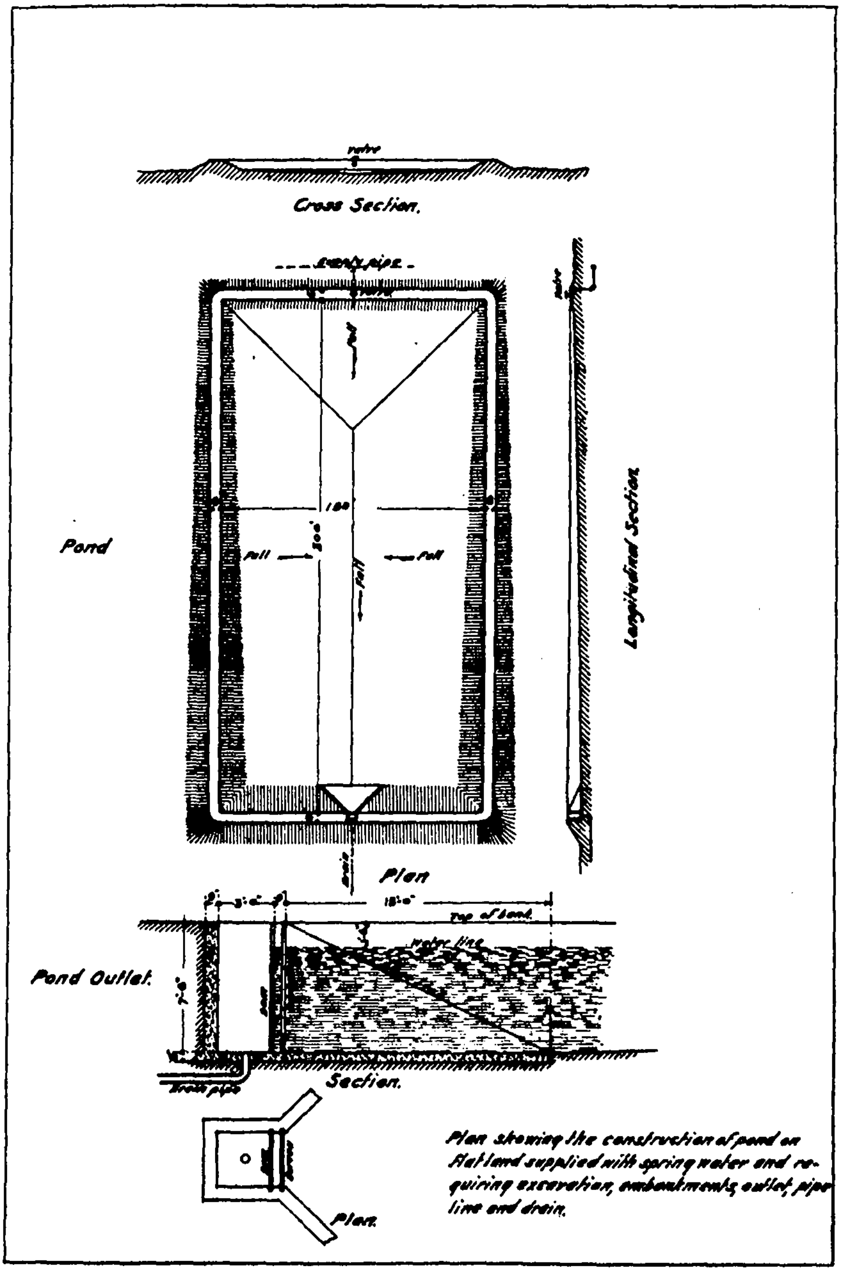

Cross Section.
Pond
Longitudinal Section
Plan
Pond Outlet.
Top of bank
water line
Section.
Plan.
Plan showing the construction of pond on flat land supplied with spring water and requiring excavation, embankments, outlet, pipe line and drain.

FIGURE 2

level lower than the supply. Thus the excavations will form solid banks, which, if impervious to water and properly sloped, will require no further attention except to bring them to uniform widths and elevation, which can be done with the material excavated in forming the pond proper. The bottom of the pond should be shaped to drain to a central point.

On swamp lands and depressions which are susceptible to drainage and are at the same time low enough to insure a gravity flow of water from the source of supply, one or more fishponds can be constructed by the erection of longitudinal and cross-section dikes high enough to provide the required depth of water. The construction of such ponds involves only sufficient excavating to give the bottom the proper slope. In other words, the pond should be built up rather than excavated, and the water level therein will be higher than the surrounding land.

The method of constructing pond embankments is governed by the topography of the land, the character of the soil, and the volume and pressure of the water to be confined. All made embankments should be at least 6 feet wide at the top and the sides sloped not less than 2 feet to each foot in height. For instance, a 6-foot fill should be 30 feet wide at the base and 6 feet at the top.

Prepare the foundation by plowing the site of the embankment, after first removing all trees, underbrush, rock, and sod, and, as an extra precaution against seepage, dig a trench 12 inches deep along the median line. This will form a break or set-off between the original ground and the made construction, which is a point of natural weakness. The filling should progress by layers over the full width and length of the levee as a continuous operation rather than by sections; otherwise the completed work will later develop checks by reason of variations in material and compactness. Rocks are of use as a protecting riprap on the slopes after completion.

In case the water supply to a pond is taken from a creek, the latter must be dammed and an intake built above the construction provided with screen and dam boards, from which a water conduit must be laid to the pond. The dam should be provided with an ample spillway, which may best be constructed of concrete.

The shape or outline of the pond is immaterial. Currents of water are undesirable in the propagation of the spiny-rayed fishes. In fact, the best brood and rearing ponds are those which are supplied by backwater from other bodies, and if there is reasonable depth and a fair growth of vegetation no stagnation will result.

Success in pondfish culture is being attained with widely varying forms of construction. To a considerable extent fish will adapt themselves to existing physical conditions. In nature they seek comparatively shoal waters in which to spawn, by reason of the prevailing higher temperatures, and during certain stages of their growth the young choose similar depths, where food is plentiful and beyond the bounds of the customary range of large fish. Relatively deep waters must be accessible to the stock fish during winter months, and what this depth shall be will depend largely upon the latitude of the location; cold climates where great thickness of ice forms require the deepest pools.

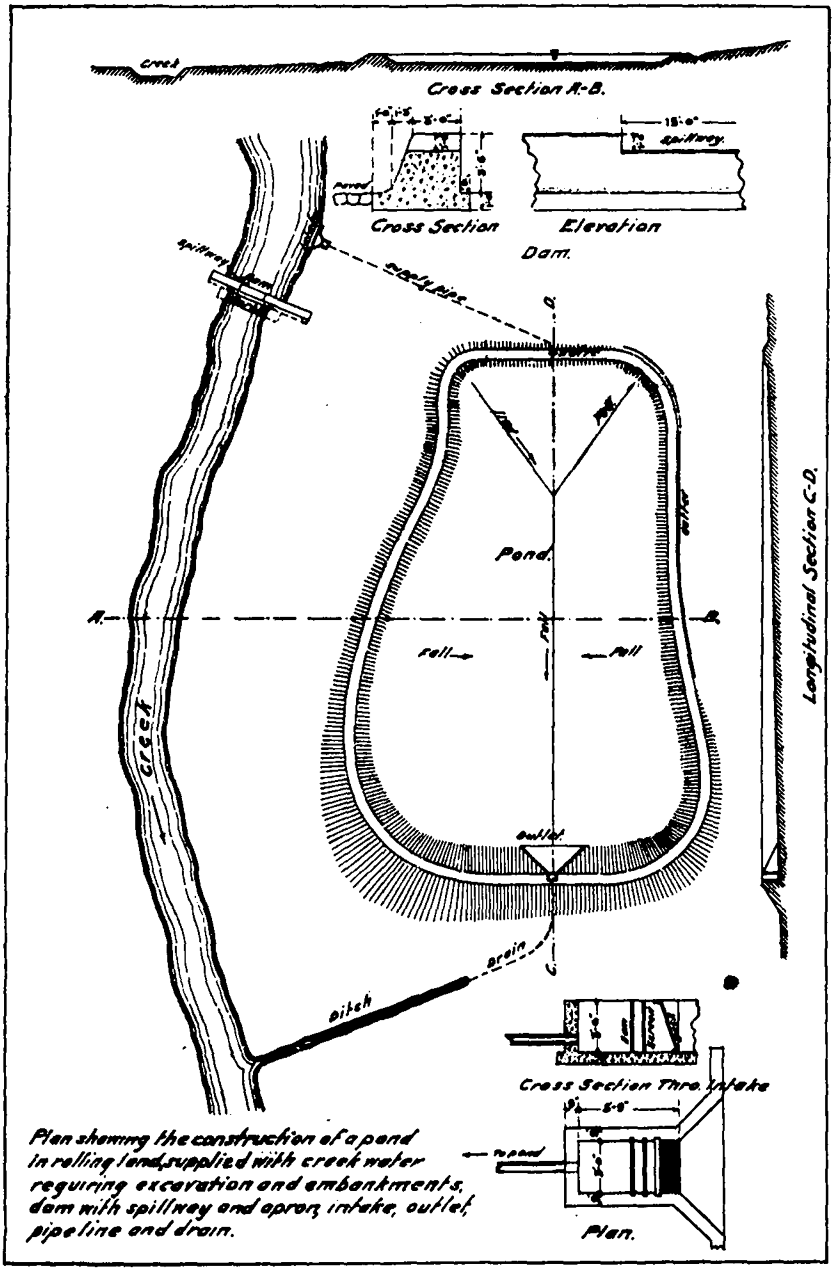

creek
Cross Section A-B.
Cross Section
Elevation
Dam.
spillway
supply pipe
Pond.
fall
fall
outlet
drain
ditch
creek
Longitudinal Section C-D.
Cross Section Thro. Intake
to pond
Plan.
Plan showing the construction of a pond in rolling land, supplied with creek water requiring excavation and embankments, dam with spillway and apron, intake, outlet, pipe line and drain.

FIGURE 3

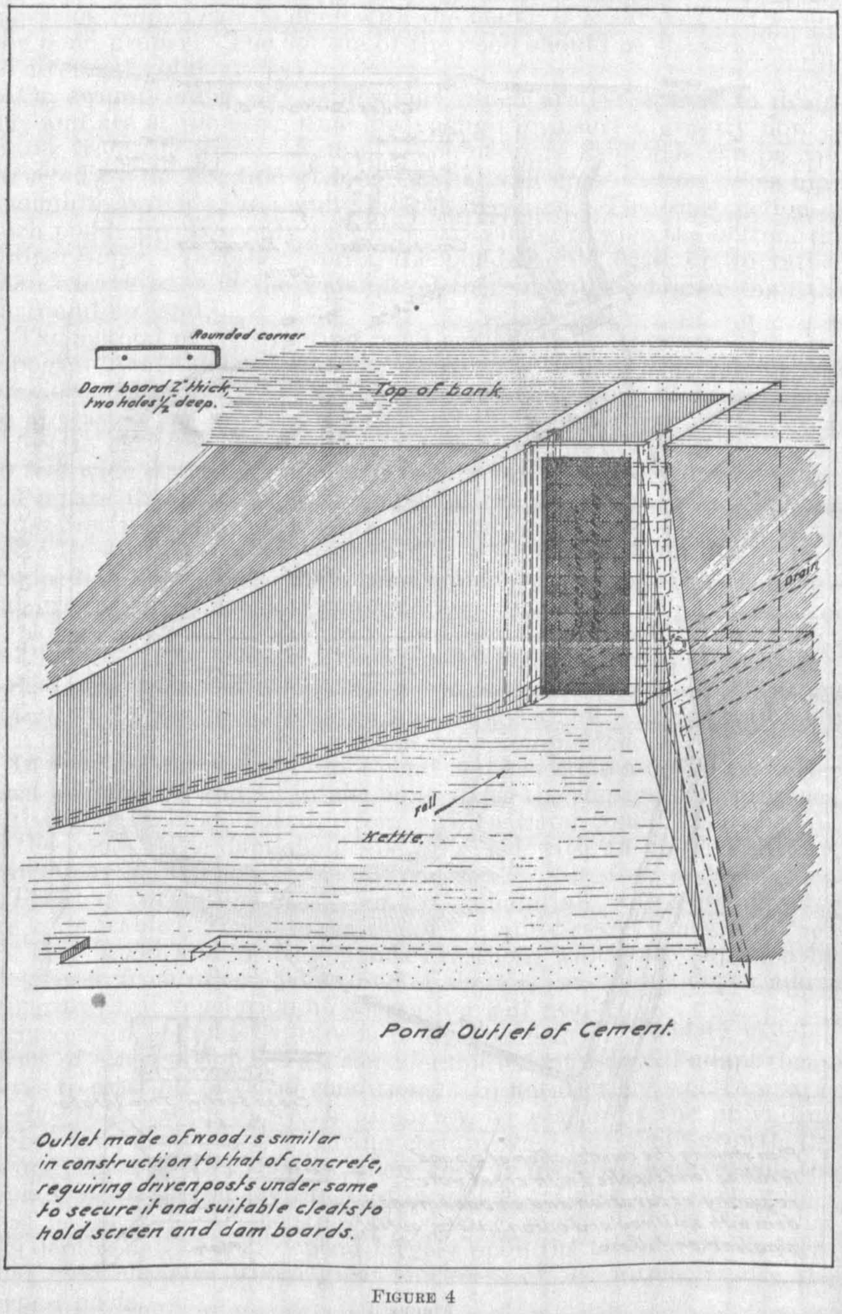

Rounded corner
Dam board 2" thick, two holes 1/2" deep.
Top of bank
Drain
fall
Kettle
Pond Outlet of Cement.
Outlet made of wood is similar in construction to that of concrete, requiring driven posts under same to secure it and suitable cleats to hold screen and dam boards.

FIGURE 4

Experience teaches that breeding ponds should be excavated to hold not less than 12 inches of water at or near the margins; that one-fourth of the pond area should range from 12 to 30 inches in depth; and that one-half its total area should be not over 3 feet deep, the bottom of the remainder to slope from this depth to 6 feet or more at the outlet. Avoid abrupt slopes. Provide complete drainage to the deepest point, where a waste pipe controlled by gates or slash boards should lead to outside natural channels.

It will be found a great convenience when draining ponds to have shallow channels 6 inches deep and 15 inches wide at the head of the drainpipe, radiating to all parts of the pond bottom from a kettle or pit, which may be of wood or concrete. A large percentage of the fish will follow such channels as the water recedes and may be removed from the kettle with less danger of injury than if picked up promiscuously about the pond.

Remove all projections from the pond bottom that might interfere with the operations of seines; plow the entire bed and level it with harrows before turning in the water or treating further for water-tightness.

As stated above, ponds located on swamp bottoms or in clay soils are virtually impervious to seepage, and there should be no difficulty in maintaining their surface levels. Sandy loams are more uncertain; they require time to become thoroughly saturated but will improve in this respect from year to year through the accumulating deposits of decaying vegetation. It is an excellent practice, when first filling newly constructed ponds with water, whatever the nature of the soil, to follow the advancing water line with a drag or harrow, driving the team knee-deep into the water. The constant roiling and puddling of the ground in this manner is very effective in cementing open cracks and crevices. Very porous soils may require the addition of a layer of clay before they will hold water. From 2 to 6 inches of stiff brick clay over the entire bottom and up the sides, well above the water line, the bottom harrowed down as explained above, will hold water over the most open ground likely to be used. The only objection to the presence of clay is its general sterility, but this may be corrected by another layer of rich loam, after the clay has been worked down and proved efficacious. Where this process is to be employed allowance must be made at the time of excavation for the refill of 12 or more inches. Coarse stable manure, and even clean straw, well trampled into the pond bottom, has been reported as a successful remedy for seepage.

A good set of native sod or sedge grass around the entire pond at the water line is the best preventive of wave washing and encroachments upon new fills. If the location is such that strong currents or eddies are present, piling, rock riprap, or other reinforcement will be necessary at the points of greatest exposure.

Landowners desiring to undertake fish propagation may feel that the expenditure necessary to secure completed ponds, as described above, is prohibitive; or they may have waters available for fish culture that it would not be expedient to remodel along the lines indicated. The plans outlined are in accordance with the present-day standards. Fish may and are being propagated successfully in far less ideal environments, but in such cases more native ingenuity is required. This, however, is a common attribute of the American farmer, and anyone who can mix balanced feeds, practice scientific grain breeding, or master the intricacies of modern farm machinery need not hesitate for fear of failure to add fish culture to his daily routine.

Summarizing the construction, these features should be provided for:

1. Water-tightness, so that a small inflow will be sufficient. This will result in high temperatures during the summer months.

2. A shallow area, from 18 to 30 inches deep, where the fish may nest.

3. A deeper area, of 6 feet or more, for winter quarters. This will also be occupied by the adults in the summer, after nesting is completed.

4. A fertile bottom for the growth of aquatic plants, upon which fish food depends.

If these requisites, together with a suitable water supply, are provided the fish will thrive.

The accompanying drawings explain the types of intake and drainage devices that have proved effective. These may be varied to meet the conditions encountered and be constructed of either wood or concrete. The latter material is shown in the illustrations and is the most durable, but wood will be equally as satisfactory while it lasts.

While the type of pond outlet illustrated is probably the cheapest and most satisfactory, variations may be employed with equal success. Where it is not practical to locate the drainage outlet immediately contiguous to the pond embankment, a standpipe outlet may be constructed at the lowest point in the pond. This is merely a chimney-shaped structure of cement with one side open. Provision is made for slots to retain dam boards and a screen on the open face. The outlet should be 3 or 4 feet square, and the top should be 6 or 8 inches above the highest water level. It is connected at the base with a tile outlet pipe conducted through the pond embankment to discharge in a ditch. To facilitate rapid drainage the tile should be of 10 or 12 inch diameter. The same result may be gained by utilizing an upright piece of large-diameter iron pipe for a standpipe. The base is attached to the drain line by a loosely threaded elbow. The height of water in the pond can thus be regulated by swinging the upright pipe at an angle and holding it by attachment to stanchions constructed for the purpose. A hemispherical screen covers the top of the standpipe. However, such an arrangement is undesirable in cold climates or where floating algæ or débris may clog the small screen surface.

AQUATIC PLANTS AND THEIR VALUE IN PONDFISH CULTURE

Frequent reference has been made to the necessity of vegetation in fishponds. Its advantages are many. It serves as food and a harbor for the lowest forms of minute animal life. Each advance in the scale of life constitutes a food for higher forms, and in the guise of fish the fertility of the ground contributes to the food of the human race.

Plants play an important part in the purification of water, taking up the carbonic acid gas liberated by decomposition and liberating the oxygen essential to living creatures. They thus prevent the asphyxiation of fish life and act as a corrective of many abnormal characteristics of individual waters.

Losses of fish through the depredations of enemies will be greatly lessened where there is an abundant aquatic growth in which they may hide. It furnishes a grateful shade on bright warm days, and the interlacing roots so bind the bottom soil as to prevent turbidity from casual disturbances.

The aquatic flora of a locality varies greatly with its latitude and is also governed by the chemical ingredients of specific waters. The most desirable species usually thrive best in waters of limestone origin. Plants of filamentous character are preferable to the large spatulate-leaved kinds, as they present greater surface expanse for the exchange of gases and, on account of their shallow rootage, are more readily controlled by the fish-culturist. Pond lilies, cat's-tail, and coarse water grasses or weeds in moderation are beneficial, as they afford shade and shelter. However, they are lower forms of oxygenators than the plants of finer growth, and they make seining operations more difficult; and it is virtually impossible to eradicate them after they have obtained a foothold.

All species herein described that are indigenous to the waters of the locality in question may be utilized advantageously in pondfish culture. Undoubtedly one or two of the introduced species eventually will drive out the others, but those remaining will be the ones best adapted to the environment. All of these will grow from cuttings, making it unnecessary to transplant the roots. The plants may simply be raked or pulled out of the open waters and pressed by handfuls into the soft earth in the shallow sections of the new pond in spaces about 5 feet apart. The bottom must be covered with 6 to 12 inches of water during the operation, otherwise the sun and air will soon ruin the sets. In deep water the plants may be started by attaching a weight and sinking them to the bottom of the pond.

Much time and trouble are often required to bring about a profuse growth of aquatic vegetation,[4] but after a pond is thoroughly stocked even more labor is required to keep it within bounds. Ponds may become literally choked with water mosses, resulting in inconvenience to the owner and a detriment to the fish. They will roll the seines, snag the lines, and smother the fish when an attempt is made to draw down the water. It will usually be necessary to thin the moss out once or twice in the course of a summer, and all growth should be removed when draining the pond. An efficient method of removal is by raking, the worker standing on the embankment and throwing the moss out on land, or wading into the shallow water of the pond, drawing it from a circle about him, and building cocks of it. The deeper waters will have to be worked from a boat or raft.

Considerable difficulty is experienced at times with floating mats of the slimy green or blue-green alga. These masses of 1-celled

---

[4] All but one of the cuts published herewith are copied from Britton & Brown's Illustrated Flora of North America. The figure of *Chara* is taken from the Text Book of Botany, by Strasburger, Noll, Schenk, and Schimper.

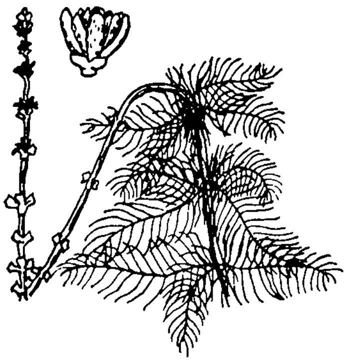


FIGURE 5.—Spiked water milfoil (*Myriophyllum spicatum*). Found in deep water, Newfoundland to Manitoba and the Northwest Territory, south to Florida, Iowa, Utah, and California. Commonly known as foxtail. Suited to southern ponds of high temperature, and, unlike most species, will thrive in comparatively soft waters. "Parrot feather" and introduced species of Myriophyllum will make better growth in sterile ground than the foxtail; otherwise the two have similar characteristics

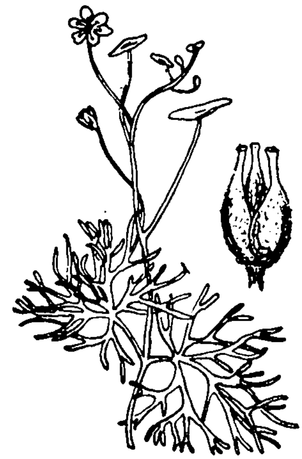


FIGURE 6.—Fanwort (*Cabomba caroliniana*). Found in ponds and slow streams, southern Illinois to North Carolina, south to Florida and Texas. Characteristics similar to Ceratophyllum

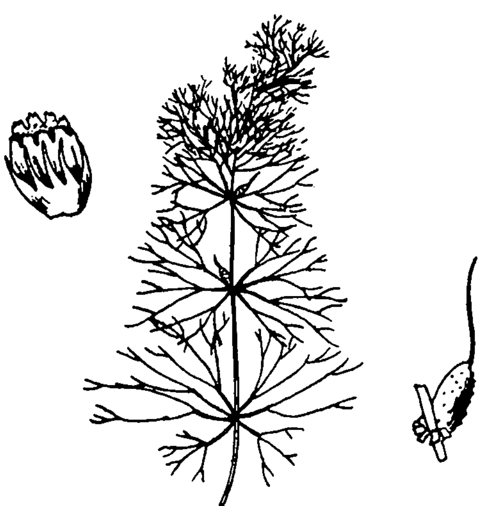


FIGURE 7.—Hornwort (*Ceratophyllum demersum*). Found in ponds and slow streams throughout North America except extreme north. This plant is shallow-rooted, deriving most of its sustenance from the water. Will thrive in cold spring water

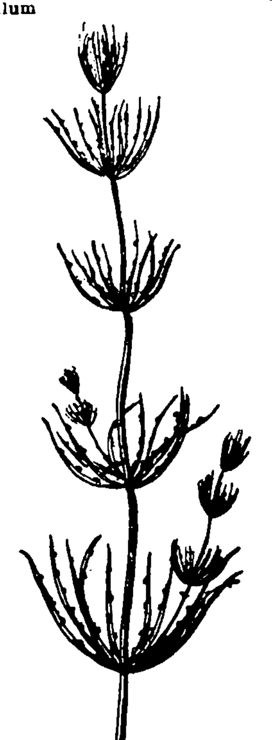


FIGURE 8.—*Chara fragilis*. A common form of chara. There are many varieties of this species and all are classed very high as food producers and oxygenators. Grows profusely in all limestone waters throughout the United States

microscopic plants harbor a rich fauna of the organisms consumed by the fish, but occasionally they may become so abundant that the periodical decay of the older plants may constitute an actual pollution of the water and make it uninhabitable for fish. Algæ are particularly obnoxious in connection with the draining of ponds or the handling of fish. It is almost impossible to prevent the smaller individuals from becoming entangled in the filaments. The most effective means of control is to haul the floating masses ashore by a seine or a drag of fine-mesh poultry netting. The various chemical methods of control—employing copper sulphate or other compounds—should never be applied in a fishpond.

SPECIES OF FISHES SUITABLE FOR POND CULTURE

Smallmouth black bass (*Micropterus dolomieu*).—Indigenous to lakes, rivers, and smaller streams from Lake Champlain to Manitoba and south to North Carolina and Arkansas. It seeks by preference the clear cool waters of its range and in the Southern States is confined to the more rapid streams. The maximum weight is about 5 pounds and the average weight from 1 to 2 pounds. This species should be selected for cultivation only in ponds of 2 or more acres in area where the temperatures and other physical characteristics conform to those of its natural habitat. Rock bass and sunfish will live congenially with the smallmouth black bass and can be propagated successfully in the same ponds with them.

Largemouth black bass (*Micropterus salmoides*).—Known locally as straw bass, green bass, bayou bass, Oswego bass, trout, and chub. Its range is from Canada to the Gulf of Mexico and from the Atlantic coast to the Rocky Mountains. The species is prolific in congenial waters but reaches its greatest size in the warmer lakes and more sluggish streams of the South. Its maximum weight is authentically stated to be from 20 to 25 pounds, though in most localities it does not exceed a weight of 6 pounds, and the average is probably less than 3 pounds.

Because of their size and cannibalistic tendencies the two species of black bass should be selected only for ponds not less than 2 acres in area. The largemouth species is equally well adapted to cultivation in northern or southern climates, but its cultivation in the former should be restricted to waters attaining maximum temperatures. Crappie, sunfish, and warmouth bass are suitable species to introduce in waters with the largemouth bass.

The two black basses are frequently confounded, but they have contrasting marks of distinction, which vary somewhat with their environment. They may be reliably classified by the number of rows of scales on the cheek, the largemouth possessing 10 and the smallmouth 17 rows. The mouth of the former species extends back of the eye and that of the smallmouth even with the anterior margin of the eye.

Crappie (*Pomoxis annularis*).—Commonly called bachelor, campbellite, new light, sac-a-lait, tinmouth, crapet, and chinquapin. Its range is from New York and Vermont westward through the Great

Lakes region and the Mississippi Valley to the Dakotas and south to Texas. It inhabits sluggish muddy water and reaches a length of 1 foot in its most southerly range. The crappie is an excellent pan fish and should be generally cultivated where conditions are favorable. It is an extremely delicate fish to handle, its protruding eyes being easily injured and frequently blinded when constantly exposed to direct sunlight in clear water. In ponds devoted primarily to the

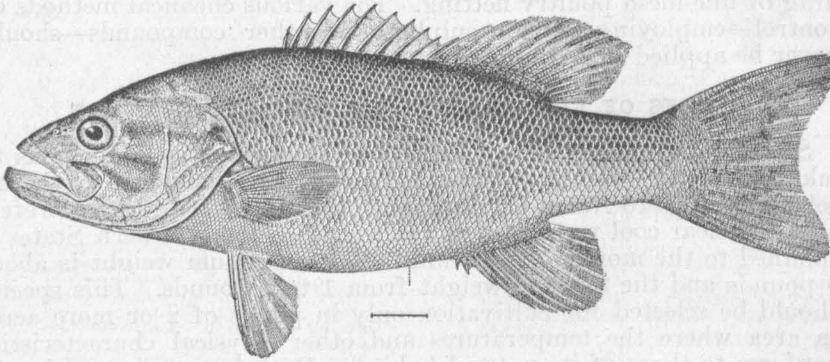


FIGURE 9.—Smallmouth black bass (*Micropterus dolomieu*)

propagation of crappie many fish-culturists introduce carp, suckers, or other bottom feeders, as the resulting turbid water seems to be a favorable condition for them. The natural habitat of the crappie suggests its suitability for ponds containing largemouth black bass or catfish, where the water supply is drawn from turbid streams or furnished by surface drainage.

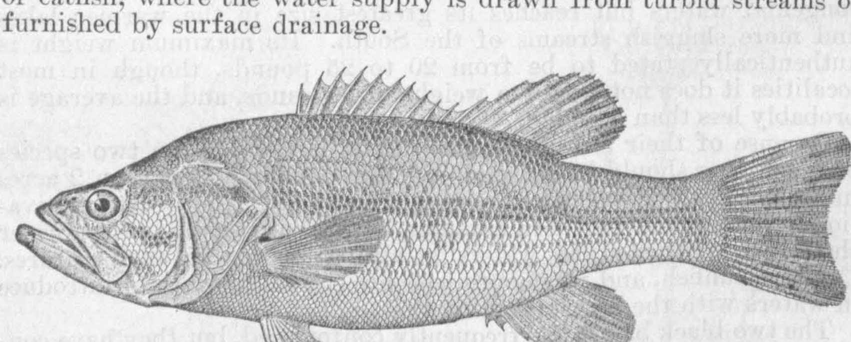


FIGURE 10.—Largemouth black bass (*Micropterus salmoides*)

CALICO BASS (*Pomoxis sparoides*).—Also known as strawberry bass, grass bass, and barfish. Is abundant in the Great Lakes region and the upper Mississippi Valley, with extreme range east to New Jersey and south to Texas. It very much resembles the crappie but is hardier in every respect and better adapted to pond culture. It may be distinguished from the crappie by the presence of 7 or 8 spines in the dorsal fin, where the crappie has but 5 or 6. It will thrive in company with any of the pond species that are suited to relatively high temperatures.

ROCK BASS (*Ambloplites rupestris*).—Colloquially termed red-eye and goggle-eye. This species is found in lakes and streams from

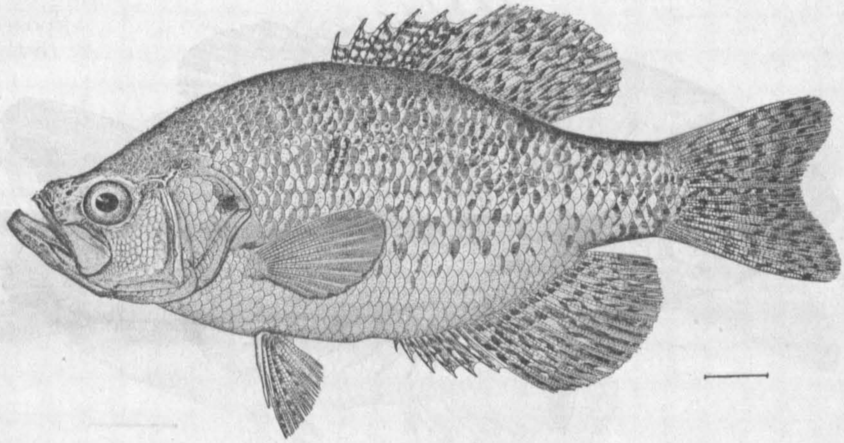


FIGURE 11.—Crappie (*Pomoxis annularis*)

New England to Manitoba and south to Louisiana and Texas, being particularly abundant in the cooler lakes and streams of the upper Mississippi Valley. It inhabits by choice only clear, cool waters and

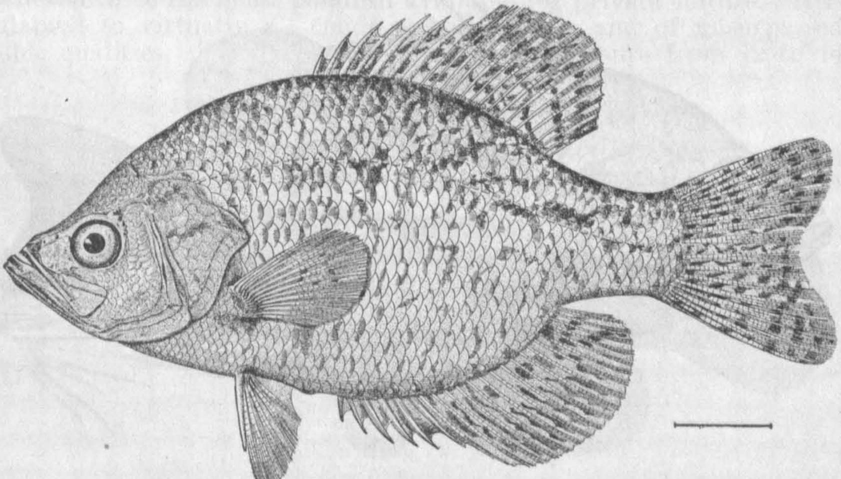


FIGURE 12.—Calico bass (*Pomoxis sparoides*)

is therefore less thrifty in its southern range. The rock bass has been known to attain a weight of 1½ pounds and a length of 12 inches, but the average specimen probably does not exceed a weight of one-half pound or a length of 7 inches. Fish of this species are well suited for introduction into spring-fed ponds with the smallmouth black bass.

Warmouth bass (*Chænobryttus gulosus*).—Is often confused with the rock bass. It has very much the same range and similar general

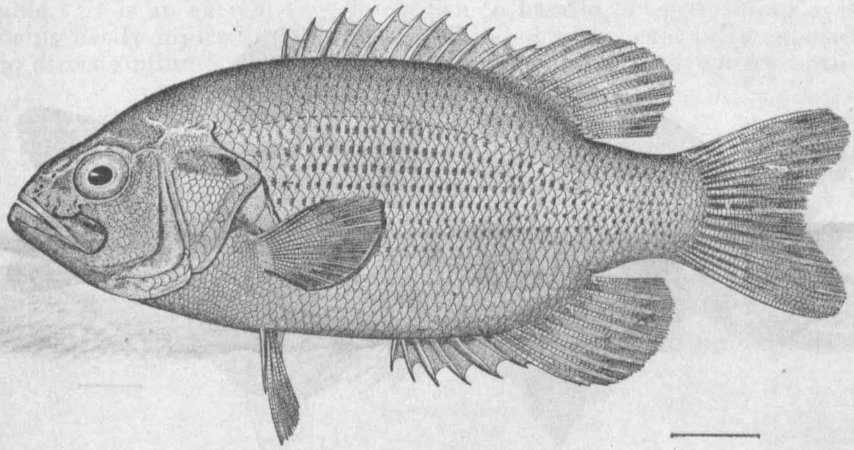


Figure 13.—Rock bass (*Ambloplites rupestris*)

characteristics but is better adapted to waters of a high temperature and is therefore most abundant in the South. The two species may be distinguished by the three oblique dark stripes radiating backward

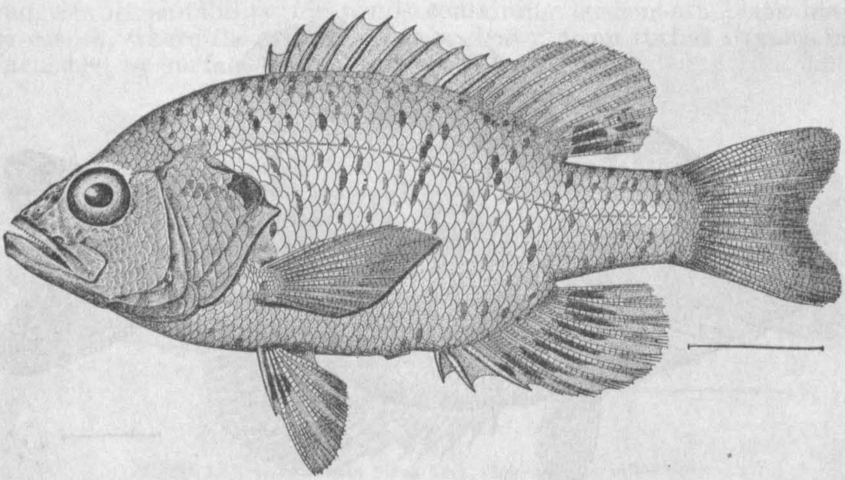


Figure 14.—Warmouth bass (*Chænobryttus gulosus*)

from the eye in the warmouth bass and by the rather indistinct vertical stripes on the body of the rock bass. The warmouth bass may be propagated in conjunction with the largemouth black bass or in small ponds with the crappie and sunfish.

SUNFISH (*Lepomis incisor*).—Locally termed bluegill, blue sunfish, copper-nosed bream, dollardee, and blue bream. Of the many species of sunfishes distributed throughout the United States east of the Rocky Mountains, this is the only one that can be recommended by the Bureau of Fisheries as worthy of artificial propagation, and it is

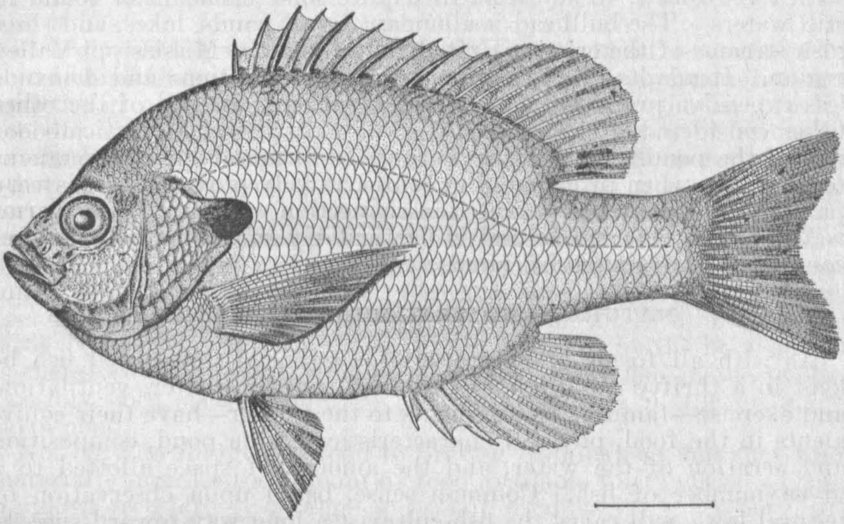


FIGURE 15.—Bluegill sunfish (*Lepomis incisor*)

believed to be the finest pondfish available for private culture. It is adapted to virtually all conditions, is prolific and of unsurpassed table qualities. The largest specimens will measure from 12 to 14

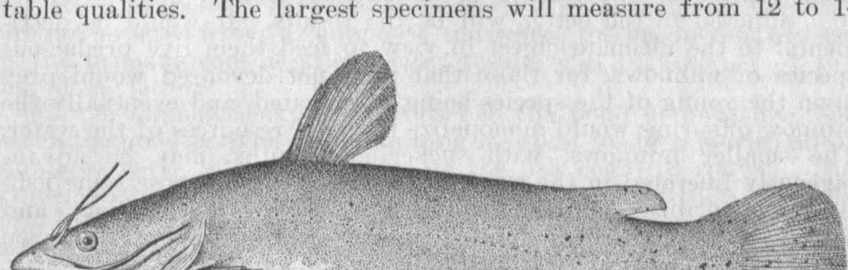


FIGURE 16.—Catfish or bullhead (*Ameiurus nebulosus*)

inches in length and attain a weight of nearly a pound. The bluegill may be propagated in connection with any of the other species listed above.

CATFISH (*Ameiurus nebulosus*).—Locally known as bullhead, horned pout, Schuylkill cat, small yellow cat, and the subspecies *Ameiurus nebulosus marmoratus* is known in the South as marble cat.

This is the only member of the catfish family that is adapted for rearing in private ponds. It is distinct from the genus *Ictalurus*, which embraces the larger catfishes—blue cat, channel cat, forked-tail cat, and spotted cat. Many attempts have been made to propagate these latter species, but extensive experience is requisite for success with these forms. They seem to require some element not found in still waters. The bullhead is abundant in all ponds, lakes, and sluggish streams of the eastern United States and the Mississippi Valley region. It adapts itself to widely varying conditions and demands less expensive preparation for its cultivation than any of the other fishes considered. The bullhead is the most easily domesticated of any of the pondfishes. Its appearance is formidable and repugnant to some, but when propagated in comparatively pure water it is very palatable. It may be cultivated in connection with any of the warm-water species referred to and is particularly suited to the changing conditions of drainage-fed ponds.

NATURAL AND ARTIFICIAL FISHPONDS

As with all forms of livestock, it is essential that brood fish be kept in a thrifty condition. Good food, proper shelter, ventilation, and exercise—familiar requirements to the farmer—have their equivalents in the food, physical characteristics of the pond, composition and aeration of the water, and the amount of space allotted to a given number of fish. Common sense, based upon observation of natural laws, will carry the fish-culturist a long way toward success.

All the fishes recommended for pond culture are naturally carnivorous, choosing live food through preference. Their predatory instinct in this respect can not be catered to exclusively where their culture is undertaken on an extensive scale, but the closer it is adhered to the better will be the results. It would be detrimental to the ultimate object in view to feed them live predacious species of minnows, for those that were not devoured would prey upon the young of the species being propagated, and eventually the minnow offspring would monopolize the vital resources of the water. The smaller minnows, with suckerlike mouths, may be advantageously liberated in the pond as food; for this purpose some fish-culturists utilize goldfish, which are herbivorous feeders and scavengers and which, in limited numbers, do not materially lessen the supply of natural food available for the game fishes. However, if the object is the production of a maximum quantity of food and game fish, goldfish have certain characteristics that make them undesirable in large numbers, and they may well be excluded from bass or crappie ponds. A separate pond a few square yards in area generally will produce an abundant supply of goldfish if it is desired to rear them for their ornamental value. Frogs, worms, and flying insects all contribute to the food supply of the brood fish; likewise the larger aquatic insects inhabiting the water. If not overstocked, therefore, the average pond may be managed so that it will furnish all the live food necessary for the adult fish. Where this is insufficient to maintain the stock properly, recourse may be had to stocking with forage fish or to pond fertilization.

USE OF FORAGE FISH IN BASS PONDS

Recent experiments conducted under the direction of Dr. H. S. Davis, using forage fish in ponds, have shown conclusively that the production of bass can be increased materially by stocking the ponds with minnows, on which the bass can feed. After reaching a length of 2 to 3 inches, bass, under natural conditions, feed largely on fish, and it has been found that they will make a much better growth if fish are included in the diet than when their food is confined to insects and Crustacea. Fingerling bass are naturally cannibalistic, and the greater part of the losses during the first summer usually are due to this habit. However, if there are plenty of minnows available, the tendency on the part of the fingerlings to devour each other is largely overcome, and the losses from this cause are reduced correspondingly.

The fish that so far have given best results for forage purposes are the golden shiner, *Notemigonus crysoleucas*, and the blackhead minnow, *Pimephales promelas.* On the whole, the golden shiner has been found to be more satisfactory than the blackhead minnow. The latter is a small, weak fish that is easily captured by the bass, and it is therefore difficult to maintain a stock of these fish in the ponds. Possibly both species could be used to advantage in the ordinary farm pond.

Not only do forage fish tend to prevent cannibalism, but they also materially increase the amount of food available for the bass. These minnows feed largely on algæ and small organisms that are not ordinarily eaten by bass and consequently make available a food resource that is largely lost if no forage fish are present.

The bluegill sunfish may also be used as a forage fish and have the added advantage that those not eaten by the bass are valuable for other purposes. However, for purely forage purposes bluegills are not as satisfactory as minnows, and where the production of bass is the primary consideration better results will be attained by the use of the latter.

Forage minnows may be liberated in the pond at any time, but when the pond is to be self-sustaining it is best to stock it with adult minnows early in the season before the fish begin to spawn. The golden shiner and blackhead minnow spawn at about the same time or a little later than the bass, but their spawning season extends over a much longer period. Consequently, if the pond is properly stocked with adult minnows there will be a supply of young of just the right size to serve as food for the fingerling bass.

FERTILIZATION OF PONDS

Doctor Davis's experiments have shown that when it is desired to obtain maximum production from a pond it will be advisable, in most cases, to fertilize it each season. The constant removal of fish from a pond without the addition of any fertilizer is like trying to grow crops without fertilization, and the results are much the same. As the amount of food available for the fish is dependent on the amount of plant life in the pond, it is evident that within certain limits we can increase the growth of fish by stimulating the growth of aquatic plants. Some recent experiments in carefully controlled ponds have shown that properly fertilized ponds will produce from two to four times as much fish as unfertilized ponds.

A number of fertilizers have been used for the purpose, but it has not yet been determined which yield the best results. Well-rotted stable manure has been used successfully in some cases, but great care must be taken not to add too much of it at one time, as the dissolved oxygen in the water may become exhausted, with disastrous results to the fish. Probably the safest fertilizer for the purpose is a mixture of equal parts of dried sheep manure and superphosphate applied at the rate of 500 to 1,000 pounds per acre. This fertilizer should not all be added at one time, but small amounts should be applied at intervals of two to three weeks during the spring and early summer. It is best to scatter the fertilizer as evenly as possible in the shallow water along the margin of the pond.

DISEASES

There are no diseases of pondfishes that can be successfully combated by artificial means. A well-fed fish is usually a healthy fish, whereas thin specimens are wanting in resistance to their habitual parasites and can not readily recover from external injuries. If they are fed well on as nearly appropriate foods as can be secured and are carried in ponds of natural characteristics, sickness will be of rare occurrence.

STOCKING PONDS WITH BROOD FISH

The most successful and the speediest results in pond culture are attainable by the use of adult fish for the original brood stock. In most cases these can be secured from the public waters of the immediate locality during the open season prescribed by the State laws.

It is such a common failing to want something new and strange that many prospective fish-culturists endeavor to procure some species of fish foreign to their community with which to begin their operations. To illustrate some of the impractical ideas entertained, the Bureau of Fisheries is sometimes asked to furnish the species of trout indigenous to the Great Lakes for stocking southern waters or salt-water fish for introduction into ponds in the interior.

In general, it may be assumed that the species that is most prolific in the public waters of the region in question will be the likeliest to produce material results, and by procuring adult fish for breeders the pond in which they are placed should become stocked to its maximum capacity within a year. On the other hand, if State or Federal aid is relied upon, only a limited number of fingerling or, at best, yearling fish will be available for beginning operations, and it will require from two to three years for them to mature and stock the ponds through natural reproduction.

The wisest course, then, will be to choose some native species and to make a persistent effort to secure adult specimens. This can best be done in the fall months, when the fish will more quickly recover from slight injuries, which, during a period of high temperature, might develop into ugly sores and possibly kill them.

Fish hooked only in the mouth are in no way harmed as breeders, but the greatest precaution must be taken in holding them and in transporting them to the pond. Loosening or rubbing off scales induces a fungus growth that eventually will spread over the body and result fatally.

As the fish are captured they may be placed in buckets or tubs, which may be darkened by throwing an old blanket or carpet over the top. In changing the water, which should be done as often as the fish seem to require it, care should be taken not to excite them. When the fish are to be held for several days before they can be transferred to the pond it is advisable to excavate a shallow basin at the margin of the lake or river where the collection is being made and arrange for a moderate flow of water from the main body through its entire length. A pool of running water 6 feet long, 3 feet wide, and from 12 to 18 inches deep will hold two or three dozen large fish with safety. Live boxes should not be used, as fish held in them will bruise themselves beyond recovery.

In conveying fish a considerable distance by rail or wagon, receptacles of such diameter that each specimen may lie at full length on the bottom should be provided. The depth of the water is a matter of less importance, but it should be kept at the proper temperature and well aerated. If necessary, ice may be used to maintain an even temperature corresponding to that from which the fish were taken; but if that be high and the distance to the pond great, it will be found easier to reduce the temperature to 65° and gradually raise it when nearing the destination to conform to that of the water in which the fish are to be liberated. During conveyance the water in the receptacles will be kept in motion and adequately aerated, but when standing still it must be aerated artificially by dipping out some water and pouring it back into the receptacle from a height.

The ordinary 10-gallon can or a special type of bucket developed by the bureau, and which holds about 6 gallons, is employed by the Bureau of Fisheries for the transportation of small fish, but if the fish are too long for their diameter nothing is better than wash boilers. Any clean receptacle may be used, but those mentioned are the most convenient to handle.

If the use of artificial food is not contemplated, the number of brood fish allotted to a pond must be apportioned to the natural food available for both the adults and the expected fry and fingerlings. Fifty of either species of black bass or 100 specimens of any of the smaller species are maximum numbers for an acre of water when the offspring is to remain in the brood pond. These numbers should produce a much larger number of fry than the waters can sustain until mature, but allowance will have to be made for losses through cannibalism and the ordinary vicissitudes of their environment. Promiscuous collections of fish invariably will run about equally as to sex, and the numbers recommended will therefore give 25 and 50 pairs, respectively.

There are no external markings by which the sex of pondfishes can be determined positively, but the female black bass usually presents a more mottled appearance than the male and her colors are brighter.

SPAWNING SEASON

Black bass will nest in the spring when the water temperature rises above 60° F. Ordinarily, 63° F. will bring about deposits of eggs, but if the season is a backward one the fish may spawn at 58° F. On the other hand, an unusually advanced season may not bring results until the temperature exceeds 65° or 68° F.

Suitable temperatures for spawning prevail in the more southerly States as early as February; in the latitude of Tennessee, in March; in southern Illinois, during April; in Iowa, during May; and in northern Minnesota, in June. The spawning season extends over two or more weeks and is usually marked by two periods of intense activity following a rise in temperature after several days of abnormally cool weather. In the Southern States the nesting season is not so sharply defined, owing to the almost continuously favorable temperatures throughout the year, which cause rapid development of the ova. At the Texas station of the Bureau of Fisheries there regularly occurs a hatching period in February, one in April. and scattering hatches throughout the summer. The crappies, sunfishes, rock bass, and catfishes will spawn from one to two months later than the black bass in the same waters, and the sunfishes and rock bass will continue nesting to some extent until the approach of cold weather in the fall.

SPAWNING HABITS

Ordinarily, ponds will require no special preparation for the spawning season. Some of the species choose the roots of water plants on which to spawn, while others seek out gravel spots and find them, however much they may be hidden by deposits of mud. Catfish burrow into embankments and under rocks and logs, and it is well to provide substitutes for such shelters where this species is being propagated, for which purpose heavy planks weighted to the bottom of the pond will be suitable and will offer the least impediment to seining operations later on.

With the right material at hand the male will prepare the nest to his precise taste and after its completion will seek a partner. There are many ups and downs in the domestic life of fishes, especially in the case of such pugnacious species as the black basses. The battles of the males for favorite females are liable to cause injuries resulting in death; or, after being won, a consort may prove not sufficiently advanced in maturity, in which case the fish separate and the male continues his search for a more congenial mate.

Actual spawning will extend over several hours, the eggs being emitted and fertilized at varying intervals.

All the eggs carried by a female may not be ripe at one time, and the male will repeatedly seek new mates until the nest has been stocked to his satisfaction, driving each companion away when she ceases to perform the function for which she was obtained. The eggs are adhesive and attach themselves to gravel, roots, or other material on the beds. The male remains on the nest during the entire period of incubation, fanning the eggs clean of sediment with a gentle motion of his fins and watchfully guarding against the encroachment of other fishes on his domain. He is the personification of valor at this time, and all other creatures in the pond apparently have the greatest respect for him. Nothing but the loss or death of the eggs from low temperatures, heavy deposits of sediment, or other adverse conditions will cause him to abandon his nest. Notwithstanding their ferocity, black bass will nest in close proximity to one another and attend to their respective parental duties in entire amity, whereas the approach of a strange fish will be resented.

Sunfish are decidedly gregarious during the spawning season and will locate their nests very close together. With them all is harmony, the sole thought of each appearing to be centered upon his own particular business.

The crappies spawn in comparatively deep water on isolated nests. Owing to their color, the depth of the water, and its usual turbidity, but few observations have been made of their peculiar characteristics at this period.

Rock bass and warmouth bass deposit their eggs on gravel beds of greatly varying diameters, and their spawning instincts are somewhat similar to those of the black bass, though in a less marked degree.

By reason of their intrepidity at the time, all of the species referred to appear to be very tame while guarding their nests, but this instinct should not be presumed upon by permitting unnecessary disturbances about the beds.

The incubation period of eggs of the various pondfishes ranges from a few days to two weeks or more, depending upon the mean water temperature. A drop below 55° F. is invariably fatal, while the percentage of hatch below 58° F. is greatly reduced.

Under uniformly favorable conditions healthy eggs will hatch without any loss to speak of, but the average hatch of domesticated stock is not over 50 per cent. This, however, is a sufficiently large percentage to make pondfish culture profitable.

CHARACTERISTICS OF THE YOUNG FISH—THEIR FOOD AND GROWTH

When first hatched the fry of most of these species are colorless and, because of their tendency to collect among the roots and in the crevices of the spawning beds, are difficult to find. They become darker in a few days, however, and are easily distinguished. In a short time they rise a few inches off the bed during the day and return to the bottom at night, increasing the distance each day until they eventually reach the surface. During all this time the parent fish has given them the same sedulous attention as when they were in the egg stage. Gradually the school enlarges in circumference to such an extent that he has difficulty in keeping his brood together. He crowds them into shoal water—their natural feeding ground—and patrols the shore in an effort to ward off enemies, but they finally separate into small bands, escape the vigilance of their guardian, and become free lances in the strife for survival.

The largemouth black bass and catfish fry school much longer than the other species mentioned; in fact, catfish fry retain this gregarious tendency throughout the first year, while young black bass remain together until 2 inches or more in length.

Young sunfish and catfish are easily taught to take artificial food when the natural food of the pond is insufficient for their nourishment. As with the adult fish, animal tissue is the most readily accepted and will produce the strongest growth, though cooked cereals or vegetables will answer and are even relished by young catfish when given in the raw state.

The food should be scattered along the natural feeding grounds, starting with a small amount and increasing the quantity to what the fish will daily consume. Care should be taken to prevent the pollution of the pond through the decomposition of excess food.

The young basses and crappies can not be fed successfully and must depend entirely upon the insect life in the pond for their sustenance. For this reason no more young fish of these species should be carried in a pond than the natural food supply contained therein will support.

When such food is inadequate for the number of fish in a pond the only alternative is to provide additional ponds, to which a portion of the fry may be transferred for rearing. A public-spirited course would be to plant the surplus stock in neighboring public waters, taking care not to introduce them into streams and lakes that should be reserved to trout or salmon, as their presence would be detrimental to the latter species. Such a policy pursued by several fish-culturists in a given vicinity would maintain good public fishing without diminishing to any appreciable extent the quantity of edible fish in the waters under private control. Ordinarily, well-constructed ponds are capable of producing from two to ten times the number of fry that can be reared therein. The surplus is of some value as food for the stronger specimens but would be of much greater value if liberated in adjacent lakes or streams.

Some fish-culturists are feeding small fish by cultivating Daphnia—small aquatic crustaceans commonly known as water fleas. These multiply in great abundance in small, stagnant pools and ditches that are rich in organic matter or humus. These organisms can be raised artificially in pools, vats, or tubs that are fertilized with small quantities of rotted manure, prepared sheep manure, or rotting plants, such as lettuce leaves. Such a Daphania pool is first fertilized, taking care to avoid the use of an excess of organic matter, which would tend to develop putrescent conditions. After several days the pool may be seeded with a stock of crustaceans taken from some natural pool where they abound. They multiply rapidly if the proper conditions are present, and in a few days a stock may be removed for introduction into the fishpond. They may be strained out of the pool by means of a bag or net of fine cloth, preferably silk. However, the successful use of these organisms for feeding fish requires considerable experimenting, and it should not be attempted without some knowledge of the fundamentals of aquatic biology involved.

CAPACITY OF A POND FOR THE PRODUCTION OF FISH

It is difficult to estimate the capacity of ponds for the various stages in the growth of fish. It depends for the most part upon the amount of appropriate food available. A 2-acre pond producing ten thousand 1-year-old black bass from 4 to 6 inches long would be a remarkably successful enterprise, and twenty thousand 1½ to 2 inch yearling crappie or sunfish to an acre of water would be likewise notable. These numbers have been realized and in some instances exceeded, but the average results are doubtless much smaller.

The stock will be decreased through cannibalism at least 50 per cent by the end of the second year and the yearlings held over will consume a large percentage of the fry hatched during the second and succeeding years of operations. Enough should survive, however, to maintain the adult stock at the maximum number that the pond will support.

In waters of high temperature those species adapted to culture in ponds will attain maturity and reproduce at the age of 2 years. In cool waters reproduction may be delayed until the fourth year, or in case the species is very poorly adapted to the temperature conditions the fish may remain small, stunted specimens throughout life and never reproduce.

ENEMIES

There are many enemies of fish, especially of fry and fingerlings, against which the fish-culturist must wage continual warfare. The heaviest losses will result from cannibalism, and these will be gauged by the balance of the food and fish in the pond. Some species are more predacious than others. For this reason black basses, the scourge of restricted waters, are recommended only for large areas of the highest fertility. Such species as pike and pickerel should never be selected for culture in ponds, as they are the most piratical and devastating fishes inhabiting fresh waters.

It is necessary to guard closely against the inadvertent establishment in a pond of any undesirable species of fish or animal. Turtles and snakes will consume large numbers of fry and fingerlings in the course of a season and should be barred from the waters as strictly as possible. Kingfishers, herons, ducks, mudhens, and fish hawks soon discover a pond and prove most persistent poachers. Powder and shot is their most effective deterrent. If inroads on the stock are made by mink, they should be trapped in season—at a time when they will, at least in part, make reimbursement for their board. Muskrats, while not fish destroyers, work havoc with pond embankments and should be exterminated.

METHODS EMPLOYED BY THE BUREAU OF FISHERIES IN THE DISTRIBUTION OF FISH

The Bureau of Fisheries will undertake to furnish fish to individuals for stocking public and private waters. Blanks upon which to submit formal application will be supplied on request. Assignments of fish are made large enough to form the nucleus for a brood stock for a given area of water and are delivered at the applicant's railroad station free of charge. From the information given in these applications the bureau decides as to the suitability of the waters for the fish asked for and reserves the right to substitute other species if in its judgment the applicant's selection is ill chosen or it is impossible, with its limited facilities, to supply the species specified within a reasonable length of time.

None of the pondfishes recommended in the foregoing pages will be furnished by the bureau for stocking lakes or streams in Washington, Oregon, California, Idaho, Nevada, or the western portions of Wyoming or Montana, as it is believed their introduction into such waters might prove detrimental to the important salmon and trout fisheries of the Pacific coast.

REMOVING FISH FROM PONDS

In removing fish from a pond at any time the same care should be exercised as in handling stock, due precaution being taken to reserve the best specimens for breeders and to retain a sufficient number for future reproduction. Their number and size must be left to the judgment of the proprietor of the pond, as it will vary greatly with the character of the water, size of the pond, climatic conditions, and geographical location.

In southern latitudes pondfishes commence nest building in March, while farther north, in Iowa and Illinois, reproduction does not occur until May or June. Young fish recently hatched are very tender and should not be molested for at least 30 days.

Care should be taken in removing adult fish from a pond, especially during the spring and summer months. In making the selection the larger fish should be preferred to the medium-sized ones, as the larger specimens are very destructive to the smaller fish. They are not as prolific as those of average weight and usually have attained their size through cannibalism.

If a few fish for table use are desired, and one has the time, they can probably best be taken with hook and line. A fyke net might be used under certain conditions, or a few might be taken in a trap constructed of light wooden framing covered with netting or galvanized wire cloth of about 1-inch-square mesh. The trap should have a cone-shaped entrance for the fish, and the interior should contain a few minnows in a wire cage, which are used as bait.

Where many fish are to be removed from a pond a seine should be employed. To use it to the greatest advantage about one-third of the water should be drawn off; this will cause the adult fish to congregate in the deeper waters, where they may be secured more readily. The water should be drawn off slowly in order to give the small fish a chance to follow it down.

Before drawing the pond the vegetation should be removed from the lower portion of it, where the seine is to be hauled. It may either be cut or raked out from the bank with a long-handled garden rake. Wading in the pond is to be avoided as it makes the water roily and leaves deep holes in the bottom, in which the young fish are likely to be caught.

In lowering the water vegetation of a rank and dense growth is very apt to settle down and smother the young fish. It should be moved as soon as observed, but cat's-tail and other plants having stems of sufficient strength to support them in an upright position need not be removed unless this is necessary in order to haul the seine.

In many instances it might not be necessary to draw off the water if the vegetation were removed from a portion of the pond and the fish fed regularly in the cleared space. for with a seine could be passed around them and a large number secured.

It is inadvisable to draw a pond during the warm summer months unless one has the supply of water available to refill it at once.

Better results are attained by drawing off the water in the cool fall months, but even then one should be sure of being able to refill the pond before freezing weather. For this reason it is believed that seining with a large net in the clearing where the fish have been accustomed to feed would give the best results.

When the proper amount of water has been drawn off the seine should be laid out from a boat and hauled toward the bank at the deeper end of the pond. In case the deepest place is near the middle of the pond, it will be necessary to work the seine around the fish and haul it toward the nearest bank.

Should more fish be removed from the pond than are desired for immediate use, the surplus can be placed in a floating live box anchored near the outlet or where the water is deep. This box should be made of wooden slats placed far enough apart to permit a free circulation of water and yet retain the fish. The slats should be nailed to a small frame of 2 by 2 inch material, forming a box 16 feet long, 4 feet wide, and 3 feet deep and provided with a hinged cover.

If preferred, a small inclosure in the pond, fenced with galvanized wire, might be provided for holding surplus fish, removing them when required with a large hand dip net or a small seine. The advantage of the inclosure over the live box is that it will not crowd the fish, and they can thus be held under more natural conditions.

PRODUCTION OF FISH FOR STOCKING PURPOSES

While the foregoing information is largely applicable to the production of fish, either for food or for transplanting to fishing waters, the two purposes are somewhat different, and some variation in procedure is necessary. In one case the object is to produce the greatest possible poundage of adult edible fish, while in the other the aim is to provide the greatest possible number of individuals 2 or 3 inches or more in length. To accomplish the latter purpose it is desirable to assure a minimum of cannibalism by providing an abundant food supply, usually correlated with an extensive water area, in which the fish can forage. Above all, it is essential to segregate the various ages so that any one pond will contain fish of the same season's hatch only; although, if it is impossible to remove the parent fish, they will not prey upon their progeny to the same extent as would the yearlings.

Spawning ponds therefore should be drawn down yearly and the season's output planted in open waters or transferred to other ponds for rearing. In the case of bass it is desirable, if possible, either to remove the adult fish after the schools of fry have scattered or, preferably, to remove at least half of the young fish to another rearing pond. It is frequently the case that 50 per cent or more of the bass fry may be removed from a spawning pond, and virtually as many 2-inch or 3-inch fingerlings will be obtained from the original pond as would be the case if none had been removed. The quantity of fingerlings secured from the transferred stock thus constitutes an additional return. The fry may be captured before the schools have scattered entirely by means of a bobbinet seine 10 or 12 feet long or a rectangular dip net of the same material operated from the shore. At the bureau's hatcheries fry are captured by circular wire fry retainers or by special fry traps, construction details of which will be furnished on application.

It is obvious from the foregoing that many ponds that are satisfactory for raising of a limited number of adult fish for food will be useless for raising fish for stocking purposes. If conditions are such that virtually 100 per cent of each season's hatch of fingerlings can not be removed, the pond will be lacking in one of the primary essentials for this purpose. Many mill ponds, ice ponds, and similar ponds, which may be very productive of fish, will be of no value as nursery ponds because the crop can not be harvested. The ideal plan for a project to be devoted to the rearing of fish for angling is to have a series of several ponds, only one of which will be stocked with breeders, the rest serving as nurseries. In this respect a practice should be followed that may not be applicable to farm fishponds that are kept constantly stocked. If possible, ponds should be left dry for several months of the year, preferably during the winter. This sweetens the soil, tends to check the development of obnoxious vegetation or diseases, and permits cultivation of the pond bottom.

In stocking a pond for fry production only a small number of breeders will suffice. Not more than 40 adult bass should be allotted to an acre of water, and under favorable conditions half this number will produce all the young the pond will support. There is no advantage in hatching a surplus of fry to compete among themselves for food with a resultant production of underfed fingerlings of little value for stocking.

Any pond that meets the above requirements will, of course, serve equally well as a rearing pond for the retention of young fish received from Federal or State hatcheries. While the confinement of any large number of young bass in a small pond undoubtedly augments the losses due to cannibalism, the protection from other enemies generally prevalent in open waters will, to a large extent, offset this drawback. Under intensive methods, with attention to pond fertilization, artificial feeding, etc., an acre of pond may be made to produce 10,000 or more 2-inch to 4-inch bass at an age of 5 months. Ordinarily, however, a production of one-half or two-thirds of this number may be considered highly satisfactory. In stocking a pond with fry a loss of from 50 to 65 per cent may be expected during the first six months. Hatches of 20,000 or 30,000 fry per acre are not unusual, however, and nature has thus provided for this early mortality.

A number of sportsmen's organizations have provided their own bass hatching and rearing establishments along these lines with great success. Some have utilized ponds in city parks, others have constructed entirely new ponds, while others have altered existing natural ponds to serve their purposes. In Michigan the State authorities have furthered such work by creating an official position, the duties of which are the development and supervision of such projects. Wherever it is intended to carry on such operations on any but a limited scale the whole project should be reviewed by a competent fish-culturist for the purpose of determining its feasibility and the most efficient scheme of development.

O

FISHING GROUNDS OF THE GULF OF MAINE[1]

By Walter H. Rich
Agent, United States Bureau of Fisheries

CONTENTS

INTRODUCTION

Paralleling the northeastern coast line of North America lies a long chain of fishing banks—a series of plateaus and ridges rising from the ocean bed to make comparatively shallow soundings. From very early times these grounds have been known to and visited by the adventurers of the nations of western Europe—Northman, Breton, Basque, Portuguese, Spaniard, Frenchman, and Englishman. For centuries these fishing areas have played a large part in feeding the nations bordering upon the Western Ocean, and the development of their resources has been a great factor in the exploration of the New World.

According to statistics collected by the Bureau of Fisheries,[2] these banks annually produce over 400,000,000 pounds of fishery products, which are landed in the United States; and, according to O. E. Sette,[3] annually about 1,000,000,000 pounds of cod are taken on these banks and landed in the United States, Canada, Newfoundland, France, and Portugal.

Apparently the earliest known and certainly the most extensive of these is the Great Bank of Newfoundland, so named from time immemorial. From the Flemish Cap, in 44° 06′ west longitude and 47° north latitude, marking the easternmost point of this great area, extends the Grand Bank westward and southwestward over about 600 miles of length. Thence, other grounds continue the chain, passing along through the Green Bank, St. Peters Bank, Western Bank (made up of several more or less connected grounds, such as Misaine Bank, Banquereau, The Gully, and Sable Island Bank); thence southwest through Emerald Bank, Sambro, Rose-

[1] Appendix III to the Report of the U. S. Commissioner of Fisheries for 1929. B. F. Doc. 1059. Submitted for publication Jan. 18, 1929.
[2] U. S. Bureau of Fisheries Statistical Bulletin No. 703.
[3] U. S. Bureau of Fisheries Document No. 1034.

way, La Have, Seal Island Ground, Browns Bank, and Georges Bank with its southwestern extension of Nantucket Shoals. To all these is added the long shelving area extending from the coast out to the edge of the continental plateau and stretching from the South Shoal off Nantucket to New York, making in all, from the eastern part of the Grand Bank to New York Bay, a distance of about 2,000 miles, an almost continuous extent of most productive fishing ground.

Within the bowl that is the Gulf of Maine, the outer margin of which is made by the shoaling of the water over the Seal Island Grounds, Browns Bank, and Georges Bank, this chain is further extended by another series of smaller grounds, as Grand Manan Bank, the German Bank, Jeffreys Bank, Cashes Bank, Platts Bank, Jeffreys Ledge, Fippenies Bank, Stellwagen or Middle Bank; and again, lying inside these, this fishing area is increased by a very large number of smaller grounds and "fishing spots" located within a very short distance of the mainland. All these banks are breeding places of the most valued of our food fishes—the cod, haddock, cusk, hake, pollock, and halibut—and each in its proper season furnishes fishing ground where are taken many other important species of migratory and pelagic food fishes as well as those named here. It is probable that no other fishing area equaling this in size or in productivity exists anywhere else in the world, and the figures of the total catch taken from it must show an enormous poundage and a most imposing sum representing the value of its fishery.

With the most distant of these grounds we shall not deal here, leaving them for later consideration when noting certain of the fishery operations most characteristic of them. Thus, we may treat of those well-defined areas that lie within or are adjacent to the Gulf of Maine, such as the Bay of Fundy, the Inner Grounds (those close to the mainland), the Outer Grounds (those within the gulf), the Georges area, Seal Island Grounds, and Browns Bank, these forming the outer margin of the gulf; and also make mention of certain others of those nearer offshore banks that are most closely connected with the market fishery of the three principal fishing ports within the Gulf of Maine.

ACKNOWLEDGMENTS

As to the charts, it has been the writer's endeavor, by consulting a large number of fishing captains of long experience upon these grounds, to reduce the margin of inaccuracy as much as possible. In case of conflict of their opinion, the greatest agreement as to the facts has been accepted.

The grounds as drawn are not meant to include any definite depth curve but are meant to show certain fishing areas. It is known, of course, that most species frequent the shallows and the deep water at the various seasons; also, that certain other species are found on the deeper soundings during virtually all the year. Thus, if a given area appears as a larger ground than is shown upon other charts made for navigating purposes, often this is because we have included in it a cusk ground or a hake bottom lying adjacent to the shoal as charted.

A large number of these grounds have been described before by G. Browne Goode and others, and where possible their work has been used as a basis for the present paper, with any further information or the noting of any changed condition of the grounds or difference in fishing methods employed upon them that was obtainable.

Grateful acknowledgment is hereby made to the many captains who furnished information that made the drawing of the charts possible and for the facts used in the descriptions of the fishing grounds.

With the offshore banks, particularly with the Georges area and Browns Bank and to a certain extent, also, the western portion of the Inner Grounds, the writer has had a considerable personal acquaintance from which to draw.

For the geographical and historical data the writer has quoted freely from various modern authors, who, in their turn, have drawn their facts from older records. Among those quoted are Holmes's American Annals; Parkman's Pioneers of France in the New World; Southgate's History of Scarboro; Abbott and Elwell's History of Maine; Willis's History of Maine; Sabine's Report on the Principal Fisheries of the American Seas; A History of the Discovery of the East Coast of North America, by Dr. John G. Kohl, of Bremen, Germany; various chapters of Hakluyt's Voyages; the Journal of John Jocelyn, Gent.; and New England Trials of the famous Captain John Smith.

GULF OF MAINE

GEOGRAPHICAL AND HISTORICAL

Name.—What is apparently the earliest mention of this body of water appears on some old Icelandic charts that show, roughly, Cape Cod Bay in their southern areas and the Bay of Fundy in the northern. On these maps the cape itself was shown on the "Promontory of Vinland" and was given the name Kialarnes, or the Ship's Nose, from its resemblance in form to the high upturned prow of the old Norse ships. To the entire area of the gulf was given the title Vinland's Haf.

Oviedo (Historia General de las Indias) sometimes names this gulf the Arcipelago de la Tramontana, or the Arcipelago Septentrional—the northern archipelago. He gives us to understand that he, himself, or Chaves, had this information from the Report and Survey of Gomez, who, in his search for a northwest passage to Asia in 1525, "discovered all these coasts lying between 41° and 41° 30′ north." As a matter of fact, his careful explorations certainly covered all the territory between 40° and 45°.

The Spanish navigators who followed Gomez, in describing these coasts, when indicating this gulf, usually named it in honor of Gomez, the first of their nation to make a careful survey of its shores. Thus it became known as the Arcipelago de Estevan Gomez, and the mainland behind it as La Tierra de Gomez. It was so named on the map of Ribero in 1529 who thus acknowledged the source of his information. The Biscayans followed Gomez but later gave way to the French fishermen, who followed down the chain of banks extending southward from the Grand Bank and entered these waters by way of Cape Sable. These gave to it the name Gulf of Norumbega or Sea of Norumbega. The name Norumbega was for a time applied to the coast lands and to the inland country stretching away indefinitely westward and northwestward from the waters of the gulf. Later, with the coming of the English and the establishment of their colony in Massachusetts, the title Massachusetts Bay came into general use, although this name was afterwards restricted to the smaller section of the gulf at present so termed.

The charter of Gorges (in April, 1639) designated the territory deeded to him as the Province or County of Maine,[4] whence, perhaps, the modern custom of referring to these waters as the Gulf of Maine may have arisen. This latest name seems especially appropriate, in view of the fact that the present State of Maine, lying directly opposite its entrance capes, stretches along the inner borders of the gulf and with its deeply indented shore line occupies by far the greatest section of its coasts. Thus the title has finally come into general use and acceptance in modern times. Apparently it was first officially proposed and used by the Edinburgh Encyclopedia in 1832[5] and later was adopted by the United States Coast Survey.

Description.—A very striking and peculiar body of water is this Gulf of Maine, markedly different in character from any other of the bays on the coast line of the eastern United States. Especially does it differ in the depth of its coastal waters, where in all the others, except the much smaller New York Bay, the shoal water is found extending far out from the land. In the Gulf of Maine, however, with the single exception of the vicinity of Ammens Rock on the eastern part of Cashes Bank, the entire central area presents navigable deep water having a mean depth of 100 fathoms, out of which rise the various underwater plateaus, whose depths average about 50 fathoms and which constitute the larger of the fishing grounds. In addition to these, many smaller banks and "fishing spots" are found nearer the land, where they lie along the 50-fathom curve. In general this curve lies at a distance of about 16 miles from the coast line, but in many instances it approaches much nearer to the mainland. From this 50-fathom depth the soundings decrease very gradually to the 20 and 10 fathom marks. These latter soundings are often held far in toward the coast line, even carrying the deep water well into the river mouths, so that in deeply indented bays, in long inlets running far into land, in the river mouths, the deep water behind the rocky headlands, or in the lee of the thousands of surf-washed islands that line the coast, are found innumerable safe anchorages within easy run of the fishing grounds, where the fleets may take shelter from a sudden blow or await the arrival of a "fish day," when conditions may permit "making a set" under the hardships of winter fishing.

If the marine features of this region are radically different from those of other coastal bodies of the eastern United States, so, too, the shore land, battered as it has been by sea and storm or worn by glacial action or by Arctic currents, is no less remarkable. No other section of the eastern United States has a similar coast, so serrated, indented, and rugged, as has this shore line of the Gulf of Maine. Here the battering by the forces of nature has resulted in making

[4] "All that parte, purport and porcion of the Mayne Land of New England, we doe name, ordeyne and appoynt shall forever hereafter bee called and named The Province and Countie of Mayne."

[5] Edinburgh Encyclopedia, Philadelphia edition, by Thomas Parker, Vol. XVIII, p. 263.

thousands of safe harbors and havens for the navigator. All along shore are strewn hundreds of islands, a characteristic feature of the region and one noted with wonder by every early explorer.[6] These islands, if near the land, are beautiful and smiling; if in the open sea, of rugged grandeur; and mainland and island alike are inhabited by a numerous and hardy race of fisher folk.

The tides within the Gulf of Maine have a very great rise and fall as compared with other waters in this region. At the south of Cape Cod tides are seldom over 4 feet in their range, but beginning at once at the north of Cape Cod with a rise of from 7 to 10 feet these increase quite constantly as they go eastward, reaching about 28 feet in the neighborhood of Passamaquoddy Bay, to touch their highest point in the Bay of Fundy, where in many places is a rise and fall of 50 feet, and in some few places tides of 70 feet are reported. These Fundy tides probably are the greatest in the world.

This great ebb and flow of water serves to aid shipbuilding and the launching of vessels as well as to carry the deep water far up into the inlets of the coast and into the mouths of the rivers, making these navigable for crafts of considerable size well into the land or up to the lowest falls of the streams.

The climate here is one of extremes, and, lying as it does between 42° and 45° north latitude, the region may be said to be cold. Apparently the waters of the Gulf of Maine are not affected by any stray current from the Gulf Stream, which passes at a considerable distance from its mouth, thus doing little to temper the cold of this area either on land or at sea. Whether these waters are cooled further by any flow from the Labrador Current may be questioned.

The winters are long, usually bringing heavy snowfalls; and strong gales are frequent during much of the fall and winter season. Perhaps the most dangerous of these "blows" come out of the mountains to the north and northwest of the gulf. Thus, in addition to the uncertainty of an opportunity to set gear when once upon the fishing grounds, the winter fishing here is not without its element of serious danger. While the ice crop in northern New England never fails, yet, perhaps because of the strong tidal currents of these waters, the principal harbors rarely are closed by ice, or, if closed, for but a few days only.

While the summers are fairly mild and in certain parts of them even extremely hot, fogs are heavy and virtually continuous during the "dog days" (July 20 to September 1), when southerly and southwesterly breezes bring the warm moist air from the Gulf Stream into the cooler currents from the land. The fogs of Fundy are especially noted, even in these waters. During the summer seasons winds from the east and north bring the only clear weather experienced in the outer chain of fishing grounds.

The main body of the gulf lies approximately between 42° and 45° north latitude. It is in form like a deep bowl whose outer rim is made by Georges Bank and Browns Bank, with a narrow, deep-water spillway between; its area is half encircled in the arms of the main-

---

[6] William Strachey (1609), speaking particularly of Casco Bay, but the words equally applicable to almost any stretch of the Maine coast, says: "A very great bay, in which there lyeth soe many islands and soe thick and neere togither, that can hardly be discerned the nomber, yet may any shipp passe betwixt, the greatest part of them having seldome lesse water than eight or ten fathome about them." (Historie of Travaile into Virginia Britannica.)

land, two conspicuous headlands reaching bodily seaward to mark its wide entrance at the opposite sides—Cape Cod,[7] Mass., on the western side, and Cape Sable,[8] Nova Scotia, on the eastern flank, distant from each other about 230 miles. These two capes range with each other about ENE. and WSW., thus matching alike the general trend of the coast line, of the island chains, and of the offshore ledges within this area.

From a base line connecting these outposts of the gulf the distance to the Maine coast opposite averages about 120 miles. From Cape Sable, at its eastern end, the coast trends for some distance to the northwest, whence a continuation of this course strikes the coast of Maine near West Quoddy Head at a distance of rather more than 110 miles. From West Quoddy Head to Cape Elizabeth (in a direct line about 160 miles) the coast, in general rough, rocky, and with many lofty headlands, is extremely irregular and deeply indented and follows a general course of WSW. Thence, the coast, lower and becoming more and more sandy, begins to trend more decidedly southwest until it reaches Boston, when it turns to the southeast and to the east toward Cape Cod.

But this is not the entire story. There remain outside of these stated limits the Bay of Fundy in the north, with a possible area of 3,000 square miles; and at the south Cape Cod Bay, whose area, with that of the waters west of a perpendicular drawn from the western end of the base line that strikes the land in the vicinity of Portsmouth, N. H., makes an additional section containing close to 1,500 square miles. Within the limits thus inclosed there are, roughly, 30,000 square miles of most productive ground most intensively fished through all the year.

The Bay of Fundy is divided at its head by Cape Chignecto, making two branches to north and to east—Chignecto Bay and Minas Basin. With these smaller areas, lying as they do entirely within the territorial limits of Canada, American fishermen have little to do, although both are valuable and productive fishing grounds.

BAY OF FUNDY

At the different seasons of the year the entire Bay of Fundy[9] is a fishing ground for sardines and large herring; and while these are of somewhat less importance in recent years than formerly, the

[7] This, the most striking cape of the Atlantic coast line, made a very prominent landmark for all the early ocean voyagers approaching it, and all were greatly impressed by it, whether they came from the south and fought their way through its shoals to eastward, or, coming from the north, found themselves caught in the deep pocket which it makes with Cape Cod Bay. The Spaniard Gomez (1525) gave it the name "Cabo de Arecifes"—cape of the reefs—referring to the dangerous shoals to the eastward. The Frenchmen Champlain and De Monts named it "Cape Blanc," and the Dutch pilots, also noting its sandy cliffs, called it "Witte Hoeck." The English mariners at first accepted this last name of "White Cape," but the English captain Anthony Gosnold, the first to make a direct passage to the waters of the Gulf of Maine from Europe, although at first he called it "Shoal Hope," soon changed this, because of the success of his fishing, to "Cape Cod," which title, commonplace though it be, has been the name to endure despite Prince Charles's attempt to change it to "Cape James" in honor of his father.

[8] Cape Sable, at the southern end of Nova Scotia, has held this title from very old times. It is so indicated on a Portuguese map of the middle of the sixteenth century.

[9] "It [Fundy] was not clearly indicated by Verrazano (1524) nor in the report of Gomez (1525), who probably saw something of its entrance; but fog or other unfavorable circumstances may have prevented him from observing it more accurately; but we find in the first old Spanish maps, in the latitude where it ought to be, names like these: 'Rio hondo,' or 'fondo' (a deep river); or 'Bahia hondo' (a deep bay); or 'Golfo' (a gulf); once, also, 'La Bahia de la Ensenada' (the bay of the deep inlet)."

Doctor Kohl, here quoted, further says: "On the maps of the seventeenth and early part of the eighteenth century, especially, it is written Bay of Funda. I believe that this name grew out from, and is a revival of, the old Spanish name 'Bahia fonda.'"

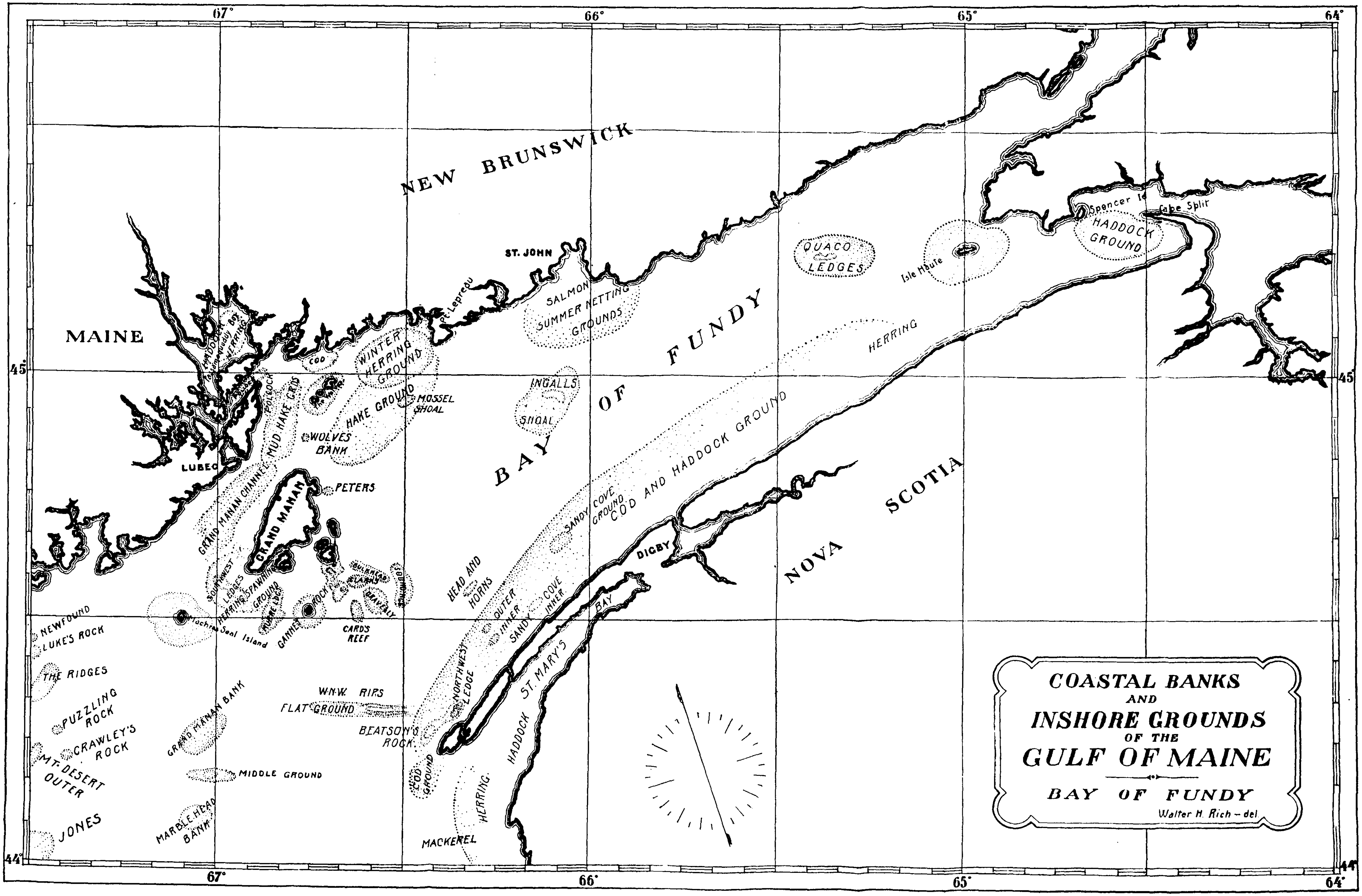

COASTAL BANKS
AND
INSHORE GROUNDS
OF THE
GULF OF MAINE
BAY OF FUNDY
Walter H. Rich - del
NEW BRUNSWICK
MAINE
BAY OF FUNDY
NOVA SCOTIA
ST. JOHN
LUBEC
DIGBY
Pt. Lepreau
Spencer Id
Cape Split
HADDOCK GROUND
Isle Haute
QUACO LEDGES
SALMON
SUMMER NETTING GROUNDS
HERRING
INGALLS
SHOAL
COD AND HADDOCK GROUND
SANDY COVE GROUND
WINTER HERRING GROUND
COD
HAKE GROUND
MOSSEL SHOAL
WOLVES BANK
MUD HAKE GRD
GRAND MANAN CHANNEL
GRAND MANAN
PETERS
SOUTHWEST LEDGES
HERRING SPAWNING GROUND
Machias Seal Island
GANNET ROCK
CARD'S REEF
HEAD AND HORNS
OUTER
INNER
SANDY COVE
ST. MARY'S BAY
NORTHWEST LEDGE
HADDOCK
NEWFOUND
LUKE'S ROCK
THE RIDGES
PUZZLING ROCK
CRAWLEY'S ROCK
MT. DESERT OUTER
JONES
GRAND MANAN BANK
W.N.W. RIPS
FLAT GROUND
BEATSON'S ROCK
MIDDLE GROUND
MARBLE HEAD BANK
COD GROUND
HERRING
MACKEREL
67°
66°
65°
64°
45°
44°

Figure 1

principal fisheries of this region still center around the herring industries—the supplying of the canning factories with the small herring used as sardines and the taking of large herring for food and bait. The sardine industry of the State of Maine is largely concentrated in the district about and including Eastport and Lubec, where about 30 of the 59 factories and 16 of the 43 operating firms are located; so that, while the herring catches of recent years have fallen much short of their former proportions, they still show imposing figures.

In the past much of the catch was taken in St. Andrews (Passamaquoddy) Bay and along the north shore of the Bay of Fundy to Lepreau Bay and Point Lepreau. Of late years virtually no herring have been taken in these waters, in which the herring schools that arrive in October were accustomed to remain until spring. Of past fishing in this locality Capt. Sumner Stuart, of Lubec, says:

> The herring left St. Andrews Bay and the North Shore about 1885. There is no summer netting there now. Those waters and Lepreau Bay were formerly very productive fishing grounds, it being not unusual to take 5,000 (count) big herrings (food fish) in a single haul. These were mainly spring and winter fishing grounds for large herring. The fish seem to have disappeared from all these grounds at about the same time.[10]
>
> In past years (25 to 30 years ago) small herring were driven ashore in such quantities by their enemies—squid, silver hake, and dogfish—that it sometimes became necessary for the authorities at St. John to use a snowplow to cover them where they lay decaying on the beach.

From the statistics of the sardine and smoked-herring industry for the year 1924 (a year, be it noted, in which the sardine industry almost reached low-level mark for the pack) the waters of the Bay of Fundy furnished to American purchasers alone a total of herring for smoking and canning purposes amounting to 76,756,250 pounds, valued to the fishermen at $957,665. This showing, poor as it is when compared with the figures of other years, by no means represents the herring fishery as an unimportant industry. There still remains to be accounted for the catch of herring of Grand Manan and the neighboring Canadian Provinces.

A new source of profit to the fishermen in this industry has been developed in the purchase of herring scales by firms engaged in the manufacture of artificial pearls. For this purpose there were collected at Eastport and Lubec 700,000 pounds of herring scales, valued at $39,000; and a further amount was taken at Grand Manan of 140,000 pounds, valued at $7,000. With other entrants already in the field, this branch of the industry bids fair to grow to still greater importance.

An estimate of the number of weirs in St. Andrews Bay, by Capt. Guilford Mitchell, of Eastport, Me., is as follows:

Canadian, 1921, 126; 1923, 40.

Calais to Eastport, 1921, 35; 1923, 7.

Total number in operation, 1923, Canadian, about 300; American, less than 130.

North Shore and coast of Nova Scotia.—Along the North Shore and from Yarmouth to Cape Sable, over a hard bottom, cod abound. The western shore of Nova Scotia is virtually all fishing ground for cod, haddock, hake, and cusk,

---

[10] It is gratifying to announce that the winter of 1925-26 saw a large run of herring on this ground, where for a number of years past there has been virtually no fishing for this species.

but trawling is somewhat handicapped here by strong tides and rocky bottom, these combining to destroy much gear. Halibut are somewhat unusual on this western shore except about the mouth of the Bay of Fundy, but in summer these fish are occasionally found close inshore along the southwest coast, going somewhat beyond Digby to the northward. Haddocking is quite an important industry off Yarmouth, Nova Scotia, during the winter, the sets being of rather short duration and made at the slack of the tide at high water. This practice is made necessary by the heavy tidal currents on these grounds.

The whole western coast of Nova Scotia is herring ground at some season of the year. "Drifting" for herring was formerly a considerable industry from Digby to Briers Island, but in these last few years it has not been important, although the year 1927 had a very good run of large food fish. This western coast is also an important fishing area for lobster men.

Swordfishing in the Bay of Fundy was formerly profitable in September, although these fish were never so numerous here as upon the outer shore of Nova Scotia.

St. Marys Bay is a summer herring ground. Good haddocking may be had here, also, from April 15 to October 15, with the period from the opening of the fishing in April up to July 15 the best of it.

The mackerel fishery of the Bay of Fundy seems of comparatively small importance in these latter years. The local fishermen say that the fish can not stem the tides of these waters! The abundance of small herring should be an inducement sufficient to bring them here. Apparently these fish pass straight inshore northwesterly and reach the coast of Maine. A considerable amount of this species is taken by traps and by netting in St. Marys Bay and in the general vicinity of Yarmouth, Nova Scotia, as at Cranberry Head, Burns Point, Beaver River, Woods Harbor, and at various other points between Yarmouth and Cape Sable; but the inner waters of the Bay of Fundy show very small catches when compared with the great amount taken on the outer shores of Nova Scotia in a normal mackerel season. It has been 32 years, it is said, since any number of mackerel have been "hooked" in St. Marys Bay.

Lurcher Shoal.—This lies WSW. from Cape St. Mary 19 miles and WNW. from Cape Fourchu, distant 13 miles. It is an irregularly shaped piece of bottom, a rocky ground, about 5 miles long, north and south, by 3 miles wide. There are a number of "nubbles" rising to 5, 7, and 9 fathom depths—with a spot reported as having only 12 feet of water over it—rising from the average depths over the rest of the shoal of from 13 to 15 fathoms. Over this generally rocky bottom are scattered patches of gravel and of shells. Depths about the shoal are from 30 to 50 fathoms over a bottom consisting mostly of stones. Tide rips are very heavy here. The seasons and species found here are as on Trinity—cod, haddock, pollock, and herring. It is a good lobster ground.

Trinity Shoal.—This shoal, 14 miles N. by W. from Cape Fourchu and 7½ miles SW. from Cape St. Mary, with a rocky bottom upon it and over an indefinite area about it, is perhaps 3 miles long, NE. and SW., by some 2 miles wide. Near the center is a rock, uncovered at low water, but over the greater part of the shoal there are depths of from 6 to 10 fathoms, with an average of from 12 to 16 fathoms over the sandy and stony ground about it. There is a strong tide rip here on the eastern and northeastern part known as Flood-Tide Eddy, where is good fishing by hand line for pollock in September and October. Cod and haddock are taken here in small amounts by trawling. It is a herring ground also, and there is a lobster ground on the shoal and all about it.

A cod ground extends offshore SW. from Briers Island, beginning about 5 miles out from the island and extending to about 18 miles from the land. Its width is about 4 miles. Depths over this area are from 40 to 60 fathoms over a hard, shelly bottom. Cod are taken here in from 30 to 44 fathoms on the shoal ground running from 5 miles from Gull Rock and the South-West Ledges down to the Lurcher Shoal, a distance of about 22 miles. Between these points fishing is done mostly by hand-lining "at a drift." Cod are taken over the ledges in 5 fathoms of water and thence out to 60 fathoms about them from August to November. Pollock are taken by the same method. The best season is August, September, and October. This is a good lobster ground.

Northwest Ledge.—Lies about 3¾ miles northwesterly from Briers Island. This is a piece of rocky bottom about 2 miles long by something less than 1 mile wide with depths of from 2 to 10 fathoms over the ledge and soundings of 12 to 30 fathoms on the gravelly ground about it. Cod are found here in good number from September to November, inclusive, and are taken by hand-lining. Pollock also are taken here in summer, "drailing" by hand line.

A narrow piece of rocky ground with somewhat greater depths connects this with Batsons Shoal, some 5 miles SW., the two thus making what is virtually one piece of ground. Depths on Batsons Shoal are rather less than on Northwest Ledge, but the methods of fishing, the species taken, and the seasons of their abundance are the same on both. The bottom all about these two grounds is rocky, with from 20 to 40 fathoms inside of them, but this deepens rapidly to 100 fathoms over rocks and coarse gravel outside of them to W. and NW.

West-Northwest Rips and the Flat Ground.—These lie WNW. from Briers Island, extending offshore about 18 miles. On the eastern end of this area two parallel shoals, about 1½ miles across and having 50-fathom depths between them, rise from the 100-fathom depths of water over the muddy ground around them to reach 15 fathoms on the landward end of the rips, deepening to 35 fathoms on the western part, where the two ridges come together at about 9 miles distance from Briers Island, to carry on to the westward over the Flat Ground, which extends to a distance of about 18 miles from the island. This Flat Ground, deepening gradually westward, averages to have 50 fathoms of water over a level, gravelly, and rocky bottom, to pitch down suddenly, as do all other slopes of this piece of ground, to the 100-fathom depth, which prevails on all sides of The Rips.

Currents are very strong here, as elsewhere in these waters, so that trawls are set only on the slack of the tides, beginning about one hour before and remaining down until about one hour after these periods. Formerly this was a good ground for the taking of large herring. In these days The Rips furnish good cod and haddock fishing for the entire year, with hake abundant at all times on the mud about them. In fact, virtually all the ground from this point S. to the Lurcher Shoal furnishes good fishing for these species.

Inner or Boars Head Ground.—This parallels the coast about 4 miles N. by W. from the Boars Head, at Petit Passage, into St. Marys Bay. This ground is about 4 miles long by 3 miles wide, having depths from 55 to 65 fathoms over a hard bottom of broken ground. Cod are most numerous here from April to July, inclusive; haddock from July to September, inclusive. Hake are found here in summer and early fall, principally on the muddy ground between this and the next fishing ground—the Outer Ground.

Outer Ground.—This is about 3 miles long by 2 miles wide, lies about 9 miles out from the main on the same bearing as the Inner Ground, and is visited by the same species, their periods of abundance upon this piece of bottom being the same as on the former ground. Virtually all taking of ground fish on these grounds is done by hand-lining, though the practice of trawl fishing has come more and more into use in recent years.

Head and Horns.—A shoal of 68 fathoms, about 2 miles long in a NNE. and SSW. direction by 1 mile wide, lies due north from the Boars Head of Long Island. Here is a hard bottom where good cod fishing is had during the spring and summer. Hand-lining from the bottom is carried on in summer for pollock. Haddock are few here, these appearing mostly in the summer. Depths about the ground average 80 fathoms over mud and stones.

Sandy Cove Ground.—Lies offshore NNE. about 7 miles from West Sandy Cove. It has from 40 to 50 fathoms of water over a sandy bottom, lying parallel with the coast, about 4 miles long by 2 miles wide. Cod are abundant on this ground from May to July, hake coming somewhat later. As were most of the grounds of this vicinity, this ground was mainly a hand-line spot, but in recent years fishing here has been done mostly by the trawl method.

Inner Sandy Cove Grounds.—About 2 miles NNW. from West Sandy Cove. These are 3 miles long NNE. and SSW. by ½ mile wide. Both hand-lining and trawling methods of fishing are in use here, but the trawl is fast displacing the older gear. Depths are about 35 fathoms over a sandy bottom and 50 fathoms all about it. Species and their seasons of abundance are as on the Outer Sandy Cove Ground.

Almost anywhere between Spencer Island and Cape Split there is good haddock fishing in June and July and cod fishing in May and June. Depths are from 16 to 40 fathoms; the bottom is generally stony, with considerable areas of gravel. The fishing is done principally by trawling, rather short "sets" being made. Off Cape Split are considerable whirlpools, which, with spring tides, are very dangerous. These sometimes run 9 knots an hour.

Isle au Haute.—Lies far up within the bay 9 miles W. ½ S. from Cape Chignecto. All about this island are good summer haddock grounds with fair cod fishing. The latter are taken by trawling principally. Depths about the island are from 9 to 14 fathoms, deepening offshore to 35, the average depths being 22 to 27 fathoms. North of the island the bottom is generally sandy; elsewhere much of the ground is rocky or stony, with here and there a small patch of gravelly ground. To the S. of this ground, toward the Nova Scotia shore and to within 2 miles of the coast, the bottom is mainly muddy and of little account as a fishing ground. Tides are very heavy on all the inner grounds of the Bay of Fundy.

Quaco Ledges.—This ground lies about 10 miles SE. from Quaco Head and is out at low tide, the water about the ledges having depths from 14 to 30 fathoms over a bottom of stones and gravel. There is a heavy tide rip over these ledges when covered. These furnish good pollock fishing in the summer months, and cod fishing is carried on here by hand-lining from May to July.

A salmon-netting ground lies off about the Mouth Harbour and St. John Harbour, where these fish are netted, for the most part during June and July, when they are en route up the St. John River, where are their spawning grounds.

Ingalls Shoal.—This is the name given by some of the fishermen of the vicinity to a shoal lying about midway between Digby, Nova Scotia, and Point Lepreau, New Brunswick. This ground is about 9 miles long, NE. and SW., by about 5 miles wide. It lies about 22 miles NW. from Digby and 18 or 20 miles from Point Lepreau. The depths are from 35 fathoms on the shoalest area (where is a piece of ground some 4 miles long by 1 mile wide near the center of the bank, lying in a NE. and SW. direction), the bottom sloping away from this on all sides to 47 or even 55 fathoms in a few places. The bottom is mostly of sand and gravel or of small stones over much of the ground except for the shoal parts, where it is mainly rocky. This piece of fishing ground furnishes good cod fishing in June, July, and August, which formerly was carried on by hand-lining but now, as elsewhere in the bay, is more and more becoming a trawl fishery. Haddock and pollock also are taken here in fair amounts.

Mussel Shoal Ground.—This is a mussel-covered bottom lying 8 miles ESE. from the Eastern Wolf and 9 miles from Point Lepreau. It runs in an E. and W. direction and is about 2 miles long by 1 mile wide. Depths are from 40 to 50 fathoms. This is a mussel and scallop bed, where large cod are usually in abundance in winter. Pollock are plenty here in June, and hake are here and in the surrounding Hake Ground in all the summer months.

The Wolves.—These make a group of small islands lying N. ½ E. from Grand Manan, distant 8 or 10 miles. On the bottom of rocks and gravel, extending about a mile from the shores of these, in depths of from 18 to 34 fathoms, small boats and small vessels take a quantity of fish by trawl and hand line. These are mainly haddock and cod grounds in May and June and pollock grounds in June and July. It is also a winter lobster ground for Canadian fishermen.

The Wolves Bank.—This bank lies between The Wolves and Grand Manan, distant about 8 miles from East Quoddy Light, SE. ½ E. Marks: The Coxcomb, showing to the eastward and just touching on the western edge of Green Island; bring the heads of Grand Manan to form The Armchair, and White Horse and Simpson Island into range. This is a small-boat ground of scarcely more than 6 acres, with depths of 18 to 30 fathoms on a bottom of rocks and mud. Species and seasons are as on The Wolves. Southeast from The Wolves from 2 to 20 miles lies a piece of muddy bottom where hake are usually abundant in summer.

Campobello and vicinity.—Fair quantities of haddock and cod are found between Grand Manan and the American shore in the North Channel (Grand Manan Channel) between West Quoddy Head and Grand Manan in depths of from 40 to 50 fathoms, over a bottom of rocks, mud, and sand in June, July, and August and up to September 15, while hake is the most abundant species present. No haddock or cod are on these grounds in winter. Halibut are taken in small numbers in the North Channel in May, June, and July. Pollock are taken on the western side of Campobello Island, near the eastern side of Indian Island, and at the mouth of the channel between Campobello and Casco Bay Island. In all these places are strong tidal eddies. Some fish are taken by seining, but most are caught by hook and line in a small-boat fishery lasting from June 1 to September 1.

All around Campobello and Deer Island and on the New Brunswick shore as far as St. John are located weirs, which furnish large quantities of herring to the factories at Eastport and Lubec.

Passamaquoddy Bay.[11]—Depths here are from 10 to 24 fathoms, even 30 fathoms where the St. Croix River passes out into the sea. In general the bottom is muddy, although there are rocky patches.

In most years a school of cod "strikes" here in April, the early comers being mostly of small size, but the later arrivals may reach 30, 40, or even 60 pounds. Haddock sometimes make their appearance in the bay as early as May 1, remaining through August. Hake, also, are present from June to September, but this excellent fish is held of little account by local fishermen. A considerable flounder industry is developing in these waters, the fish being taken in specially devised traps as well as by the smaller otter trawls. Passamaquoddy Bay is also a spring netting ground for herring (food fish), and there are also many weirs in operation here each year whose catch goes to the factories of Eastport and Lubec for canning as sardines.

Pollock are very abundant, and a great deal of fishing for them is carried on from June to October, both by seine and hand line. At times the pollock completely fill the many herring weirs, until, from their numbers, there is no market for them. Pollock are also abundant at the same season and are taken by the same methods in the St. Croix River, though perhaps they leave the river a month earlier in the fall.

The Mud Hake Grounds.—These grounds extend about N. and S. between Campobello and The Wolves and from about West Quoddy Head to Grand Manan. Their length is about 15 to 18 miles and their width 3½ miles. This is a summer ground much used by Canadian fishermen out of Campobello, Grand Manan, and Beaver Harbor. It is said to be the best hake grounds in this vicinity. Depths are from 45 to 60 fathoms, and fishing is done by trawls and hand lines.

There is a stretch of muddy bottom from Point Lepreau and Beaver Harbor to Grand Manan, which furnishes good hake fishing. In general, the bottom on the western side of the Bay of Fundy is muddy.

Off Beaver Harbor on a mud bottom with 30 fathoms of water cod are found the year around, although this fishery is mainly carried on in the winter in small craft from Beaver Harbor and Campobello, mostly by trawling, but some hand-lining is carried on.

Grand Manan.—As elsewhere in these waters, the taking of herring is the most important fishery industry at Grand Manan. Weirs are operated here all about the southern and southeastern shores, where in most years these are built upon practically every available privilege around the island from Southwest Head and Whale Cove. The water about the Northern Head is too deep to permit of the operation of weirs. The winter season, however, sees considerable netting of herring here, the catch being mainly food fish, as the large herring are termed.

Weirs in the Bay of Fundy are usually fished from April to December for fish bait and sardine herring for the canning industry; but the season at Grand Manan begins early in July and regularly continues through August, September, and October and at times even to December. A few spawn herring appear at Seal Cove in August.

Netting grounds about the Southern Head are Southern Head Reef, 3 miles WNW. from Southern Head Light, in July and August; Seal Cove, also a netting ground in July and August; Bulkhead Rips, called also The Ripplings, lie 6 miles SE. by S. from Big Duck Island, with depths running from 20 to

---

[11] "According to Porter C. Bliss, a thorough student of the Indian dialects, Acadie is a pure Micmac word meaning place. In Nova Scotia and Maine it is used by the Indians in composition with other words, as in Pestum-Acadie; and in Etchemin, Pascatum-Acadie, now Passamaquoddy, meaning 'the place of the pollocks.'" (Doctor Kohl, Dis. of Maine, p. 234.)

"This derivation is doubtful. The Micmac word Quoddy, Kady, or Cadie means simply a place or region and is properly used in conjunction with some other noun; as, for example * * * Pestum-oquoddy (Passamaquoddy), the place of pollocks." (Dawson and Rand, in Canadian Antiquarian and Numismatic Journal.)

"La Cadie, or Arcadie: The word is said to be derived from the Indian Aquoddiaukie, or Aquoddie, supposed to mean the fish called a pollock. The Bay of Passamaquoddy, 'great pollock water,' if we may accept the same authority, derives its name from the same origin." (Potter, in Historical Magazine, I, 84.)

80 fathoms over a hard bottom of rocks. Formerly large catches of herring were taken at the latter place. Captain Stuart, before quoted, says:

> Practically no "drifting" at the Bulkhead in the past five years. These methods employed on the Murre Ledges (a collection of ledges from 5 to 8 miles SSE. from the Southwest Head of Grand Manan) and on The Soundings on the outer edge of The Ripplings. Drifting operations were carried on in the daytime during July and August, the catch being large herring.

Drift nets for herring are about 100 fathoms long (66 fathoms when "set," the fishermen estimating that they "slack up" about one-third with their weight and because not pulled to their full extent when in the water) by 3 fathoms deep, having a 2¼-inch mesh. In heavy tides it is seldom that more than one net is operated at a time, but when conditions favor, three or four may be joined together.

Pollock are taken about the Northern Head from June to September. They are even more numerous about the Southern Head and on the Bulkhead in June, when they are feeding upon the young herring. Hand-lining and trawling have been the principal methods used in their taking, although within the past five years seines have been employed successfully.

A few cusk are taken on the western shore in 25 fathoms on the rocky ground. Halibut are taken in small quantities about the Southern Head and on the Southeast Ground on a rocky bottom, mixed sand, and gravel in May, June, and July.

Cod, haddock, and hake are found in fair quantity about the Northern Head from June to October 31. These fish are also abundant about the Southern Head and in the vicinity of the Bulkhead in August, at both places seeming to be chasing the small herring. There are virtually no haddock on these grounds in winter. Another small ground for haddock lies close inshore to the westward of the Northern Head of Grand Manan, about 2 miles long by ½ mile wide, the bottom mainly rocks, the depths from 15 to 40 fathoms. Fishing in these waters is done both by trawl and hand line, the latter being in more general use along the southern shore.

Lobstering is an important industry on virtually all the coast line of the Bay of Fundy, and, as elsewhere in these waters, the vicinity of Grand Manan furnishes a good harvest of these, which, with the greater part of its catch of fish, goes to the United States, though a considerable quantity goes to St. John. The salted hake of the island is shipped mostly to Brazil and the West Indies. Of the lobsters, a correspondent says: "Of course, they are each year growing more scarce." Which statement, unfortunately, is probably true of this species everywhere.

Scallop beds have been located in various places in the Bay of Fundy and are found on virtually all the coast line of Nova Scotia. A number of these beds are to be found E. of Campobello Island and S. and E. of Grand Manan.

Peters.—A small piece of ground lying about ½ mile E. of Swallowtail Light and having 55 to 60 fathoms of water over a somewhat broken bottom. This in a cod ground the year around, and hake are found here from June 1 to October 1.

Clarks Ground.—This lies SSE. from White Head 4½ miles (just inside the Bulkhead) and has depths from 6 to 14 fathoms over a rocky bottom. Here are very heavy "rips" on the ebb tide. This is a good summer ground for pollock, cod, and halibut, and it is a good herring-netting ground in the season.

Southern Head Reef.—The chain of reefs extending S. from White Head Island is all good ground in summer for cod and for pollock, also, when the herring schools are on this ground. Currents are very heavy here. The ledges that make up this reef are more or less connected. Among these are Brazil Shoal, Tinker, Inner Diamond, Outer Diamond, Crawleys, Rans, Proprietor (Foul Ground), and the Old Proprietor. While virtually all this reef is pollock ground, Crawleys and Rans perhaps furnish the best fishing.

Gravelly.—Lying about 5 or 6 miles SE. by S. from White Head, this piece of bottom has about 25-fathom depths over a rocky bottom. This is a cod and pollock ground in their season, while an occasional halibut is taken here in summer. Heavy tide rips occur here also.

The Soundings.—Mentioned elsewhere as a herring ground, these lie outside the Bulkhead Rips 8 or 9 miles SE. from White Head. There are 30 or 40 fathoms of water here over a rock bottom, where pollock and cod are found in good number in July, August, and September, and a certain amount of halibut in summer.

Bulkhead Rips, called also The Ripplings.—This is a long rocky barrier rising sharply from the deep water about it to depths of from 12 to 20 fathoms. Here are found cod, haddock, hake, and pollock in abundance from June 1 to October 31. Apparently all are feeding on the small herring, so numerous in this vicinity at this season. Virtually no haddock are found on the grounds in the near neighborhood of Grand Manan in winter. The Ripplings were formerly one of the principal fishing grounds of the herring netters but of late years have been less productive.

Cards Reef.—The depths here are from 28 to 30 fathoms, over rocks, and the ground lies 3 miles S. by E. from the Old Proprietor and 9 miles from White Head. This is a cod and haddock ground from June to November.

Gannet Rock.—This lies east of the Murre Ledges. All about it is good ground in from 40 to 70 fathoms over a hard bottom. Cod are found here in good number from March to May, and halibut are taken here from March to May, inclusive.

Southeast Ledge.—This lies 6 miles SE. from Machias Seal Island and has a 5-fathom shoal, which breaks in heavy weather. The ground about is rocky and gravelly and has depths from 30 to 55 fathoms. Species and seasons are as on Machias Seal Island, but in addition a certain amount of halibut occurs in May, June, and July.

Southwest Ledges.—These make an area of roughly circular form with a diameter of some 6 miles, and whose center lies about 4 miles SW. from the Southwest Head. Depths on the ledges vary from 9 to 22 fathoms, with soundings of 30 fathoms or more about them. The ledges and their vicinity are spawning grounds for herring, and netting is carried on here in June, July, and August.

Machias Seal Island.—Nineteen miles E. by S. from Moosabec Light. This furnishes good ground in the water all about it, where depths are from 15 to 50 fathoms over a generally rocky and uneven bottom. In summer cod, haddock, and pollock are abundant here, the cod and haddock remaining all winter. The fishery is carried on mostly by the smaller vessels from Maine ports, principally those from Cutler, with an occasional visit by larger craft, usually from the Portland fleet. This ground is not much visited in winter. Fishing is done by trawling and hand-lining.

TABLE 1.—*Fishing grounds of the Bay of Fundy area of the Gulf of Maine, showing the principal species taken upon them*

Fishing ground	Cod	Haddock	Hake	Pollock	Cusk	Halibut	Herring	Mackerel	Lobsters	Miscellaneous
Bay of Fundy	x	x	x	x	x		[1] x		x	
North Shore and Nova Scotia	x	x	x	x	x		x		x	
Lurcher Shoal	x	x		x			x		x	
Trinity Shoal	x	x		x			x		x	
Cod Ground	x			x						
Northwest Ledges	x			x						
WNW. Rips, Flat Ground	x	x	x				x			
Inner Ground, Boars Head Ground	x	x	x							
Outer Ground	x	x	x							
Head and Horns	x			x					x	
Sandy Cove Grounds	x		x							
Inner Sandy Cove Grounds	x		x							
Spencer Island Grounds	x	x								
Isle au Haute Ground	x	x								
Quaco Ledges	x			x						
Salmon Ground										[2] x
Ingalls Shoal	x	x		x						
Mussel Shoal	x		x	x						
The Wolves	x	x		x					x	
The Wolves Bank	x	x		x						
Campobello	x	x	x	x			[3] x			
Passamaquoddy Bay	x	x	x	x			[3] x		x	[4] x
Mud Hake Ground			x							
Beaver Harbor	x									
Grand Manan	x	x	x	x			[1] x		x	
Peters Bank	x		x						x	
Clarks Bank	x			x		x	x			

[1] Large herring and sardine herring. [2] Salmon. [3] Sardine herring. [4] Flounders.

TABLE 1.—*Fishing grounds of the Bay of Fundy area of the Gulf of Maine, showing the principal species taken upon them*—Continued

Fishing ground	Cod	Haddock	Hake	Pollock	Cusk	Halibut	Herring	Mackerel	Lobsters	Miscellaneous
Southern Head Reef	x			x			[5] x			
Gravelly	x			x		x				
Soundings	x			x		x	[5] x			
Bulkhead, Ripplings	x	x	x	x			[5] x			
Cards Reef	x	x								
Gannet Rock	x					x				
Southeast Ground	x	x		x		x				
Southwest Ledges				x			[5] x			
Machias Seal Island	x	x		x						

[5] Large herring.

INNER GROUNDS

Under this heading are listed those grounds of the innermost chain of shoals, ledges, and "fishing spots," patches of rocky and gravelly bottom, the deeper water between them being over the muddy ground, which line the coast of the Gulf of Maine, making of it an almost continuous piece of fishing ground. In the Reports of the United States Bureau of Fisheries, on which all the statistics of the catch and value of the various species quoted in this report are based, these figures are grouped under the heading "Shore."

The larger and more important of these grounds are outcroppings along the edge of the 50-fathom curve and lie at distances varying from 12 to 20 miles offshore; but there are many inside this line, and where the deep water of the Gulf of Maine extends so far inshore some are close in to the land. Thus, nearly all are within comparatively easy reach even for the smaller craft (where these all now have power) and so furnish productive fishing for a large fleet of gill netters and sloops (small craft of from 5 to 10 tons net) and to the myriad of "under-ton" boats (of less than 5 tons net), all these being enabled to run offshore, "make a set," and return the same day.

With the uncertainties of the weather and the hazards of the winter fishing, very often the large vessels also follow this practice on those not too frequent "fish days" (when conditions permit fishing "outside") that intervene between the storms; and with the scarcity of fish in the markets usual to the season and the consequent better price for the catch, with ordinary fishing luck they are well paid for doing so.

The fish of these shore grounds, due perhaps to the greater abundance of food here, are thought to be distinctly superior in quality to those of the same species taken on the offshore banks. The cod and the haddock, especially, of the Gulf of Maine are particularly well conditioned fish and are noted for their excellence.

The figures presented in table 2 show only a fraction of the catch from the Inner Grounds, since they deal entirely with the fares of fishing vessels of 5 net tons and over. There are literally thousands of the so-called "licensed" or "under-tonned" boats, mainly gill

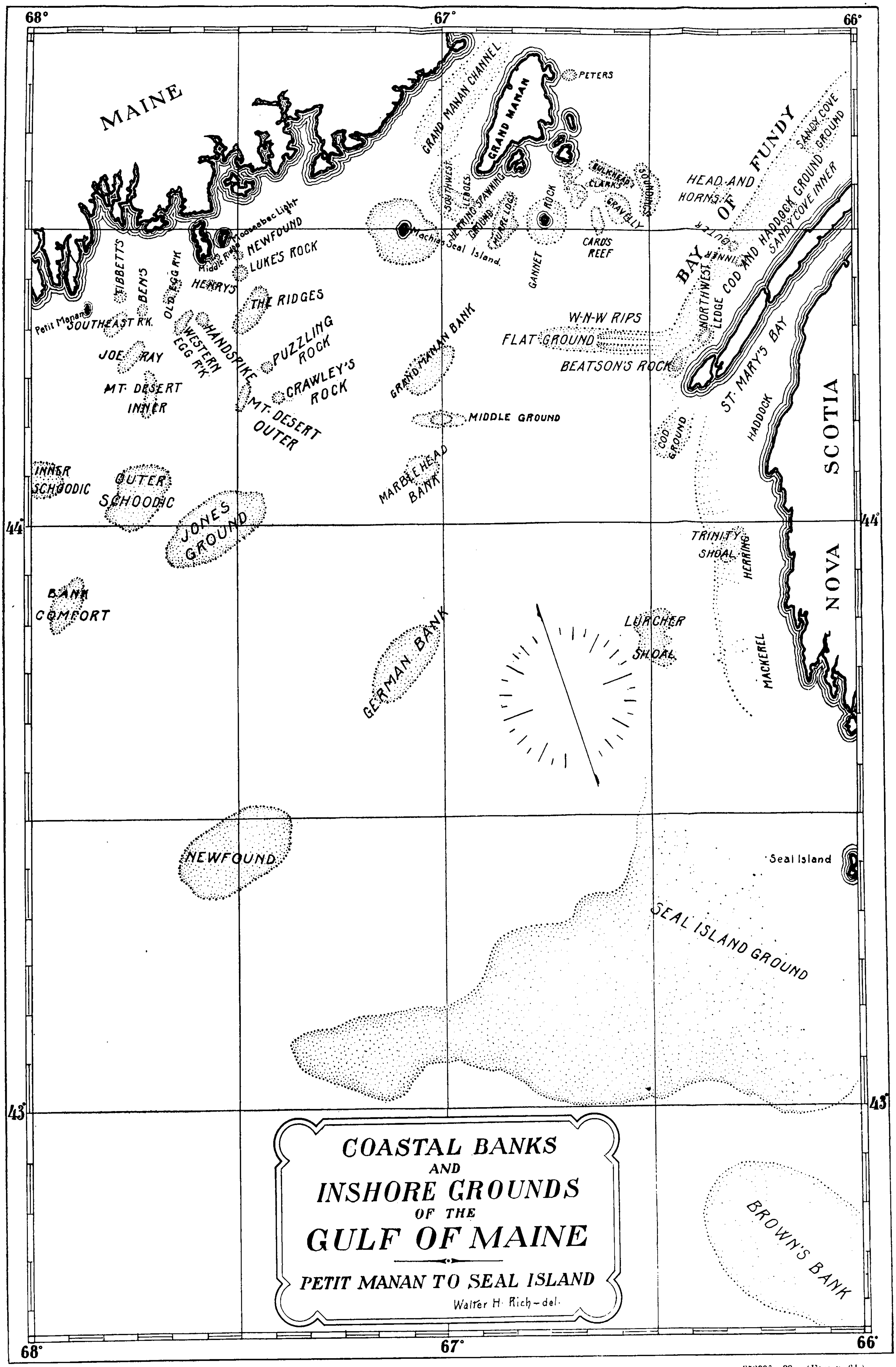

68°
67°
66°
44°
43°
MAINE
GRAND MANAN CHANNEL
GRAND MANAN
PETERS
BAY OF FUNDY
SANDY COVE GROUND
HEAD AND HORNS
SANDY COVE INNER
COD AND HADDOCK GROUND
INNER
OUTER
NORTHWEST LEDGE
SOUTHWEST LEDGES
HERRING SPAWNING GROUND
BULKHEAD
CLARKS
SOUNDINGS
GRAVELLY
ROCK
CARD'S REEF
GANNET
Moosabec Light
Middle Ridge
Machias Seal Island.
NEWFOUND
LUKE'S ROCK
TIBBETT'S
BEN'S
OLD EGG R'K
HENRYS
THE RIDGES
Petit Manan
SOUTHEAST R'K.
WESTERN EGG R'K
HANDSPIKE
PUZZLING ROCK
JOE RAY
MT. DESERT INNER
CRAWLEY'S ROCK
MT. DESERT OUTER
GRAND MANAN BANK
W-N-W RIPS
FLAT GROUND
BEATSON'S ROCK
ST. MARY'S BAY
MIDDLE GROUND
COD GROUND
HADDOCK
NOVA SCOTIA
INNER SCHOODIC
OUTER SCHOODIC
JONES GROUND
MARBLEHEAD BANK
TRINITY SHOAL
HERRING
BANK COMFORT
LURCHER SHOAL
MACKEREL
GERMAN BANK
NEWFOUND
Seal Island
SEAL ISLAND GROUND
BROWN'S BANK
COASTAL BANKS
AND
INSHORE GROUNDS
OF THE
GULF OF MAINE
PETIT MANAN TO SEAL ISLAND
Walter H. Rich—del.

FIGURE 2

netters, that take millions of pounds from these waters annually, principally cod and haddock.

On the Maine coast and across the line in New Brunswick there are more than 300 weirs, which furnished to American smokers and canners during the year 1923 (whose figures have been chosen as representing an average season) 77,000,000 pounds of herring. On the coast of Massachusetts there are 50 or more weirs and fish traps, and from the Isle of Shoals to Pemaquid Point in Maine there are more than 50 floating traps in the various bays, on the points of offshore islands, or even in the open sea, and all these take a rich harvest from these waters. Then, too, there is the lobster fishery, more important in the Gulf of Maine than anywhere else in the United States.

Of these various branches of the fisheries industries few statistics are available; yet we may say that the figures of the 1919 census showed that the "under-ton" boats mentioned landed 5,324,426 pounds of fish at the port of Boston, mostly of cod and haddock, and that the same type of craft in 1923 landed at Portland, Me., more than 3,000,000 pounds, principally of ground fish. We also know that every island, hamlet, village, town, and city along this nearly 4,000 miles of coast line takes its toll from the sea.

Lukes Rock.—This rock lies S. by E. 3 miles from Moosabec Light, circular in shape, and about 1 mile in diameter. Depths are from 25 to 35 fathoms; the bottom is rocks, gravel, and mud. This is mainly a small-boat fishing ground, but there is some vessel fishing. Hake are taken here from June to September, inclusive; cod are present about the rocks the year around. Pollock are here in spring and fall, and haddock from December to February, inclusive. Fishing is by trawl and hand line.

Newfound Ground.—A small rocky spot about ¼ mile across with an automatic buoy in the center for guidance into the Bay of Fundy. This is a small-boat ground having depths averaging 18 fathoms. It lies about 3 miles S. by W. from Moosabec Light. Species and seasons are as on Lukes Rock. Fishing is by trawl and hand line.

Henrys Rock.—Five miles SW. by S. from Moosabec Light, ¼ mile in diameter, and 30 fathoms over a level bottom. Fishing is done by hand line and trawl. Cod are present the year around, a few haddock in the fall, hake in the summer but not in the fall, and pollock in spring and fall.

Handspike Grounds.—Eight miles SW. by S. from Moosabec Light, nearly circular in form, and ½ mile across. It has a bottom of rocks and depths of from 35 to 40 fathoms. Species and seasons are the same as on Lukes Rock, but mainly cod and pollock are taken here by trawl and hand line.

Western Egg Rock.—This is SW. from Moosabec Light, 8 miles distant, lying in a NE. and SW. direction, 3 miles long by 1 mile wide. The bottom is irregular, sharp, and rocky and has 25 to 30 fathoms. Fishing here is mostly by hand line, the ground being said to be too rough for trawling. This is a small-boat ground, and fishing is done mainly in the summer season. Cod and pollock are taken in the spring, summer, and fall; haddock are present in spring and fall; and cusk in 35 to 40 fathoms in spring and fall. This is not a hake ground.

Old Egg Rock.—This rock is WSW. from Moosabec Light, 6 miles distant, and running in a NE. and SW. direction. It is 3 miles long by 1 mile wide; has a rocky bottom and depths of 25 to 30 fathoms. This is also a small-boat ground, where fishing is done mainly by hand lines, but trawls also are employed. This ground is fished by the larger vessels in the fall months when the weather is too rough for fishing on the outside grounds. Cod, haddock, and a few pollock are taken in spring and fall; hake in fair number in the fall months.

Middle Ridge.—This is W. by S. from Moosabec Light 3 miles. It lies in a NE. and SW. direction and is about 1 mile long by ½ mile wide. The depths are from 18 to 25 fathoms and the bottom is rough and rocky. It is a small-boat ground mostly and of little importance as a fishing ground. Cod are present the year around; haddock in late spring and summer, with a smaller number in the fall. Cusk are here the year around. A few pollock are here in the spring and fall.

Broken Ground.—This lies S. by E. from Moosabec Light 15 miles, whence the ground extends WSW. to within 4 miles of Mount Desert Rock with an average width of 1 mile. The depths run from 15 to 100 fathoms. The shallows are sharp and rocky; the deeps, clay and gravel. There are places ½ mile long and others 3 miles long having average depths of 70 fathoms. Several of these spots have special names, such as Crawleys Rocks, Puzzling Rock, and The Ridges.

The grounds mentioned here and those previously mentioned are known to the fishermen as The Moosabec Ridges. All these seem to be fishing spots cropping out upon the 50-fathom curve. On the Broken Ground the fishing season is from June 1 through September. Herring usually are abundant here from May to September. Cod are taken outside of the grounds in spring and fall. Pollock and small cod are taken on the shoals in summer and fall and hake on the mud bottom in summer and fall.

The Ridges bear S. from Moosabec Light 9 miles to the center. They are 7 miles long NE. and SW. and 2 miles wide, and have depths of from 30 to 35 fathoms. The bottom consists of rocks and gravel, on which cod and pollock are abundant.

Crawleys Rock, S. from Moosabec Light and distant 17 miles, is a shoal of about 15 acres having 15-fathom depths over a bottom of sharp rocks.

Puzzling Rock lies S. from Moosabec Light 14 miles. It is about ½ mile of ground over which is a depth of 15 fathoms of water with a bottom of sharp rocks. Because of the strong tides over them, these are all "hand-line spots."

Tibbetts' Ledge.—This lies east from Petit Manan 4 or 5 miles. The marks are Schoodic Island over Green Island of Petit Manan and the Ladle over Nash's Island.

This ledge consists of two rocky shoals with depths of 3 to 3½ fathoms, about 1 acre apiece in extent and ¼ mile apart, lying NW. and SE. from each other. To the westward of these is broken ground nearly to Petit Manan. These are favorite small-boat grounds. The eastern ledge drops suddenly into the mud.

In May large cod are caught over the muddy bottom just E. of the ledge in 27 to 30 fathoms. Hake and haddock are taken in late spring (May) and fall. Fishing is by hand line and trawl.

Ben's Ground.—Lies ESE. from Petit Manan 4 or 5 miles. The marks are Petit Manan Light to northward of Middle Hill of Mount Desert, and Humpback Mountain on the west side of Trafton's Island, or Pond Island Light to the eastward of Jordan's Delight. The ground is circular in shape, about ¾ mile across, having 14 to 30 fathoms of water. The bottom is of rocks and mud. This ground is of little importance except as a small-boat ground in summer for cod and haddock. Hake are taken on the muddy bottom near it. It is a winter haddock ground in calm weather, these fish leaving it in the storms, the water being somewhat too shallow for them to "ride out a blow" in comfort. Such, at least, is the reason the fishermen give for the sudden cessation of their taking on shoal grounds after a period of heavy weather.

Southeast Rock.—This is a ledge, nearly uncovered at low tide on its shoalest spot, SSE. from Petit Manan and 4½ miles distant. The shoal portions slope toward the NE. a distance of 4 miles over an irregular bottom. Depths vary from 17 to 30 fathoms. The shoals are rocky, and the deeps are muddy.

Cod and haddock are taken here in May and June; hake from July to September. It is a good lobster ground, also. Fishing here is by hand line and trawl operated from vessels and small boats from near-by Maine ports.

Broken Ridges; Joe Ray Ground.—This lies SSE. from Petit Manan 7 miles to the center. It is 2 miles long NE. and SW. and 1 mile wide. Depths are from 27 to 33 fathoms, and the bottom of rocks and mud is very uneven. The shoalest portion is near the center. It is said to be a good cod and haddock ground and is mainly a small-boat ground, although some vessel fishing is carried on here in the spring.

Black Ledges Ground.—This ground lies between Jordan's Delight and the Halibut Ledges, or Black Ledges. It is a good haddock ground for a brief season in the spring and early summer when the fish are following the herring schools. In general, it is a small-boat ground on which chiefly hand lines and

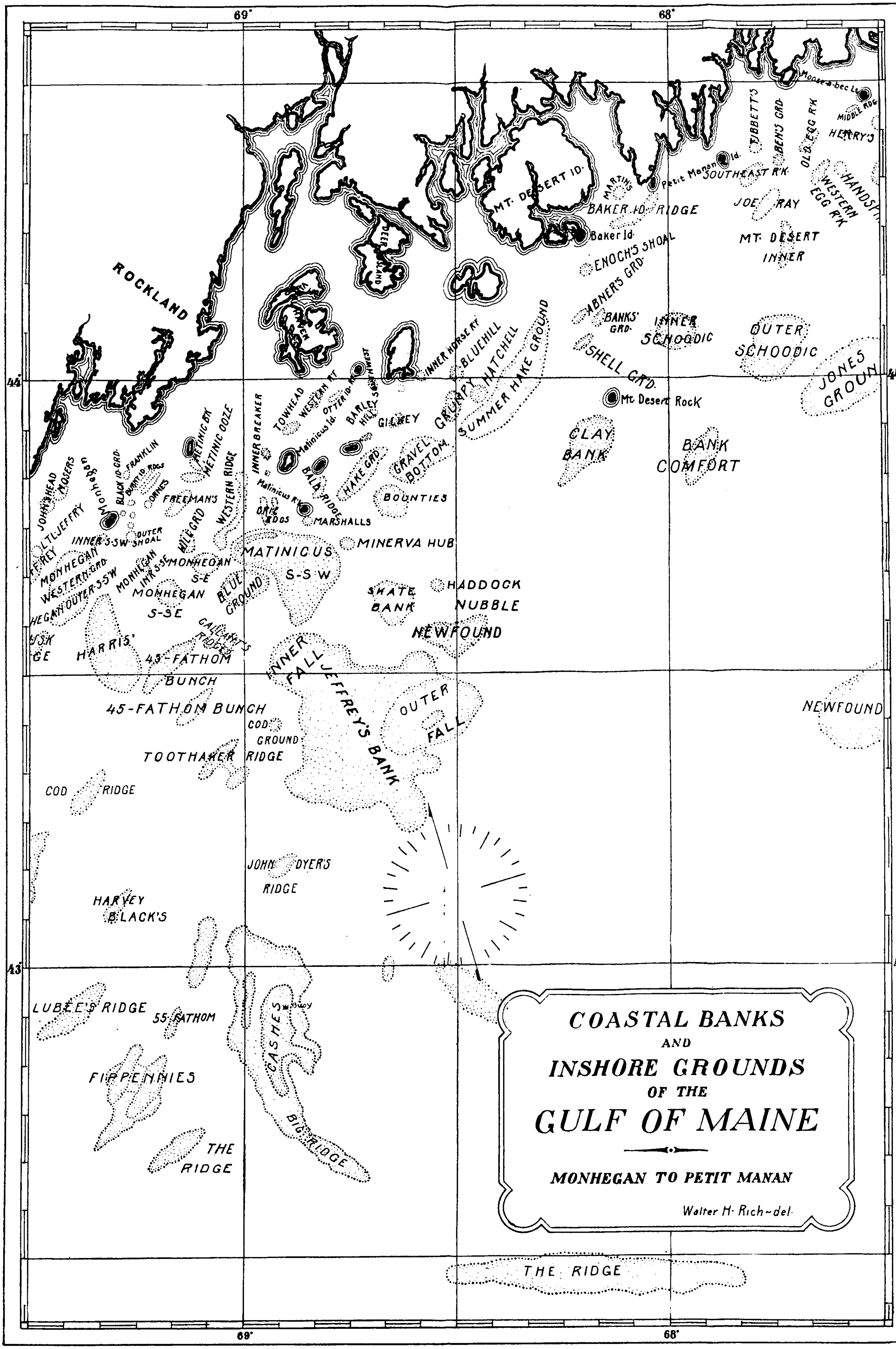

COASTAL BANKS
AND
INSHORE GROUNDS
OF THE
GULF OF MAINE
MONHEGAN TO PETIT MANAN
Walter H. Rich-del.
69°
68°
44°
43°
ROCKLAND
MT. DESERT ID.
Baker Id.
Petit Manan Id.
Moose-a-bec Lt.
Mt Desert Rock
BAKER ID. RIDGE
ENOCH'S SHOAL
ABNER'S GRD.
BANKS' GRD.
INNER SCHOODIC
OUTER SCHOODIC
SHELL GRD.
JONES GROUN
CLAY BANK
BANK COMFORT
TIBBETT'S
BEN'S GRD.
OLD EGG R'K
HENRY'S
MIDDLE RDG.
SOUTHEAST R'K.
WESTERN EGG R'K
HANDSPI
JOE RAY
MT. DESERT INNER
MARTIN'S
INNER HORSE R'F
BLUEHILL
HATCHELL
GRUMPY
SUMMER HAKE GROUND
GILKEY
GRAVEL BOTTOM
HAKE GRD.
BOUNTIES
BARLEY HILL
OTTER ID.
WESTERN R'F
TOWHEAD
INNER BREAKER
Matinicus Id.
Matinicus R'k
BALD RIDGE
MARSHALLS
ORIE ROOS
MINERVA HUB
MATINICUS S-S-W
BLUE GROUND
SKATE BANK
HADDOCK NUBBLE
NEWFOUND
METINIC BK
METINIC OOZE
WESTERN RIDGE
FREEMAN'S
MILE GRD
CORNES
FRANKLIN
BLACK ID. GRD.
Monhegan
OUTER SHOAL
MOSERS
JOHN'S HEAD
LTL. JEFFRY
JEFFREY
INNER S-S-W
MONHEGAN WESTERN GRD.
MONHEGAN OUTER S-S-W
MONHEGAN INR S-S-E
MONHEGAN S-E
MONHEGAN S-SE
HARRIS'
GALLANT'S RIDGE
45-FATHOM BUNCH
INNER FALL
JEFFREY'S BANK
OUTER FALL
NEWFOUND
COD GROUND
TOOTHAKER RIDGE
COD RIDGE
JOHN DYER'S RIDGE
HARVEY BLACK'S
LUBEE'S RIDGE
55-FATHOM
CASHES
Buoy
FIPPENNIES
THE RIDGE
BIG RIDGE
THE RIDGE

Figure 3

trawls are operated. A few cod and cusk are taken here in the fall, and it is a good lobster ground.

Bakers Island Ridge.—This is a narrow ledge making out from Bakers Island E. by N. The eastern part bears S. by E. from Schoodic Island, ¾ mile distant. The ridge is much broken, its average width being ½ mile, and it has depths of from 20 to 25 fathoms over a rocky and gravelly bottom. It is not much fished on the shoaler spots, but in 30 to 35 fathoms, on a muddy bottom, hake are abundant from July to October, inclusive. Cod and cusk are found here in the spring and fall; haddock from October to January, inclusive. Fishing here is done by small boats and small vessels mainly from Bass Harbor and Southwest Harbor by trawl and hand line. It is a very good lobster ground.

Martins Ground; Hillards Reef.—The center bears WSW. from Schoodic Point, distant 3 miles. It is a rocky patch of 4 or 5 acres and has depths of from 15 to 25 fathoms. It is not important except for its hand-lining for cod and haddock in the spring and fall months and for hake in the fall. It is a good lobster ground.

Egg Rock Broken Ground.—This is a rocky ridge making out S. by W. from Egg Rock Ledges and is about 2 miles long by ½ mile wide. It has an irregular bottom, with depths from 9 to 15 fathoms. This ridge, with Martins and Seaveys Grounds, divides the western or Bakers Island mud channel from Schoodic mud channel. Both these were formerly considered very good hake grounds but, while still good, are not as profitable for hake fishing as in past years.

Haddock are taken on the ridge in the spring and in October, November, and December. A few cod are taken in the spring and fall. Fishing is by trawl and hand line. It is a good lobster ground.

Inner Schoodic Ridge.—This ridge bears SE. by S. from Bakers Island, the center distant 12 miles. This ground is nearly circular in form, about 4 miles in diameter, and has depths running from 18 to 60 fathoms. The bottom is of rocks, gravel, and mud; the shoaler portions are sharp and rocky. Vessels from Maine ports use this ground, fishing by hand line and trawl. Cod and haddock are abundant here in spring and fall, and hake fishing is good through the summer. It is a good lobster ground.

Outer Schoodic Ridge.—The northwest part of this ground bears SE. from Bakers Island, from which it is distant 22 miles. It lies 7 miles outside Inner Schoodic, has long been considered one of the best shore fishing grounds of the Maine coast, and still seems to deserve the reputation.

The ridge is about 8 miles long in a NE. and SW. direction, lying nearly parallel with the adjacent coast. Its greatest breadth is 6 miles. The bottom is broken and irregular and has depths from 22 to 80 fathoms, over rocks and gravel on the shoaler parts and mud on the deeps. Principally Maine vessels fish this ground, using hand line and trawl. Cod, pollock, haddock, cusk, and hake are present here from June to November, and a few large halibut, up to 300 pounds in weight, are taken here in June and July.

Mount Desert Inner Ridge.—The center lies SE. ¼ E. from Schoodic Island, distant 15 miles. It is 4 miles long in a W. by S. and E. by N. direction and ½ mile wide. Depths are from 30 to 45 fathoms, the shoal parts rocky, the deeper parts sand and gravel.

Good cod fishing may be had here in the spring from February to April, inclusive. Haddock are present in fair numbers in late fall, winter, and early spring; pollock and cusk in fall and spring; and rarely halibut are taken here in June and July.

Vessels come from virtually all Maine ports—Rockland, Portland, Southwest Harbor, Bass Harbor—using hand line and trawl.

Mount Desert Outer Ridge.—This ridge lies SE. by E. from the Big Hill of Mount Desert Island. From Schoodic Island to the center of this ground is about 25 miles. Its length E. by N. and W. by S. is 2 miles; its breadth is ¾ mile. Depths are from 45 to 60 fathoms; the shoals are rocky, but on the sides sand and clay predominate.

This is a comparatively small ground, but it furnishes good cod fishing in the spring (April to July) and fall. Cusk are taken in the spring and fall. Virtually no haddock are taken here. Hake are found in the deep water on the W. and SW. in spring, summer, and fall; trawl lines principally are used here. It is a good lobster ground but is too distant for present fishing methods.

Flat Ground.—This ground lies between Mount Desert and Swan Island, SW. from Long Island. In 50 fathoms, on a hard mud bottom, there is good fishing for hake in the summer. Fishing is by hand line and trawl.

Enoch's Shoal.—This shoal lies ENE. 3 miles from Great Duck Island. This is a small hummock on the outer parts of a ridge extending out to it from Great Duck Island. It has a sharp, rocky bottom with depths of about 18 fathoms. Hand lining and trawling are the methods employed to take a few cod in early spring; haddock are here in small numbers in the summer as well as a small quantity of hake. It is a good lobster ground.

Banks Ground.—The center bears SE. by S. from Great Duck Island, distant about 5 miles. It is about 1½ miles long in a NE. and SW. direction by ¼ mile wide and has a mud bottom with depths from 35 to 50 fathoms. It is mainly a small-boat ground, fished mostly in the summer, when hake are fairly abundant and there are a few haddock and cod. It is a lobster ground, also.

Shell Ground.—This lies SE. from Long Island Head, from which the center of the ground is distant 6 miles. It is 2 miles long, in a NE. and SW. direction and about ½ mile wide. In the middle portion is a shoal of 25 fathoms, its bottom sharp rocks. On all sides of this shoal the bottom is quite irregular, consisting of pebbles and mud. The greatest depth, near the edge of the bank, is 50 fathoms.

Cod and haddock, together with a few cusk and pollock, are taken here in June, July, and August and even into the late fall, but it is mainly a hake fishing ground for small boats and an occasional larger craft, all using hand line and trawl. It is a good lobster ground.

Abner Ground.—This ground is SSE. from Gott's Island, distant 8 miles. It extends 1½ miles in a NE. and SW. direction and is about ¼ mile wide. The bottom is broken, rocks and mud, with depths of from 25 to 50 fathoms. This is principally a haddock ground, the best season being in July and August, and is resorted to mostly by small craft.

Grumpy.—Extends from SE. 4½ miles from Eastern Ear of Isle au Haute to SE. ¼ E. from the western head of Isle au Haute, distant 7 miles. This ground is 2½ miles long by ¾ mile wide and has a small shoal of 14 fathoms on the northeast part. Over the rest of the ground the average depths run from 35 to 40 fathoms over a gravelly bottom.

Though not of great importance of late years, this was formerly considered one of the best inshore grounds for cod for the entire year and for haddock in winter. Hake usually are abundant just off the southeast edge in summer. This bank is mostly fished by craft from ports of eastern Maine—small boats as a rule—and the principal method is by trawling, although there is considerable hand-lining for cod in 25 fathoms in June and July.

Marks: Big Camden Mountain over the Eastern Ear of Isle au Haute; Fog Island in Jericho Bay, touching on the eastern part of Big Spoon Island; Brimstone between Isle au Haute and the Western Ear.

Hatchell Ground.—This ground lies SE. by E. ¾ E. 9½ miles from the western head of Isle au Haute. Marks are eastern Mount Desert Hill in the middle Saddle of Long Island, and Little Spoon Island in the great or center Saddle of Isle au Haute. The ground is only about 1 mile in diameter and has a small shoal of about 15 fathoms, which is somewhat difficult to find. Depths are from 25 to 40 fathoms over most of the ground, in general, the shoaler parts near the center. The bottom is sharp and rocky on the shoals, gravelly and pebbly on the sides. At the edge of the ground the deep water has a soft-mud bottom. There is much of low animal life here to serve as food for the fishes, and, next to Grumpy, this ground was considered the best inside Mount Desert Rock.

Cod and a few pollock are taken here in the spring. Hake are abundant on the edge in the mud throughout the summer. Haddock are plentiful from November to February. Fishing is done with hand lines and trawls by small craft and vessels from Maine ports.

Blue Hill Ground.—This ground lies approximately E. by S. ¾ S. from the western head of Isle au Haute, distant 7 miles.

Marks: Brimstone Island out by the western head of Isle au Haute and Blue Hill on the west side of Marshall Island. These marks lead to a depth of 25 fathoms on the northeast part of the ground, deepening southwest to 40 fathoms in 1 mile from the shoaler part, which is about ½ mile wide. The bottom consists of gravel and pebbles. This is a good ground for cod in the spring and fall, but is best for haddock during the entire winter. Hand lines and trawls are used.

Inner Horse Reef.—This reef lies SE. ¾ E. 1½ miles from the eastern ear of Isle au Haute. Marks: Bring Bluehill Mountain in the saddle of White

Horse, Brimstone showing between Western Ear and Isle au Haute. There is a shoal here of 25 fathoms about ⅛ mile in diameter. From this the water gradually deepens to NE. for ½ mile, where it drops off into the mud. Depths on this northeast portion are about 35 fathoms. The bottom is of pebbles and gravel.

In spring and fall this is a good cod ground. Hake are found close to the edge in summer. Fishing is by small craft, generally, using trawl and hand line. It is a good lobster ground.

Outer Horse Reef.—This is a short distance SW. from the Inner Reef, with only a narrow gully between. The small shoal falls off rapidly on all sides. It has a depth of 30 fathoms. Over a space ¼ mile in diameter the bottom is gravelly. Seasons and species are as on Inner Horse Reef.

Hake Ground.—A summer hake ground extends from 8 miles SE. of the eastern ear of Isle au Haute to 3 miles SE. of Long Island in 35 to 60 fathoms on a bottom of hard mud. This piece of ground is about 15 miles long by 4 miles wide.

Southwest Ground.—This lies 2 miles SW. from the western head of Isle au Haute. It is circular in form, ½ mile in diameter, and has a gravelly bottom with depths varying from 35 to 40 fathoms. It is a cod ground from April to June and from September to November, inclusive. A few pollock and haddock are taken with the cod. Hake are abundant in summer close to Isle au Haute. Hand lines and trawls are used in the fishing. It is also a good lobster ground.

Barley Hill Ground.—This ground lies NNE. from Seal Island and SSW. from the western head of Isle au Haute, directly in line between the two, about 3½ miles distant from each point. It is circular in form, has 28 to 30 fathoms of water, and the bottom is mixed mud and rocks. This is a ground much resorted to by sloops and larger vessels, and the fishing is by hand line and trawls. It is a good cod ground in spring and fall and a hake ground on the mud and rocks in summer. Occasionally a few halibut are taken here during June and July. It is also a lobster ground.

Gilkey Ground—This bears S. from the western head of Isle au Haute, 4 miles distant. It extends ENE. and WSW. about 1½ miles long by ⅓ mile wide. The bottom is rocky on the shoals, where depths are about 23 fathoms, sloping to 35 fathoms on the southwest part, where the bottom is gravelly and comparatively smooth.

This is a cod ground in spring and fall, a haddock ground in winter, and hake are taken on the edges in summer. Vessels fishing here are mostly from Maine ports. It is also a good lobster ground.

Rock Cod Ledge.—This ledge lies NE. of Seal Island 1 mile. It has a depth of 3½ fathoms on the shoalest part, deepening gradually on all sides for a considerable distance. The bottom is of sharp rocks and is broken in places. Rock cod are present in fair numbers in spring and fall, and this is a mackerel and herring ground in their seasons.

Haddock are abundant in the fall close in to the rocks of Seal Island in 8 to 15 fathoms. This is not a hake ground, although there are a few cusk to be had here on the deeper parts, and an occasional small halibut is taken in the kelp on the shoal in June and July. It is a good lobster ground.

Southeast Ground and Gravel Bottom.—These lie S. of Seal Island, forming an extensive piece of fairly level ground. The western part bears a little E. of S. and the eastern part about ESE. from the island. It is about 5 or 6 miles in diameter. While this is really but one piece of ground, the eastern part is called the Southeast Ground and the western part, from the nature of its bottom, the Gravel Bottom. The eastern portion is muddy and has 40 to 60 fathoms. The western has 35 to 40 fathoms.

It is a good cod ground in winter and spring. Haddock are present from November to March, inclusive; hake in summer. Fishing is done mainly by trawling by sloops and vessels.

Laisdells Ground.—This is a small, rocky spot outside the Brandy Ledges. It is about ¼ acre in extent and has a sharp, rocky bottom with 20 fathoms of water over it. It is the best cod and haddock ground in Isle au Haute Bay. This is chiefly a small-boat ground and is also a lobster ground.

Saddle-back Reef.—This reef lies S. from Saddle-back Ledge, ¾ mile distant. It is about ⅔ mile long, N. and S., by ¼ mile wide. Depths are from 15 to 35 fathoms over a broken and rocky bottom.

Cod are taken here by hand line in May and June; haddock and cod by trawling in fall and winter (November to January 1). It is a good lobster ground and chiefly a small-boat ground.

Otter Island Reef; Snipper Shin; Western Reef.—These are names applied to different sections of an irregular, broken piece of rocky ground about halfway between Vinalhaven and Seal Island. Otter Island Reef is the eastern section, lying 4 miles W. by S. by ¼ S. from the western head of Isle au Haute. Depths here are from 10 to 25 fathoms over a rocky bottom. The trawl, formerly not much used here, is now in general use. This is a cod and haddock ground at seasons when these fish are in shoal water, but it is best for cod in winter and spring and for haddock in the fall, from November 1 to January 1.

Snipper Shin is a westerly continuation of Otter Island Reef, lying between it and the Western Reef. It has a shoal of 7 fathoms, and the water about it is 25 fathoms deep in places. The ground is similar in character to Otter Island Reef and is frequented by the same species at the same seasons. In addition, small halibut are taken here in June and July.

Western Reef is of about the same character and has nearly the same depths of water as the other two. All are lobster grounds.

Old Ripper.—This lies S. from the Western Ground (Western Reef) and 10 miles WSW. from Criehaven or Ragged Island. Apparently this is a part of the Western Ground. On the deep-water mud bottom between these (Ripper and Western Reef) is good hake fishing in summer, and cusk are abundant from May to the time when the dogfish strike the ground, usually about July 5 to 10.

Crie Ridges.—These lie 4 miles NW. from Matinicus Rock. 4 miles WSW. from Criehaven or Ragged Island, and run SE. from Western Ground toward Matinicus, distant 4½ to 5 miles. Cod, pollock, and cusk are here in the spring, and haddock are abundant in the fall.

Bald Ridges.—These begin just outside Wooden Ball Island and run off in a nearly direct line for Matinicus Rock. They are each from ¼ to ½ mile wide, are quite close together, the distances between them being not over ½ mile, and they are almost parallel with each other. Soundings show from 15 to 30 fathoms upon them, with a broken, rocky bottom. The shoalest water is about 1 mile from Wooden Ball Island, the depth increasing toward the southern end.

This is a good cod ground at all times when the fish are on the coast, the spring school being the largest. The shoal is a favorite place for rock cod. Haddock are present here from January 1 to February 15. Hake are abundant in their season on the mud bottom inside the Bald Ridges 1½ miles WSW. in 50 fathoms. It is a good lobster ground.

Henry Marshalls Ground.—This ground lies S. by W. from Matinicus Rock about 3 miles; its area is about 2 acres. The shoaler portion has a depth of 35 fathoms and a gravelly bottom; on the edge the depth is 45 fathoms and the bottom is of rocks and mud. Cod are taken here in the spring, haddock in January and February, and hake in the summer months. It is a good lobster ground.

The Bounties (The Bowdies).—This ground bears SE. by S. ½ S., distant 6 miles from Wooden Ball Island. It is nearly circular in form, about 4 miles across, and has depths from 40 to 60 fathoms. The bottom, of gravel and rocks, is somewhat broken. It is a good cod and cusk ground in spring and fall and a haddock ground in winter and is fished by vessels and sloops, mainly by trawling but with a certain amount of hand lining, in May and June.

A summer hake ground extends from 3 miles ESE. of Seal Island to 4 miles SSE. of the Wooden Ball; thus it is about 7½ miles long by some 2½ miles wide. The depths here are from 35 to 60 fathoms.

Minerva Hub.—This bears SSE. from Matinicus Rock, distant 6 miles. This is a small, gravelly spot about ¼ mile in diameter and with a depth of 35 fathoms, abounding with cod in spring and fall. It is a summer ground for hake and cusk. Hand lines and trawls are used.

Haddock Nubble.—This lies SE. ½ S. from Matinicus Rock, distant 16 miles, and has an average depth of 50 fathoms over a small, circular patch some 2,000 feet across. The bottom is of gravel and rocks, and "lemons" and marine growths of like nature are abundant. This is a June cod ground, usually furnishing good haddocking, also, from November to January, inclusive.

Skate Bank.—This bank bears SSE. from Matinicus Rock, distant 12 miles. It is about 2 miles in diameter and nearly circular in form. Depths are from

35 to 60 fathoms. The bottom is gravelly but quite uneven. The best season on this ground for cod and cusk is from April to July. Hake abound in July and August. Hand lines and trawls are used here, fished by sloops and vessels.

Matinicus Sou'Sou'West Grounds.—These grounds bear SSW. from Matinicus Rock, from which the inner edge of the grounds is distant about 6 miles. They extend about 9 miles N. and S. and have about the same width, being nearly triangular in shape, broadest at the northern end. On the northern part there is a shoal of about 30 fathoms 2 miles long E. and W. and 1 mile wide. Sharp rocks cover this, but the ground is not broken and drops off gradually to depths of 50 to 55 fathoms or even to 60 fathoms on the southern part. Outside of the shoal the bottom is pebbly and gravelly. This is one of the best cod and haddock grounds in the vicinity. Cod are sometimes abundant here all winter; haddock are found here from December 1 to February and are more abundant than the cod. Hake are plentiful on this ground and in 60 fathoms on the mud off the edge SE. of this ground during the summer season.

Marks: The high pinnacle on the eastern end of Wooden Ball, showing just out by Matinicus Rock, SW. by S. from the rock, 5 miles.

Inner Breaker.—This lies 2 miles W. of the southwest point of Matinicus Island. It is a rocky shoal about 1 acre in extent and having 7 fathoms of water. From this shoal the bottom slopes gradually to depths of 25 to 30 fathoms, and this slope furnishes good fishing for cod in May and June, while haddock are here in December and January. A good school of hake is found on the edge of the ground in summer. The bottom is rocky and broken and, while sharp, is fished with trawls as well as hand lines. It is mostly a small-boat ground.

Towhead Grounds.—These grounds bear N. by E. ½ E. from Matinicus Island, from which they are distant 2½ miles. Depths are from 12 to 30 fathoms. It is somewhat irregular in shape and has a very rocky, broken bottom.

The ground is from 2½ to 3 miles long and ½ to 1½ miles wide. It extends E. by S. and W. by N. and is considered one of the best inside shoal grounds for cod and haddock in the bay. Hand lines and trawls are used here now, although in former times this and the preceding grounds were considered too sharp for the use of trawls.

Both these are good lobster grounds and chiefly small-boat grounds.

The entire bay between Vinalhaven and Matinicus and Green Islands is full of broken, rocky patches of fishing ground, certain portions of which have received local names from the fishermen of the vicinity.

Western or Green Island Ridge and the Pigeon Ground.—The northern portion of this ridge lies 6½ miles NW. by W. from Matinicus Rock, from which the ground extends about 7 miles in a SSW. direction. The greatest width is not over 1 mile. Depths are from 15 to 30 fathoms. The bottom is broken and rocky. It is a good cod ground in the spring and fall. Haddock are found here in June, November, and December. In summer this is a good hake ground. Halibut are found on the shoals (10 fathoms) and about the northern part of Western Green Island, on the sandy bottom, during June and July.

Matinic Bank.—This is an extension of the shore soundings that make out to the southward and eastward of Matinic a distance of 2 or 3 miles, with depths (outside of 1½ miles) of 23 to 30 fathoms. The bottom is level, consisting of rocks, pebbles, and gravel, and the ground abounds in cod in the season from March to June. Just off the edge, in depths of from 40 to 50 fathoms, the bottom is soft mud, on which hake abound in summer. Very few haddock are taken on this bank. Halibut are sometimes abundant here in 10 to 15 fathoms during May and June.

Matinic Ooze.—This is a flat bottom, composed of ooze and shells, that makes off to the eastward of the Haddock Ledge and Shoal and bears about S. from Matinic. The Haddock Shoal and the Ooze are really parts of one ground, though they have been given different names by the fishermen. The Haddock Shoal (3 miles S. by E. from the Seal Ledge; breaks in rough weather) is thought to be poor ground and is but little fished, although it is a fall haddock ground. The Ooze falls off gradually, reaching a depth of 50 fathoms on the outer part. It is considered fair fishing ground for cod and haddock in the spring and for cod and hake in the summer and fall.

Freemans Ground.—This ground lies 6½ miles E. from Monhegan Island between Ornes Ground and Matinicus Western Ground. It is 3 miles long and 1 mile wide and runs in a NE. and SW. direction. There is a shoal on the southwest part having 20 fathoms over a sharp rocky bottom. The rest of the ground has depths of 25 to 40 fathoms, the bottom of rocks, gravel, and shells, in some places uneven and in others smooth. This is a good spring ground for cod; and for cod, hake, and pollock in the fall. Haddock are not numerous on this ground, though a few are usually to be found here in December. Herring are here May to August, inclusive.

Middle Shoal, Pollock Rip, Allens Shoal, and Deckers Shoal.—These are small rocky patches lying to eastward of Monhegan Island and northerly from the Outer Shoal. They have depths from 6 to 30 fathoms over a sharp, rocky, and broken bottom. Middle Shoal is 2 miles from the island; Pollock Rip 1½ miles; Allens Shoal 1¼ miles, having 5½ fathoms and breaking in rough weather; and Deckers Shoal 1 mile. Depths vary here from 6 to 30 fathoms over a bottom generally sharp and rocky. The principal fishing here is hand-lining for cod in the spring during the herring season and in the fall in "squid time." A few pollock are taken here also.

A number of small patches lie westerly from the Outer Shoal and close to Monhegan Island. These are the Cusk Ground with a depth of 20 to 35 fathoms; Gull Rock Ledge (breaks in rough weather), 3½ fathoms; Lobster Point Ground, 15 to 30 fathoms; Inner Spring Ground, 15 to 30 fathoms; Outer Spring Ground, 25 to 35 fathoms. All these are fished for cod nearly all the year, for haddock in December and January, and for pollock in early spring and late fall. The Spring Grounds are near the harbor and so are fished before the others. All are lobster grounds. Small boats and vessels operate here.

North of the island lies a patch called the Hake Ground or Mud Channel, the first name because of the abundance of hake taken here during June, July, and August. It extends from just outside White Head to abreast of Monhegan Island on the northern side. The depths vary from 20 to 45 fathoms, and the ground is still considered one of the best hake grounds alongshore. It is fished by small boats and vessels when the dogfish are on the outer grounds. This is a good haddock ground in December and January, as well as a good lobster ground.

Black Island Ground.—This ground is ENE. 2 miles from Monhegan, 1 mile in diameter, has a shoal of 10 fathoms, and sharp rocky bottom in the center. The ground slopes gradually from this to the edges, where are 40 fathoms. Beyond the depths of 28 to 30 fathoms the bottom is gravelly and smoother. This is a cod ground in spring, and cod and hake are taken here on the edges in summer and fall. Pollock are found about the shoal in summer. It is a good lobster ground.

Franklin Ground.—This ground is NE. by N. midway between Monhegan and Burnt Island, distant 4 miles. Cod and haddock are found here from April to June and pollock in summer. In summer and fall hake are taken by night fishing with hand line about the rocks in 20 to 30 fathoms on the broken ground. Fishing here is by hand-lining in summer and trawling in fall and winter. It is a lobster ground.

White Head Ground.—Marks: Bring Black Head, White Head, and Gull Head in range on the east side of Monhegan Island. Depths on the shoal (the White Hub: Bring Budd cottage out by White Head, Black Head, and Allens Island touching) are 7 fathoms, thence to 20 fathoms on the edges about it. This ground extends NE. and SW., 2 miles long by ¼ mile wide. The bottom is chiefly broken, of rocks, and with spots of coarse gravel and sand. Fish and their seasons are as on Franklin Ground.

Burnt Island Inner Ridge; Andrews Shoal.—This is NE. by E. from Monhegan, distant 5 miles. It is a broken ground with depths from 15 to 20 fathoms, the bottom rocky and gravelly, with occasional mud holes. It extends NE. about 4 miles, nearly to Roaring Bull Ledge, and is ½ mile wide. There are strong tidal currents here, the flood being NE., the ebb SW. It is a cod ground from April to June, and cod and hake are taken from September to November; haddock in December. It is a good lobster ground.

Burnt Island Outer Ridge.—This ground is parallel with the Inner Ridge and at a distance of ¾ mile. Depths are from 5 to 25 fathoms, the bottom being rather less broken than on the Inner Ridge. Fishing seasons and species are as on Inner Ridge. Hand-lining is done mostly because of strong tides. It is a good lobster ground.

Ornes Ground.—This ground bears E., distant 4½ miles, from Monhegan Light to the center. It is 1 mile long, E. and W., and 1 mile wide. Depths are from 30 to 45 fathoms. On the shoal parts the bottom is of sharp rocks and broken. On other parts it is generally pebbly and quite level. The shoal lies toward the eastern part of the ground and is a good spring cod ground; also a pollock ground in the spring and fall. It is a night-fishing ground for hake, by hand-lining close in to the rocks during September and October. Herring are abundant here usually in May and June. It is a good lobster ground. Fishing is done by hand lines and trawls.

Outer Shoal.—This ground is ESE. from Monhegan Light about 2¼ miles. It is circular in form and about 1½ miles across. Depths are from 10 to 38 fathoms. There is a small rocky shoal in the center of the ground; the remainder of this piece has a gravelly bottom.

This is a cod ground from spring to fall and a good pollock ground in September. A few haddock are taken here about the edges in December. Hake are abundant on the edges on the mud in 45 to 50 fathoms during the spring, summer, and fall.

Fishing here is by hand line and trawling, and recently the use of the gill net is becoming quite common. Apparently this vicinity is at present the most eastern point at which the gill net is used.

Monhegan Inner Sou'Southeast Ground.—This ground is SSE. from Monhegan Light. It is circular in form and 1¼ miles across. The center is 5 miles from the light. Depths are from 30 to 50 fathoms, the shoalest water being on the eastern part. The shoal has a broken and rocky bottom, but the rest of the ground is gravelly and muddy.

The principal fishes taken are cod and cusk in the spring, summer, and fall. Very few haddock are found here. Pollock are numerous in the fall, when they are taken by hand-lining. Hake are abundant in September and October. June is the best fishing month, except when the squid strike the ground in the fall.

This is mainly a small-boat ground, fished by trawls, hand lines, and an increasing number of gill nets.

Monhegan Outer Sou'Southeast.—Three miles outside the Inner Ground, on the same bearing and similar in size and form. The bottom is rocky and muddy or of hard clay. The depths are from 35 to 55 fathoms. The same species are found here as on Inner Sou'Southeast and at the same seasons, and, in addition, hand-lining is done for cod in August and September.

Blue Ground.—This is SE. ½ E. from Monhegan, distant 14 miles; E. ½ S. from Portland Lightship 45 miles, and SW. from Matinicus Rock, 9 miles to southern edge. Fishermen usually take the Monhegan[12] bearing for their starting point. This ground has a small shoal in the center, having 28 to 30 fathoms, from which the bottom slopes off to 45 and 60 fathoms on the edges. The shoal is broken and rocky, but the deep water is over a level gravelly bottom. This ground is circular in form and about 2 miles across. It is both a small-boat and vessel ground, larger craft operating here mainly in the fall.

Hake are found here in large numbers in summer and fall; cusk are taken in the deep water the year around but are most abundant in the spring. Pollock are present in August and September. Haddock are taken here in the fall and winter months but are most abundant in January. Cod are here the year around, the largest school occurring in February and March.

Monhegan Southeast Ground.—This ground lies SE. from Monhegan Island, the center distant 12 miles. This is nearly circular, 3 miles in diameter. The bottom is so broken that depths may vary much within a short distance, but depths are from 35 to 75 fathoms over a bottom of rocks, gravel, and mud. Fishing is by trawl and hand line. It is good cod ground from April to July; haddock are taken in December and hake in summer on the edges in 50 to 60 fathoms.

Hill Ground.—This ground is SSW. 9 miles from Matinic; between 3 and 4 miles long, NE. and SW. and some 2 miles wide. The shoalest part has 35 fathoms and a rocky bottom. From this it slopes gradually to a depth of 50 fathoms over a bottom of mixed gravel, rocks, and mud. Its best fishing is for hake, using both hand line and trawls.

Monhegan Inner Sou'Sou'West Ground.—This ground takes its name from its bearings, lying SSW. from Monhegan Light, distant 5 miles. Its width is 1¼ miles; its length, NNE. and SSW., 1¼ miles. It has a sharp, broken, rocky bottom, including a small shoal of 20 fathoms and some hummocks of rather greater depths. The deepest water is in the neighborhood of 50 fathoms.

---

[12] Again, Captain Smith (1614): "At the Ile of Manahigan, in 43½ of Northerly latitude. * * *. The remarkablest isle, and mountains for landmarks, a round high isle, with little Monas by its side, betwixt which is a small harbor, where our ships can lie at anchor."

Fishing here is from May until July for codfish and pollock; hake and cusk are in the deep water in the spring months and halibut on the shoal in July and September.

This ground is principally fished by trawls, but there is considerable hand-lining in September and October. Gill netting, too, has become more common of late years.

Harris Ground.—From 15 miles S. ½ W. from Monhegan Island to 6 miles SSW. It has 40 to 50 fathoms over a bottom of sharp rocks and mud—a "blistery" bottom. Cod, cusk, and hake are found here the year around. Halibut are here in June, July, and August. Fishing is by trawling and hand-lining, with very little gill netting.

The Forty-five Fathom Bunch.—Sixteen miles S. ½ E. from Monhegan. This is a great ground for June hand-lining for cod. Thence 1 mile ENE. to 70-fathom depth, which leads to a piece of ground leading to the Inner Fall, on which, on a hard bottom and mud where is an abundance of "lemons" and similar forms, are found cod, cusk, and pollock in June. The ground is about 6 miles long, WSW. and ENE., by 1 mile wide.

Another Forty-five Fathom Bunch lies 22 miles S. ½ E. from Monhegan. This ground is 4 miles long by 1 mile wide, running ENE. and WSW., and has depths from 45 to 75 fathoms. This likewise is a great cod hand-lining ground in June.

Another of the name lies 26 miles S. ½ E. from Monhegan. It has a 49-fathom shoal, and the species and seasons are much the same as on the other grounds of the name. This is probably the ground known to other vessel captains as Toothaker Ridge.

Monhegan Outer Sou'Sou'West.—This ground is SSW. from Monhegan Light, the center distant 9 miles. It is 4 miles long, NNE. and SSW., and about 2 miles wide, and has 45 fathoms on the shoalest part, but the depths generally are from 60 to 80 fathoms. The bottom generally is gravelly and quite level. The ground is fished by both boats and vessels using hand lines and trawls. This is a cod ground in spring and fall. In summer hake are abundant here, and halibut are quite plentiful in July on the shoalest part.

Old Jeffrey.—An exceedingly good ground. It is said that better fishing may be had here than on any other ground of its size in the vicinity. In spring cod are most abundant; in late summer and fall hake, cod, and pollock are taken. Halibut are found on the shoaler parts in July. This piece of bottom bears SE. from Pumpkin Rock, from which the center is distant about 6 miles. It is about 3 miles long, NE. and SW., and about 1 mile wide. The bottom is broken, of gravel and mud, with depths from 25 to 50 fathoms. Fishing here is by trawling and hand-lining.

Little Jeffrey.—A small piece of broken, rocky bottom, roughly circular in form. Depths average 35 fathoms. Species and seasons are as on Old Jeffrey, from which it lies about 4 miles NE. by E.

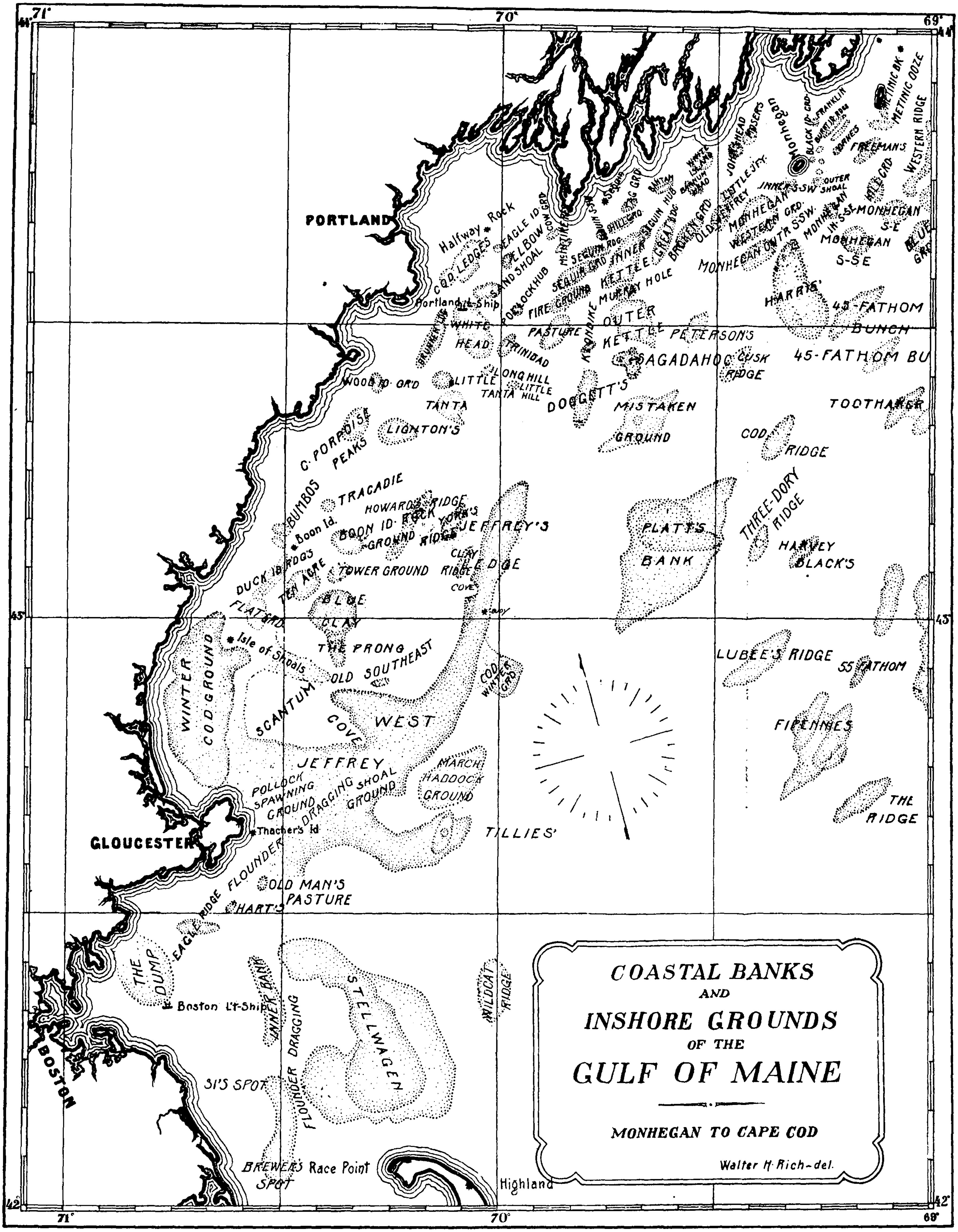
Monhegan Western Ground.—This is a somewhat extensive ground lying about 4½ miles WSW. from Monhegan Island. The depths range from 22 to 45 fathoms. The bottom is rocky and gravelly and in places much broken.

This is a good spring ground for cod and a summer ground for hake and cusk in 40 to 50 fathoms. Pollock are found here in September and October. Its length is 4 or 5 miles, and its greatest breadth is 2 miles on the eastern portion, gradually narrowing westward to about 1 mile. The ground runs SE. and NW. It is fished by hand lines, trawls, and gill nets.

Marks: Bring houses on New Harbor over the white cliff on Pemaquid 6 miles from New Harbor.

Broken Ground.—The center bears nearly S. from Pumpkin Island (at entrance to Boothbay Harbor), distant 7 miles. It extends 4 miles in an ENE. and WSW. direction and has an average width of 1¾ miles. Depths are from 35 to 50 fathoms on a bottom of rocks and mud. Cod are taken here the year around; hake from June to September. Cusk also are found here all the year in 40 fathoms depths. It is fair herring ground on spring nights.

Great Ledge.—Ten miles S. from Cape Newagen. It is about 4 miles long, SSW. and NNE., and from 1 to 2 miles wide. There is said to be a shoal of 14 fathoms on the northern edge and another of 22 fathoms near the center. These are both broken and rocky, but the main part of the ground, having depths of 30 to 45 fathoms, is mostly composed of sand, is quite level, and slopes gradually toward the edge. It is a good ground for cod and haddock in winter and for cod in the spring. A few pollock are taken here, also.


COASTAL BANKS
AND
INSHORE GROUNDS
OF THE
GULF OF MAINE
MONHEGAN TO CAPE COD
Walter H. Rich-del.
PORTLAND
GLOUCESTER
BOSTON
Halfway Rock
Portland Lt-Ship
Boston Lt-Ship
Isle of Shoals
Boon Id.
Thacher's Id
Race Point
Highland
Monhegan
STELLWAGEN
PLATT'S BANK
JEFFREY'S LEDGE
WINTER COD GROUND
SCANTUM
TILLIES'
THE DUMP
OLD MAN'S PASTURE
LUBEE'S RIDGE
FIPENNIES
THE RIDGE
THREE-DORY RIDGE
HARVEY BLACK'S
COD RIDGE
MISTAKEN GROUND
LIGHTON'S
TRACADIE
TOWER GROUND
BLUE CLAY
THE PRONG
OLD SOUTHEAST
CODS WINTER GRD
WILDCAT RIDGE
INNER BANK
FLOUNDER DRAGGING
31'S SPOT
BREWER'S SPOT
HART'S
EAGLE RIDGE
FLOUNDER
45-FATHOM BUNCH
55 FATHOM
TOOTHAKER
PETERSON'S
CUSK RIDGE
SAGADAHOC
DOGGETT'S
OUTER KETTLE
MURRAY HOLE
HARRIS'
MONHEGAN S-SE
WESTERN RIDGE
METINIC OOZE
METINIC BK
70°
71°
69°
44°
43°
42°

Halibut are found on the shoals in July. On these, also, are good lobster grounds. It is chiefly a small-boat and vessel ground, fishing being done by hand lines and trawls, with some gill netting. Marks: Show the sawtooth of Morse's Mountain coming out by Seguin on the western side; hold this until Pumpkin Island comes onto White Island.

Barnum Head Grounds.—These lie SSE. from Damariscove Island and are about 1 mile long by 400 yards wide. Depths are from 40 to 70 fathoms over broken ground of sharp rocks on the shoals, with mud on the deeper parts. This ground is fished by hand lines, gill nets, and trawls mainly by boats and small craft.

Cod, haddock, and pollock are found here in the spring and fall months; hake in the muddy parts in summer. It is a summer hand-line ground for cod and pollock also.

Marks: Bring the peak of Heron Island on Damariscove and the "Whistler" on Seguin, 7 miles from Damariscove Island (this gives 21-fathom soundings); or Big White Island's inner part just touching on Barnum Head; Morse Mountain (in Kennebec) touching on eastern part of Seguin to make a sawtooth.

Peterson's Ground.—Lies distant SW. from Monhegan 20 miles and SSE. from Seguin 16 miles. This is about 3 miles long in an ENE. and WSW. direction by about 1½ miles wide. The northern and western edges rise sharply from the 85 or 90 fathoms of the muddy bottom about it to 60 fathoms over a bottom of rocks and stones. Easterly and southerly the ground slopes away gradually over hard gravel to 90 fathoms. Cod and hake furnish the best fishing here—at its peak during October and November.

Cusk Ridge.—It lies S. ½ E. 12 miles from Pumpkin Island, 3½ to 4 miles long, NE. and SW., and ¼ mile wide. This ground is somewhat difficult to find. It has a bottom of black gravel and rocks with 30 to 60 fathoms of water over it. A "blistery" bottom that is a cod ground the year around, the best of the fishing occurring in the spring months. Hake are abundant in the fall, and cusk fishing is exceptionally good in the deep water in June.

Potato Patch.—Three miles WNW. from Monhegan. A round nubble, about ¼ mile in diameter, of sharp, rocky bottom having about 40 fathoms over it. Cusk and cod are taken on the shoal and hake from the muddy edges about it.

The Apron.—Four and one-half miles from Monhegan. Marks are the tripod on Eastern Egg Rock over Franklin Island Light; Monhegan Light over the middle of Manana.

Its length is 5 miles and its width 3 miles. It is a broken piece of ground with 10 to 45 fathoms.

Cod are present the year around and haddock all the year except for a few weeks in summer. Cusk are here most of the year, but the season for pollock is September.

Henry Gallant Ridges.—The inner one lies 16½ miles S. by E. of Monhegan Island, extending in a NNE. and SSW. direction, about 1 mile long by ¼ mile wide. The outer ridge lies about 1¼ miles farther from the island on the same bearing as the first and paralleling it and apparently is about the same size. The bottom on both shoals is of gravel and black rocks with depths averaging 45 fathoms but rising from the 80 and 90 fathoms of the surrounding muddy ground. Both these are year-around cod grounds, the spring months, however, having the largest school. Cusk also are abundant on both shoals in the spring.

Middle Ground; Mosers Ledge.—This piece of shoal ground lies about midway between Monhegan Island and Pemaquid and has a 3-fathom shoal on the eastern part where the sea breaks in heavy weather. This shoal, called Mosers Ledge, is broken and rocky but slopes gradually to the SW., reaching 48 fathoms, with a bottom of gravel and mud on the deepest part. The ground is about 2 miles long NE. and SW. and about 1 mile wide.

It is good ground for cod and haddock in the spring and for herring in June and other top-schooling fish in their season. Mackerel occur in late August and September. It is a lobster ground the year around.

Johns Head Ground.—About 4 miles SSE. from Pemaquid Point. Depths are from 25 to 35 fathoms over a sandy bottom, making a good cod ground in April and May. The ground is of circular form about 1 mile in diameter. Hand lines and trawls, together with some gill nets, are used on the sand shoal.

White Island Ground.—This is ESE. from White Island, from which its inner edge is distant ½ mile and the outer edge about 4 miles. Of triangular outline, it is widest at the outer end. It is very broken and uneven and has depths from

6 to 30 fathoms. In some places the bottom is gravelly, but on the shoal it is sharp, broken rocks. The small, rocky spots are known by other names, such as Browns Head Ground (a herring ground in June), where the fishermen catch a few rock cod. The sandy bottom furnishes good fares of haddock in May and June. "Bobber rawling" is the usual method used here in June. This ground is fished mainly by small boats and sloops using hand lines and trawls.

Steamboat Ground.—Seven miles WSW. from Monhegan Island; it is 3 miles long, NE. and SW., and ½ mile wide. Its bottom is broken with patches of rocks. Depths are from 25 to 50 fathoms, the shoalest 20 fathoms. This is fished by hand lines and trawls mainly by craft from New Harbor.

Cod are found here the year around but are most abundant in the fall. Haddock are present all the spring and fall; hake through the summer months; pollock in the fall. Cusk are most abundant in the spring. A certain amount of lobster fishing is done here.

Inner and Outer Boutens (Bootlegs).—The inner ground lies 3 miles SW. from Monhegan Island. It is about 1 mile long, NE. and SW., by ¼ mile wide. It has a sharp, rocky bottom, shoalest in the center, where are 25 fathoms, sloping gradually southwest and falling off suddenly on the northeast side to the mud in 60 fathoms on the edges.

Marks: The Tripod on Western Duck Island on the eastern side of the big eastern mountain of Camden; Black Head just out by White Head; White Head through the "Hole in the Wall."

Cod, haddock, and cusk are here the year around. Hake occur in summer on the muddy edges. It is a fairly good lobster ground on the shoal.

The Outer Bouten lies ½ mile SW. of the inner, separated from it by a deep, muddy channel. It has a small shoal of 30 fathoms rising suddenly from the surrounding mud. Fish and seasons of their presence are as on Inner Bouten. Fishing on these grounds is mainly by hand line and trawl.

Hill Ground.—SSW. from Seguin Island, distant 3 miles. It is 3 miles long, NE. and SW., and ¾ mile wide. Depths are from 12 to 23 fathoms over an uneven bottom. The northeast part is very rough and has several shoal spots with depths from 12 to 14 fathoms. Between these the depths are from 20 to 23 fathoms. The southern part, though more rocky, is more even than the northern. Both trawls and hand lines are used here, and there is a growing amount of gill netting in the spring months. Trawling and gill netting are done in the spring for cod and in May and June for hake. Hand-lining for cod, hake, and pollock takes place in September and October. It is a winter lobster ground.

Seguin Sow'Sou'West Ground.—This ground lies SSW. from the western part of Seguin Island, the center distant 4 miles. It is a rocky shoal, ½ mile long by 200 yards wide, with a ½-acre shoal in the center. The marks are as follows: Elwells Rock touching the western side of Seguin and Fullers Rock touching the southern part of Bald Head. Depths are 7 to 14 fathoms. This is evidently a SSW. continuation of the Hill Ground. It is fished by small boats for rock cod by hand-lining. Trawling is done in March for cod, and this is also a cod ground in April. It is both a small-boat and a vessel ground and is a lobster ground the year around.

Seguin Ridge.—This ridge is SSW. from Seguin Island, distant 5 miles. Four miles long, ESE. and WNW., by ½ mile wide. There are a number of small rocky spots—hummocks of 9 to 14 fathoms in depth. It is a good cod ground in the fall and also a lobster ground.

Marks: Pond Island Light on the eastern spur of Seguin; Wooded Mark Island on Bald Head (Small Point). In general the ground has from 16 to 40 fathoms over it, except as mentioned. Cod and cusk are taken in the spring, haddock in May and June, and hake in summer. A few pollock are seined here in the spring. Fishing is by hand lines, gill netting, and trawling.

Seguin Ground.—This ground is SW. by S. from Seguin Island, distant about 7 miles to the center. About 4 miles long, NE. and SW., and a little more than 2 miles wide in the widest part. There is a small hummock called Bumpers Island Ground on the northern end with depths of 13 fathoms. The northern part is mostly rocky, but toward the south the bottom is gravelly and sloping, so that on the middle and southern portions there are depths of 35 to 45 fathoms. Cod, hake, and pollock are the principal fishes taken here and furnish some of the best fishing in this vicinity. Haddock are not common here but are abundant on the sandy bottom to the westward in April and May.

Trawl fishing and gill netting are done in the spring for cod and hand lining for cod and pollock in October. It is a small-boat and vessel ground and a winter lobster ground.

McIntire Reef.—This reef is SSW. from Bald Head (Cape Small Point). The distance to the center is 4½ miles. This is 2 miles long, NE. and SW., by ½ mile wide. Marks are Yarmouth Island Hill over Mark Island and Pond Island Light on the northern part of Fullers Rock.

This reef is very broken and hummocky and has a rocky bottom and depths from 14 to 20 fathoms. A shoal of 7 fathoms is on the northwest part, where there is good hand-lining for cod. It is a good lobster ground. Just east of this ground is a piece of bottom composed of hard mud and shells where hake usually are abundant in summer.

Seguin Hub.—This lies SSE. 5½ miles from Seguin Light. There is a collection of half a dozen small hummocks rising from the 65 or 70 fathoms of the surrounding muddy bottom to 30 or 35 fathoms of rocky bottom. These are hand-line spots. Species and seasons are as on Seguin Ground, except that a great proportion of hake are taken here on mud from 60 fathoms down. It is cod ground in spring and summer.

Marks: Hunnewell Point Woods on Seguin; Damariscotta Hill over Damariscove Island.

Cow Ground.—Nearly SW. from Bald Head, the center distant 6½ miles. This is nearly 4 miles long in a NE. and SW. direction and 1½ miles wide. The northeast portion is rough and rocky and has depths from 16 to 18 fathoms. On the southwest part gravel and stones predominate, and the bottom slopes off to 20 or 30 fathom depths. Trawling and hand-lining are the principal methods employed here, but there is an increasing amount of gill netting. Cod and pollock are the principal fishes taken here, mainly in the spring. This is a lobster ground from November to April.

Murre Hub.—This lies WSW. from Small Point, the center distant 10¾ miles and 3 miles SW. from Seguin. This ground is 3 miles long, N. and S., with an average width of 1½ miles. Depths are from 34 to 45 fathoms. The inner parts are shoalest, and the bottom there is sharp rocks and broken ground. From this the ground slopes gradually to the south, where the bottom is sand and gravel.

Cod are here from spring to October; hake from June to October; and haddock are present during the winter season. Fishing is almost entirely by trawling.

Mistaken Ground.—This ground bears N. from the center of New Ledge, from which it is distant about 10 miles; from Portland Lightship SE. ½ S. 21 miles to the edge and 22 miles to the shoal water. It is 8 miles long in an E. and W. direction and 5 miles wide. Depths are from 45 to 100 fathoms, both the shoalest and the deepest soundings being on the western part, where the bottom is mostly rocks and bowlders. There is said to be a small shoal "peak" of 35 fathoms here. Over the greater part of the ground the bottom is of rocks and gravel. In proportion to its size this ground is nearly as important as New Ledge, being resorted to by the same species of fish at the same seasons and being visited by the same type of craft, with a larger number of the small crafts operating here and the larger vessels fishing here principally during the worst of the winter weather. The fishing is by hand line, trawl, and gill netting, with a lessening use of the hand line and an increase in the use of this ground by the gill-net fleet.

Cod and cusk are taken here from May to July and through October and November, the cod predominating on the ridgy bottom in the deep water, on the western and northwestern side. Hake are also found here in the winter. Haddock are fairly abundant from December to March. There are usually many pollock on the shoal in fall and winter.

Tag Ground.—Between Broken Ground and Seguin Island, ESE. from Seguin, distant 5 miles. A narrow rocky ridge 2 miles long, in a NNE. and SSW. direction, with an uneven bottom and depths from 14 to 30 fathoms. Principally a summer small-boat ground fished by hand lines, trawls, and gill nets. Cod are found here the year around. Haddock are abundant in the winter, hake in the summer months, and the pollock are here also in the summer season when "top schooling." Cusk are found in the deep water all the year.

Kettle Bottom; Outer Kettle.—The center of this ground bears S. from Seguin Island, from which the northern edge of the ground is distant 10 miles. Its length is 12 miles in a N. and S. direction, and its width 10 miles, thus being roughly circular in form. It is an uneven piece of bottom consisting of rocks, gravel, and mud. The depths range from 25 to 75 fathoms. This is one of the best fishing grounds on this part of the coast. Cod are the most abundant fish and are taken the year around. Haddock are plentiful in the winter months and cusk are present all the year in the 50-fathom depths.

Fishing here is by trawl, hand line, and gill nets operated by small boats, sloops, and, in the rougher weather of the winter, larger vessels, which visit it also, generally to make one "set" at a season when a "fish day" (one on which it is possible to fish) is the exception.

Murray Hole.—A small circular piece of ground about 1½ miles across and capable of taking about 40 or 50 lines of trawl; it lies between the two kettles and bears S. by E. from Seguin. Depths here are from 42 to 60 fathoms over a bottom of pebbles and gravel. It is a good cod and hake ground in June and July.

Inner Kettle.—This is S. by E. from Seguin and distant 8 miles. Marks are as follows: The Eastern Hawkwings (west side of the Kennebec River) on western side of Seguin; Damariscove Mountain just touching the east side of Damariscove Island. The depths here average 40 fathoms over a bottom of gravel and rocks. Species and season of abundance are as on the Outer Kettle.

Bantam.—This ground lies off Seguin 6 miles E. by N. It has a bottom of rocky broken ground. There is a buoy in the center over a reef that is said to break at low water. Elsewhere depths range from 14 to 20 fathoms. The shoal is about 2 miles long in a NE. and SW. direction and is about 1 mile wide. This is a cod and haddock ground in the spring, and hake are plentiful in summer on the edges of the ground.

White Head Grounds.—This ground extends south from the lightship at Portland (this is on the northwest part); its length is 5 miles and width 2 miles. Depths are from 22 to 27 fathoms over a bottom of rocks and pebbles; outside of 40 fathoms the bottom is mud. It has on it a shoal of 13 fathoms (bring the Ship on White Head Passage).

Cod are found here the year around. Cusk are present all the year in the southwest soundings and hake in spring, summer, and fall on the muddy edges. Haddock are taken in fair amount during November and December and from March to June on the shoal parts, with a few present the year around. A small amount of halibut is usually taken here in May, June, and July and rarely in November.

Green Ground.—This is a hand-line spot for cod all the year, but the fishing is best in the spring and continues good until the last of the fishing for cod about the river mouths in June. There are two shoals, one of 14 and the other of 16 feet, both of which break in rough weather, but depths elsewhere on the ground about are from 13 to 20 fathoms. The bottom, both on the shoals and about them, is rocky and has many starfish upon it, except on the northwestern part, where the bottom is of sand.

Marks: The eastern end of Elmwood Rock on the little high woods of Small Point; the Outer Sister on Lower Five Island.

Lambo.—This lies E. by N. from Halfway Rock 5 miles. It has a buoy upon it, marking a 5-fathom shoal that breaks in heavy weather. Good fishing is to be had in all directions about it, with haddock in June on the sand outside it, hake inside in August, and cod on the hard bottom about it; but for these it is mostly a summer hand-line spot.

Bull Ground.—This is an irregularly shaped piece of bottom of indefinite area, being perhaps 3 miles long by 2 miles wide. It lies between Lambo Ledge and the White Bull and at about 2 miles distance from Ragged Island. The bottom here is of rocks and mud with depths from 20 to 30 fathoms. This ground furnishes hake fishing in June, July, and August. Cod are taken here in good numbers in the fall by gill nets, with a lesser amount also in the spring by the same method. In the winter the cod are taken here by "bobber trawl." Haddock are taken about the edges in August, mainly by hand line. This ground is visited principally by small boats, the greater part of the catch being taken by gill nets, although trawls and hand lines also are used here.

The Garden.—This is a broken piece of ground lying outside The Elbow and Eagle Island. It runs NNE. and SSW., is about 2 miles long by 1 mile wide, and has depths running from 35 to 60 fathoms. This is a fall ground for hand-line fishing for cod, while haddock, cod, and cusk are found here in the spring. Hake are taken in May and June on the mud about the edges.

Marks: Halfway Rock Light on the big field of Chebeague Island; Eagle Island Woods on the woods in the Eastern Bay.

Sand Shoal.—It is ENE. from White Head Grounds 4 miles. This has depths of 18 to 20 fathoms and in species and seasons of their abundance agrees with White Head Ground.

The Elbow.—This lies NE. from the Sand Shoal 6 miles from the lightship; S. by E. 4 miles from Halfway Rock. Depths on the shoal parts are 26 fathoms, deepening to 40 fathoms on the edges. The bottom is of rocks and mud. The species and seasons are as on White Head Grounds.

Old Orchard Ground or Wood Island Ground, Cape Porpoise Peaks.—Extending over a piece of bottom made up of blue clay with numerous rocky patches, this ground has depths of from 20 to 50 fathoms. Bearing about NE. from Cape Porpoise and distant from 4 to 5 miles, it lies in a N. and S. direction and is about 5 miles long by 1½ miles wide. It is a good spring and summer cod ground, a summer hake ground, and haddock are here in April and May and in the fall and winter and cusk on the deeper parts the year around.

This ground is much resorted to by small boats and in winter by some of the larger vessels of the vicinity. Fishing is by hand lines, trawls, and a certain amount by gill netting over the smoother parts.

Marks: The eastern end of Wood Island on the bank at Old Orchard; to the center 6 miles SSE. from Wood Island Light.

Drunken Ledge (Drunkers).—Eight miles from Cape Elizabeth; 3 miles N. of Tanta; 4 miles S. by E. from the whistling buoy off Cape Elizabeth. Marks: Western Light of Cape Elizabeth on eastern part of woods on cape until the lightship bears NE. Depths are 18 to 40 fathoms on a bottom of sharp rocks. It is about 5 miles long N. and S. by 2 miles wide, extending SSW. and NNE.

Cod and cusk are taken the year around; hake in the summer on the mud at edges; haddock from March to June. Fishing is by trawl, hand line, and gill net.

Eagle Island Ground.—This lies S. from Halfway Rock 2 miles. It has a rocky bottom with 20 to 25 fathoms. It is a good cod ground the year around, fished mainly by hand line; there is little trawling here and only a small amount of gill netting.

Flat Ledge; Temple Ledge.—Two miles SW. of Bald Head, Cape Small Point, rises a piece of rocky ground from the 20-fathom depths surrounding it. Over the shoal in the center are 5 fathoms, and from this the water deepens on all sides, there being 16 fathoms on the deepest part of the ledge and an average of 20 fathoms about it. The rocky bottom is about 1½ miles long, NE. and SW., by about ¾ mile wide. The ledge and the hard bottom about it make good gill-netting grounds for cod in the spring months. On the ledge a considerable amount of hand-lining for cod and pollock is carried on in late May and through June. In the normal seasons of the mackerel fishery this is a good ground on which to seine these fish in June, July, and August. It is also a good lobster ground and is a haddock ground in July and August.

Marks: Wallace house in Bald Head Cove on the western edge of Bald Head; Flag Island and the eastern Brown Cow into line.

The Gully; Mark Island Gully.—Marks: Bring Seguin over Fullers Rock, 6 miles from Mark Island. This gully lies inside The Elbow. The bottom is sandy on the shoal parts, where are 50 fathoms; broken and rocky in the deep water in 70 fathoms; and muddy on the edges. It is a good lobster ground.

Haddock are taken here in the spring months by trawling; cod are taken on trawl and in gill nets during February and March and from August to November. Hake are taken during June, July, and August by the same methods as are used in catching the other species.

New Meadows Channel.—West from The Gully; E. from Seguin. This is a spring gill-net ground; mostly a cod ground.

Pollock Hub.—This ground lies SE. from the lightship 6 to 8 miles and 13½ miles S. from Cushings Island bell buoy. It is a rocky piece of bottom, having about 29 fathoms over it. It is about ½ mile across and is fished by hand line, trawl, and gill net, but is mostly a summer hand-line spot. It is a good cod ground in the spring and good for pollock in their season. Between this and Trinidad (SE. by S. from Pollock Hub 3 miles) is a fishing ground for haddock in January and February, on a broken bottom, in depths of from 40 to 60 fathoms. This is both a small-boat and a vessel ground fished by hand line, trawl, and gill nets.

Trinidad.—Six miles SE. by S. ½ S. from the lightship off Portland. It is about 2 miles long by ¾ mile wide, lying in a NNE. and SSW. direction. In general, the bottom is muddy and depths are from 40 to 50 fathoms, except for a shoal about ¼ mile across on the northeastern end of the ground, where there is a depth of 32 fathoms over a sharp, rocky bottom.

Haddock are present here in good numbers in February and March. Cod are taken here in gill nets during the summer months. and hake are fairly abundant in the spring over the deeper parts; a few cusk are taken at the same season and in the same depths as the hake are found.

Fire Ground.—This ground is E. by S. from the lightship 10 miles. It is a ridge of rocky and gravelly bottom having depths of 35 to 50 fathoms. Its length is 2 miles and its width 1 mile. Marks: Bradbury Mountain on Jaquish; Long Reach Mountain (in Quahog Bay) just to westward of Wooded Mark Island, "the length of an oar."

Cod and cusk are here the year around, the cod being most abundant in the spring. Haddock are here in February and March; hake are in the deep water on the edges in summer. Fishing here is by hand line, trawl, and gill nets operated by small boats and vessels, the larger craft visiting this ground mostly in the winter, when offshore grounds may not permit of the fishing because of weather conditions.

Cod Ledges.—These are a succession of rocky patches extending 4½ miles in an ENE. and WSW. direction, with a width of about ½ mile. The southwestern end bears SE. ¾ S. from Portland Head Light, distant 4¾ miles. The northwestern extremity lies 6 or 7 miles ESE. from Portland Head Light. The shoalest parts have from 14 to 18 feet of water (Bulwark Shoal; the eastern is Round Shoal). On other parts the depths vary from 5 to 22 fathoms. The bottom is irregular, of rocks and gravel. A favorite small-boat ground for fishermen from Portland and neighboring islands. This is a cod ground the year around and a winter haddock ground.

In June and July a few halibut are taken in 14 to 18 fathoms on the sandy patches between the ledges. We are told "Very many large halibut are sometimes taken in some seasons in this small area. Sid Doughty, a local small-boat fisherman, had $300 worth from half his gear for one day's fishing here, being obliged to leave the rest of his gear until the next day from his weariness in handling the heavy fish alone."

Hue and Cry Bottom.—This ground lies W. ½ mile from the Portland Lightship. It is about 2½ miles long by 1½ miles wide and extends in a generally N. and S. direction. The bottom is mainly rocks, though there is a sandy area lying inside it. Depths are from 4 fathoms, where is a buoy and where it breaks in heavy weather, to some 35 fathoms over much of the rest of the ground. Cod and haddock are found here in the spring, and cod, haddock, and cusk in the fall months.

The Pasture.—It lies ESE. from the lightship 10 miles; south from The Cow (Small Point) 12 miles. This ground is 4 or 5 miles long by 2½ miles wide. It has depths of from 45 to 80 fathoms over a bottom of broken ground, rocks, and mud. It is a cod ground the year around but is best in spring. Cusk also are here the year around. Haddock usually are plentiful during January, February, and March. Inside the Pasture (about 10 miles S. from The Cow) lies the Fire Ground, mentioned elsewhere.

The Klondike.—This ground lies 15 miles S. by E. from Bald Head and is 3 miles long by 2 miles wide. The bottom consists of ridges of rocks—a "blistery" bottom (abundance of "sea pears," "sea squirts," and other marine growths of a similar nature). It is a cod and cusk ground all the year. Haddock are present from January to April and hake from September to December. Depths are from 75 to 80 fathoms over mud and rocks.

Fishing on this ground is by hand line and trawl by small boats and sloops, with an occasional trip by larger vessels in winter.

Sagadahoc.—This ground is SE. by E. from Halfway Rock 22 miles and S. ½ W. from Seguin 17 miles. It has a broken bottom of rocks, "blisters," and mud, and is 3½ miles long by 2½ miles wide, with depths from 50 to 80 fathoms. It is a cusk ground the year around as well as a year-around cod ground, also, but this fishing is at its best in the spring. It is a hake ground on the deeper soundings from September to December. Fishing here is carried on by trawling, hand-lining, and gill netting.

Big Ridge, or Doggetts.—These names are given to a piece of fishing ground about 8 miles long by 2 miles wide lying 18 miles SE. by S. ½ S. from the lightship at Portland or 14 miles SE. by E. from the same point, according to which part it is desired to fish upon. It has from 45 on the shoal in the center to 80 fathoms of water on the deeper parts over a bottom of rocks and gravel on the shallower portions and of mud about the edges and in the deeper soundings. Cod are abundant here in spring and fall on the shoaler parts of the bank and are present the year around on the muddy edges and in the deep water about it; the spring school, however, is the largest. Hake are found in spring and summer on the edges in deep water. A few haddock may be taken in the winter and spring, January to April, inclusive. Cusk can be taken the year around, the best fishing being in spring and winter. The February cusk school is the largest, and the best catches are made in the deep water about the edges of the ground. Fishing here is principally by trawling, but hand-lining and gill netting also are employed, the latter method in continually increasing volume.

Lying off Cape Porpoise, between the bearings of SE. and SSE., and at distances varying from 6 to 8 miles, are a number of small, rocky, or pebbly bottoms having depths ranging from 18 to 25 fathoms. During certain seasons these abound in cod and haddock and are visited by the fishermen of the vicinity.

Tanta.—This ground is S. from Cape Elizabeth, the center being distant 12 miles. It is 2 to 3 miles in diameter and has depths of about 40 fathoms over a bottom of broken ground of rocks and gravel. This is a spring and summer fishing ground for cod. Haddock are present here in winter, the best fishing being in January, with a few in the spring. Trawls, hand lines, and gill nets are operated here. Outside of Tanta (S. 3 miles), in 80 and 90 fathoms on a muddy and broken bottom (a "punkin" bottom), hake and cusk are abundant in February and March, the hake remaining into the summer. Herring and mackerel usually are present here in those years when their schools are abundant in this locality.

Winker Ground.—Marks: Run 5 miles SW. from the whistler buoy off Cape Elizabeth, or until Ram Island winker light shows out by Cape Elizabeth. The ground lies in a NE. and SW. direction, about 2 miles long by ¼ mile wide. The bottom is broken, of mud, rocks, and sand, with depths from 35 to 40 fathoms. Outside of the 40-fathom depth the ground is mostly of mud. This is a cod ground in the early spring, haddock and hake being here from July 1 to September 1. Haddock are found here also from March 10 to April 20. This is a small-boat ground, fishing being done mainly by trawling and a certain amount of gill netting.

Long Hill Ground.—This lies SSE. from Cape Elizabeth, 9 miles to the center. Marks: Bring the western light of Cape Elizabeth on the middle of Johnsons Woods on the high land of the cape, which with the course given before, will bring to the center. This lies in a SSE. and NNW. direction and is a rocky bottom, having 60 to 70 fathoms. Haddock are taken here from October to January 1 and from February 15 to April 1. Cod also occur at about the same season.

Little Hill Ground.—This lies SE. from Long Hill Ground 3 miles and SW. from Trinidad 3 miles. Depths are from 30 fathoms over the rocks to 40 and even 60 fathoms over the broken ground. This is a summer ground for cod and hake. Haddock are present in the fall and winter months, and cusk are here the year around.

Outer and Inner Bumbo.—These are two small rocky ridges bearing SE. from The Nubble and extending toward Boon Island. They begin near the main shore and extend nearly to the island. Depths are from 8 to 20 fathoms over a broken piece of bottom, except for a mud gully about 3 miles from the main and running NE. and SW. about 3 miles long. In general, this is a small-boat ground, where good catches of cod and haddock are made in spring and fall, especially in the latter season, with good hand-lining for cod in July and August in 8 and 10 fathom depths. These grounds are fished by trawl, hand line, and gill nets. All the grounds between Cape Porpoise and Boon Island are good lobster grounds.

Wells Bay.—Beside a number of small, rocky patches of fishing ground of less importance, resorted to chiefly by small-boat fishermen and by gill netters from Portsmouth, Wood Island, and Cape Porpoise, this ground has a good cod shoal for spring and winter fishing, which also furnishes good haddocking from April to October. The depths on this are from 25 to 30 fathoms. These are fished by trawl, hand lines, and gill nets (perhaps mainly by the latter) operated by the smaller fishing vessels, chiefly from Portsmouth, Wood Island, Cape Porpoise, and Portland.

Lightons.—This ground is SE. by E. 8 miles from Cape Porpoise, 3 miles long by 2 miles wide, with depths of 25 to 30 fathoms over a generally gravelly bottom. This is somewhat more productive as a haddock ground from January 1 to March, but cod and hake are numerous in the same season also. A small amount of cod may be taken here in the summer. This is a good lobster ground.

Tracadie; The Acre.—This bears NE. by E. from Boon Island, distant 5 miles. It is 1 mile in diameter and has a depth of 50 fathoms over a bottom of rocks and gravel. It is a good haddock ground all the year; a cod ground in August, when these fish are "jigged"; a hake ground from April to October; and a cusk ground the year around.

Old Southeast.—Extends from the shore soundings at White Island (one of the Isles of Shoals) 7 or 8 miles SE. nearly to Jeffreys in a long, rather narrow point. It is a piece of broken ground with a hard bottom, having depths running from 20 fathoms on the inner parts to 50 fathoms farther out and deepening suddenly on all sides to the mud about it. Fish and their seasons are as on Blue Clay, haddock being most abundant on the eastern edge from January through March. This is growing steadily in importance as a gill-netting ground.

The Prairie.—This name has been given to a flat ground of generally level bottom, lying E. by N. from Boon Island 7 miles. It has depths of from 40 to 50 fathoms over mud and gravel, rising out of 60 fathoms over the muddy ground about it. It extends in a generally ENE. by WSW. direction, 2 miles long by 1 mile wide. It is a "blistery" ground, the presence of these growths on a rocky or gravelly bottom usually meaning good fishing. This is principally a haddock ground, with the best season from mid March to the 1st of May. This is a small-boat and gill-netting ground, which is also visited to a considerable extent by the larger vessels of the Portland fleet in the severer weather of the winter and early spring because of its accessibility.

Blue Clay; also called Southeast.—This bears S. by E. from Boon Island, from which it is distant 8 miles. The form of the ground is roughly square and is from 4 to 5 miles across. Depths here range from 30 on the shoalest parts to 60 fathoms, the bottom being of tough blue clay. The water deepens suddenly on the muddy ground all about it. It is one of the best winter haddock grounds in this vicinity, particularly the eastern edge, which is much resorted to by haddock trawlers from January through March, when this species is most abundant here. It is a good winter cod ground, also.

A long, narrow strip of hard bottom, separated from the Blue Clay by a narrow mud gully of somewhat greater depth, is called the Prong. Depths here run from 30 fathoms on the inner parts to 70 fathoms offshore. This piece furnishes a very suitable bottom for operating gill nets and is much visited by this type of craft. The Prong lies S. by E. from Cape Porpoise 17 miles. Marks: Bring Acre Hill in the Notch of Agamenticus at the distance from Cape Porpoise just given. From the Isle of Shoals the Prong is distant 10 miles SE. by E.

Duck Island Ridges.—These are two narrow, rocky ridges running from Duck Island (one of the Isles of Shoals) toward Boon Island, reaching within 1 mile of the latter. Depths are from 25 to 30 fathoms. These are good cusk and haddock grounds in the winter and spring, the cusk remaining on the ground also from April to October. This is a cod ground in winter and spring, the fish being taken on the "bobber trawl," which is a trawl of the ordinary type buoyed to "set" 1 fathom or so from the bottom. It is a hand-line ground in summer for cod and pollock. Both small boats and vessels, line trawlers, and gillnetters operate here. It is also a lobster ground.

Boon Island Rock Ground.—This ground begins ½ mile eastward of Boon Island Ledge and runs in an ESE. direction 2 or 3 miles from the ledge. It has a bottom of sharp rocks and clay and depths from 40 to 60 fathoms. It is an excellent fishing ground for cod, haddock, and cusk and is one of the best winter fishing grounds for haddock in this vicinity. It is fished mainly by line trawlers but is not much used as yet by gill-netters, being a somewhat difficult piece of bottom for them.

Tower Ground.—This is a winter haddock ground having depths averaging 50 fathoms over a ridgy and broken bottom. This is about 3 miles long by 2 miles wide and bears about SE. from Boon Island. Marks: Bring Boon Island

Light on the Peak of Mount Agamenticus, running off until the top of the tower and the top of the mountain are level, perhaps 6 miles from Boon Island.

Ten Acres or Nipper Ground.—Extends S. ½ E. from Boon Island 6 miles and E. from Isles of Shoals 7 miles. Marks: White Hills over Boon Island on center (these cross bearings meet near the center of the ground); also, the Black Hill W. of Portsmouth over the Star Island of the Isles of Shoals leads to the small rocky shoal that is in the middle of the ground. This shoal is about ¼ mile wide and has 18 to 20 fathoms over clay and mud, the ground sloping gradually to 50 or 60 fathoms near the edge. This is a good fishing ground for cod, haddock, cusk, and pollock in the spring, while on the muddy edges hake are abundant in September.

Ipswich Bay.—This extends from the north side of Cape Ann about to Portsmouth and is resorted to in winter by large schools of cod coming here to spawn. Shore soundings deepen here gradually from the land, reaching 35 to 40 fathoms at 6 or 7 miles out. Within this limit the bottom is mainly sandy, though rocky patches are numerous between Newburyport and Cape Ann. Beyond 40 fathoms the bottom is mainly mud.

The principal cod-fishing grounds of Ipswich Bay lie off the northern shore, from Newburyport to the entrance of Portsmouth Harbor, 1½ to 5 miles off the land in 12 to 25 fathoms. Cod are taken abundantly off Boars Head, also. During 1923 and 1924 the cod fishing in these waters, especially off Boars Head, was the best for some years.

Fishing is done by trawls and hand-lining, and of late years a large and increasing gill-netting fleet has operated in these waters, especially from March to June.

The muddy ground outside these waters is a hake ground much frequented by small boats and vessels from the Isles of Shoals and Cape Ann during the summer and fall.

"Flounder dragging" is a considerable industry in these waters, the craft employed being a small type of the otter trawler, mainly operating out of Newburyport on a piece of shallow mud bottom extending from NE. by E. to SE. of the Isles of Shoals and on another ESE. from Thacher Island. Depths are from 4 to 14 fathoms.

Massachusetts Bay.—The larger part of this ground, especially inside Stellwagens Bank, has a mud bottom, on which large quantities of fish are rarely taken. On the shore soundings between Boston Harbor and Plymouth to Sandwich are many rocky ledges, which are favorite feeding grounds for cod in winter and fall. Off Plymouth, in late March, there is generally a large school of codfish, from which the gill-netters take good fares. All over this ground, in depths of from 10 to 40 fathoms, netters from Gloucester and Boston operate in a codfishery in the months of December, January, and February. There is a considerable hand-line fishery for pollock in the fall. The gill-netters also take large fares of this species on these shore grounds as well as about Gloucester, their fares for a single month often amounting to nearly 4,000,000 pounds. November and December usually show the largest catches. These vessels operate mostly between Boston and Gloucester, and their catch goes principally to "the splitters," since the abundance of the fish naturally operates to reduce its price. This pollock netting comes to an abrupt end with the closing days of January, when the fish move offshore.

Herring appear about Cape Ann in September in large numbers in most years, the fishing lasting about two weeks, when the school moves slowly inward toward the head, and the last catches usually are taken off Minot Light, Boston.

The mackerel, after leaving the coast of Maine in their autumnal migrations, pass by Cape Ann and enter Massachusetts Bay during October and November, where they are taken in great number by purse seiners, netters, and pound nets, of which latter there are many in Cape Cod Bay, and which take many mackerel and herring in their seasons.

Near the center of Cape Cod Bay, on a line between Race Point and Cape Cod Canal, lies a rocky elevation on which cod are taken, known as Eagle Ledge or Bay Ledge, and by Provincetown fishermen as Red Bank. It has a depth of 13 fathoms.

Cape Cod Bay has a considerable industry in flounder dragging, the fish being taken by a small type of otter trawl.

South and southeast of Thacher Island from 5 to 8 miles lies a stretch of muddy bottom with patches of sand scattered over it, where a considerable amount of this method of fishing is carried on during most of the year.

Old Man's Pasture.—This ground is due S. from Thacher Island, SE. from Eastern Point Light, Cape Ann, and distant 5 miles. It is about ¾ mile long, NNE. and SSW. by ⅓ mile wide. The bottom is rough and rocky, with about 24 fathoms average depths. It is a cod ground for the entire year, which fish are taken by gill-netters principally in November. Pollock are taken here, also by gill-netters, from October 1 to December. Apparently there are few haddock here in the fall, but there is good fishing for these from February to April 1. It is also a lobster ground.

Harts Ground.—This lies S. ½ E. from Eastern Point Light, distant 5½ miles. It is ¾ mile long in an ENE. and WSW. direction by ¼ mile wide, and is a small, rocky patch with a depth of 30 fathoms. It is a summer haddock ground, visited mainly by small boats. There is little or no gill netting here.

Eagle Ridge, sometimes called Little Middle Bank.—This ridge is 7¾ miles S. by W. from Eastern Point Light, Cape Ann, and 1 mile long, NE. and SW., by ⅓ mile wide. The average depths are 25 fathoms on a rocky and uneven bottom. Formerly, with Old Man's Pasture and Browns Ledge, this was considered the principal winter grounds of the cod, but not so many have been taken here at that season in recent years.

Inside this area, at an average distance of 2½ miles from Eastern Point Light and between bearings S. ½ E. and SW., are a number of small, rocky patches having depths of from 10 to 25 fathoms—Browns Ledge, Spot of Rocks, Saturday Night Ledge, and Burnhams Rocks; SW. ½ W. from Saturday Night Ledge, 6 miles, lies Old Tillie. Farther in are two shoal spots bearing nearly west from Eastern Point, one at ¾ mile and the other at 2 miles distance, each having 11 fathoms. The first is called Eleven Fathom Ground, the second, Kettle Island Ledge. This latter lies ½ mile SE. of Kettle Island. These are cod grounds in winter and haddock grounds in summer.

Gill-netters operate from Kettle Island to Halfway Rock and Italian boats trawl at all seasons off The Graves.

Western Point Ridge.—This bears S. by E. ½ E. from Eastern Point Light, distant 9¼ miles. Its length NE. and SW. is 1½ miles and its width is ¾ mile. The depths average 29 fathoms over a broken and rocky bottom. Small vessels and boats fish here for cod and haddock in the summer. Netters take many pollock on all these shore grounds in the fall runs, October to January furnishing the largest fares. Apparently these are spawning fish that leave abruptly during January, working offshore again.

The Dump.—This lies inside the lightship at Boston, extending from this to and well into Nahant Bay. On these inner grounds soundings are from 12 to 15 fathoms over sand and gravel. This portion is a cod ground from March to May. The outer parts of the ground have from 15 to 20 fathoms of water over a gravelly and muddy bottom, which usually furnishes haddocking during the early spring. These are mainly gill-net grounds.

Inner Bank.—This lies SE. from Thacher Island 12 miles to the northern end, whence it extends in a generally southerly direction for about 10 miles, having an average width of 2½ miles. Depths here average about 40 fathoms on a hard, gravelly bottom, where haddock usually are taken in the spring, pollock in the fall, and cod in the winter months. This piece of ground is much fished by the gill-netting fleet out of Gloucester.

A large area of muddy ground lying E. of this and between it and Middle Bank is much visited by the flounder draggers out of Boston and Gloucester. Depths here are from 40 to 55 fathoms over a comparatively smooth bottom.

A ridge that lies just S. of the Inner Bank, and which may be a continuation of it, extends from a point E. by N. from Scituate buoy to a point SE. by S. from the same about 10 or 11 miles and furnishes cod fishing in February, beginning at Brewers Spot, on the southern end of the ground, and working northward with the schools to Si's Spot, at the northern end of the ridge. The bottom over much of the ridge is of mussel beds, with from 25 to 30 fathoms of water, but at the northern end it is rocky and pebbly, with from 30 to 35 fathoms; and on the southern end the bottom is composed of stones, gravel, and pebbles with 20 to 25 fathoms of water over it. This ridge is flanked E. and W. by a muddy bottom, which furnishes the flounder-dragging fleet with good fishing during most of the year.

TABLE 2.—*Inner fishing grounds, showing the principal species taken upon them*

Fishing ground	Cod	Haddock	Hake	Pollock	Cusk	Halibut	Herring	Mackerel	Lobsters	Miscellaneous
Lukes Rock	x	x		x						
Newfound Ground	x	x		x						
Henrys Rock	x	x	x	x						
Handspike Ground	x	x		x						
Western Egg Rock	x	x		x	x					
Old Egg Rock	x	x	x	x						
Middle Ridge	x	x		x	x					
Broken Ground	x		x	x			x			
Tibbetts Ledge	x	x	x							
Bens Ground	x	x	x							
Southeast Rock	x	x	x						x	
Broken Ridges	x	x								
Black Ledges Ground	x	x			x				x	
Bakers Island Ridge	x	x	x		x				x	
Martins, Hillards Reef	x	x	x		x				x	
Egg Rock Broken Ground	x	x	x						x	
Inner Schoodic Ridge	x	x	x						x	
Outer Schoodic Ridge	x	x	x	x	x	x				
Mount Desert Inner Ridge	x	x		x	x	x				
Mount Desert Outer Ridge	x		x							
Flat Ground			x							
Enochs Shoal	x	x	x						x	
Banks Ground	x	x	x						x	
Shell Ground	x	x	x	x	x				x	
Abner Ground		x								
Grumpy	x	x	x							
Hatchell Ground	x	x	x	x						
Blue Hill Ground	x	x								
Horse Reef (Inner and Outer)	x		x						x	
Hake Ground			x							
Southwest Ground	x	x	x	x					x	
Barley Hill Ground	x		x						x	
Gilkey Ground	x	x	x							
Rock Cod Ledge	x	x			x	x	x	x	x	
Southeast, Gravel Bottom	x	x	x							
Laisdells Ground	x	x							x	
Saddleback Reef	x	x							x	
Otter Island Reef, Snipper Shin	x	x							x	
Old Ripper			x		x					
Crie Ridges	x	x		x	x					
Bald Ridges	x	x	x						x	
Henry Marshalls Ground	x	x	x						x	
The Bounties	x	x			x					
Summer Hake Ground			x							
Minerva Hub	x		x		x					
Haddock Nubble	x	x								
Skate Bank	x		x		x					
Matinicus Sou'Sou'West	x	x	x							
Inner Breaker	x	x	x							
Towhead Grounds	x	x							x	
Pigeon; Western; Green Island Ridge	x	x	x			x				
Matinic Bank	x		x			x				
Matinic Ooze	x	x	x							
Freemans Ground	x		x	x			x			
Middle Shoal; Allens Shoal	x	x		x			x		x	
Black Island Ground	x		x	x					x	
Franklin Ground	x	x	x	x					x	
White Head Grounds	x	x	x	x					x	
Burnt Island, Inner Ground	x	x	x						x	
Burnt Island, Outer Ground	x	x	x						x	
Ornes Ground	x		x	x			x		x	
Outer Shoal	x	x	x	x						
Monhegan Inner Sou'Southeast	x		x	x	x					
Monhegan Outer Sou'Southeast	x		x	x	x					
Blue Ground	x	x	x	x	x					
Monhegan Southeast Ground	x	x	x							
Hill Ground			x							
Monhegan Inner Sou'Sou'West	x		x	x	x	x				
Harris Ground	x		x		x	x				
Forty-five Fathom Bunch	x			x	x					
Monhegan Outer Sou'Sou'West	x		x			x				
Old Jeffrey	x		x	x		x				
Little Jeffrey	x		x	x		x				
Monhegan Western Ground	x		x	x	x					
Broken Ground	x		x		x		x			

TABLE 2.—*Inner fishing grounds, showing the principal species taken upon them*—Continued

Fishing ground	Cod	Haddock	Hake	Pollock	Cusk	Halibut	Herring	Mackerel	Lobsters	Miscellaneous
Great Ledge	x	x		x		x			x	
Barnum Head Ground	x	x	x	x						
Peterson Ground	x		x							
Cusk Ridge	x		x		x					
Potato Patch	x		x		x					
The Apron	x	x		x	x					
Henry Gallants Ridge	x				x					
Middle Ground; Mosers	x	x					x	x	x	
Johns Head Ground	x									
White Island Ground	x	x					x			
Steamboat Ground	x	x	x	x	x				x	
Inner and Outer Boutens	x	x	x		x				x	
Hill Ground	x		x	x					x	
Seguin Sou' Sou' West	x								x	
Seguin Ridge	x	x	x	x	x					
Seguin Ground	x	x	x	x					x	
McIntire Reef	x		x						x	
Seguin Hub	x	x	x	x					x	
Cow Ground	x			x					x	
Murre Hub	x	x	x							
Mistaken Ground	x	x	x	x	x					
Tag Ground	x	x	x	x	x					
Kettle Bottom, Outer	x	x			x					
Murray Hole	x		x							
Inner Kettle	x	x			x					
Bantam	x	x	x							
White Head Ground	x	x	x		x	x				
Green Ground	x									
Lambo	x	x	x							
The Bull Ground	x	x	x							
The Garden	x	x	x		x					
Sand Shoal	x	x	x		x	x				
The Elbow	x	x	x		x					
Old Orchard; Wood Island Ground	x	x	x		x					
Drunken Ledge	x	x	x		x					
Eagle Island Ground	x									
Flat Ledge; Temple Ledge	x	x		x				x	x	
The Gully	x	x	x						x	
New Meadows Channel	x									
Pollock Hub	x	x		x						
Trinidad	x	x	x		x					
Fire Ground	x	x	x		x					
Cod Ledges	x	x				x			x	
Hue and Cry	x	x			x					
The Pasture	x	x			x					
The Klondike	x	x	x		x					
Sagadahoc	x		x		x					
Doggetts; Big Ridge	x	x	x		x					
Tanta	x	x	x		x		x	x		
The Winker Ground	x	x	x							
Long Hill Ground	x	x								
Little Hill Ground	x	x	x		x					
Bumbo, Outer and Inner	x	x							x	
Wells Bay	x	x								
Lightons	x	x	x						x	
Tracadie	x	x	x		x					
Old Southeast	x	x								
The Prairie		x								
Blue Clay, Southeast	x	x								
Duck Island Ridges	x	x		x	x				x	
Boon Island Rock Ground	x	x			x					
Tower Ground		x								
Ten Acres; Nipper Ground	x	x	x	x	x					
Ipswich Bay	x		x							[1] x
Massachusetts Bay	x			x			x	x		[1] x
Old Man's Pasture	x	x		x					x	
Harts Ground		x								
Eagle Ridge	x	x								
Western Point Ridge	x	x		x						
The Dump	x									
Inner Bank	x	x		x						
Brewers and Si's Spot	x									[1] x

[1] Flounders.

OUTER GROUNDS

Grand Manan Bank.—This bank is at the entrance of the Bay of Fundy, SW. ½ S. from the southwest head of Grand Manan Island, from which the northern part of the bank is 15 miles distant. From Mount Desert Rock, E. by S., it is 45 miles distant. The bank is 10 miles long and 5 miles wide, extending in a NE. and SW. direction. The bottom is mostly stones and gravel, the depths running from 24 to 45 fathoms. Soundings of 18 and 21 fathoms are found on the northeast part.

Cod (especially abundant when the June school is on the ground) and pollock are the principal fish. Haddock are not usually abundant, although sometimes they are plentiful in the fall from late September to December. Hake are fairly abundant on the mud between Grand Manan Bank and the Middle Ground (in The Gully). This is a good halibut bank, the fish being in 33 to 60 fathoms in June and July; the southwest soundings and the southeast soundings are most productive always.

The best fishing season is from April to October, when the fish come to this bank to feed. In the spring the fish, other than halibut, are mostly on the southwest part, but later (July to October) the best fishing is had on the northern edge of the ground. The very best herring fishing for large herring (food fish) occurs on this bank in June and July.

In general, this is a small-vessel ground fished by craft from Cutler, Eastport, Grand Manan, and, to a less extent, Yarmouth, Nova Scotia, with an occasional visit by craft from Portland and Rockland, chiefly trawlers of moderate size.

Tides run NE. in flood and SW. on the ebb and are quite strong, the flood being the heaviest. Because of these powerful currents, fishing is somewhat difficult, it being necessary to make sets at the slack of the tides, getting the gear over and traveling with the finish of the current, to take it up and come back with the tide's return.

Middle Ground.—This ground is between Grand Manan Bank and Marblehead Bank; its length from NW. to SE. is 1½ miles, and it is about ½ mile wide. Depths averaging 37 fathoms are found on the southern edge on a hard, rocky bottom, increasing to over 60 fathoms over much of the ground. The remainder of the bank has a bottom of sand and gravel. There is a shoal of 28 fathoms near the center with a bottom of rocks and stones.

The species and seasons of their abundance are much as on Grand Manan Bank and German Bank, but the Middle Ground is rather better as a cod ground than as a ground for other species, June, perhaps, being the best month for the fishing.

Marblehead Bank.—Situated between Grand Manan and German Banks, the shoal water bearing SSE. from Moosabec Light, distant 32 miles. It is from 12 to 15 miles long and 7 or 8 miles wide, lying between 44° 00′ and 44° 10′ north latitude and 66° 58′ and 67° 13′ west longitude. There are from 35 to 70 fathoms of water over it; the bottom is mostly clay and gravel. The principal fishing is for cod, pollock, and haddock, but there are more or less hake and cusk to be had from this ground. The best fishing season is from early spring through the early part of the summer, and this ground is of little account after July.

The same type of vessels operate here as on the neighboring banks, with an occasional larger vessel. The craft are mostly hand-liners from Cutler, Jonesport, and Rockland, with a few vessels from the trawl fleets of Portland and others from the Canadian Provinces.

Haddock are found in the shoal water from May to October. Cusk are on the eastern portion in from 60 to 70 fathoms virtually the year around. Many large hake are present on the western edge in 80 to 90 fathoms in the summer. The June and July cod school is the best, but this species is present in smaller numbers all the year. Halibut are found all over the bank, being especially abundant in the eastern shoal water in spring and summer (April to October). It seems necessary to leave the halibut trawls down for a longer set here than on other grounds in order to make a good catch.

German Bank.—This is one of the most important banks in the Bay of Fundy. (We are here referring to the German Bank in the bay and not to the part of Seal Island ground, so marked on some charts.) It bears SE. from Bakers Island Light, Mount Desert, from which the northeast part is about 52 miles distant. Its length is about 15 miles, the width 9 or 10 miles. It lies between 43° 38′ and 43° 53′ north latitude and 66° 58′ and 67° 15′ west longitude.

Depths are from 65 to 100 fathoms with soundings of 47 fathoms on the northern part. The bottom is mostly tough red clay with spots of mud, sand, gravel, and pebbles on some parts.

The tides set in and out over this bank to and from the Bay of Fundy, the ebb SW. and the flood NE., but the currents are not so strong as might be expected.

Cod, hake, and cusk are the principal species taken, with pollock and haddock in lesser amounts. It is a fairly good halibut ground also, wherever a bottom of black and white gravel is found, though formerly little regarded as such. The fish (except hake) are most abundant in the spring.

This ground is not much fished of late years, but was formerly considered a good place for hake fishermen in summer. Probably it is equally as good now, but the demand for hake has diminished materially in recent years, and this fishery has suffered in consequence.

Mostly Maine vessels fish this bank, from Cutler, Moosabec, and Rockland, with a few from Portland and perhaps an occasional visitor from the Yarmouth, Nova Scotia, fleet.

Newfound.—This ground is 45 miles SE. by S. from Mount Desert Rock and has depths of 90 to 100 fathoms over a gravelly bottom. Apparently, this title is given to some rediscovered old ground and with a new generation of fishermen displaces the old name. This is not a haddock ground, but cod, cusk, and hake (large fish) are abundant here in the spring. Perhaps this is an all-the-year fishing ground, but thus far no further information about it has been obtainable. It is about 12 to 15 miles long, ENE. and WSW., by 7 miles wide, lying in the track of the Yarmouth (Nova Scotia) to Boston steamers.

Jones Ground.—This is an important cod ground though of small size. The western part bears SE. from Bakers Island Light, distant 32 miles. The ground is 10 to 12 miles long, NE. and SW. and 5 miles wide. Depths range from 50 to 100 fathoms. The bottom, which is quite broken, consists of rocks, gravel, and mud. On the northeast parts, where depths vary from 50 to 70 fathoms, the bottom is rocky and rough. This part bears SE. by E. ½ E. from Bakers Island Light, distant 35 miles. (Green Mountain, of Mount Desert, bears NW.) It is a hake ground in 110 fathoms. The center of the ground furnishes good trawl fishing from May 1 to September. The principal catch is large cod, but a smaller amount of hake, cusk, and pollock are taken also.

Bank Comfort.—This is a comparatively little known fishing ground lying SE. by S. from Mount Desert Rock, distant 12 or 13 miles. It is said to be 5 miles long, SW. and NE., by 3 miles wide. Here are depths of from 75 to 80 fathoms over a hard gravelly bottom, the shoalest water being some 65 fathoms. This is an excellent ground but little fished because its small size makes it somewhat difficut to find. It is a very good cod ground in spring and summer, hand-liners catching large cod here from May to August. Hake and cusk are present here in summer also. It is scarcely fished at any other than the seasons mentioned.

Clay Bank.—This bank lies SW. by W. from Mount Desert Rock, the center distant 7 miles. It is 4 miles long, WSW. and ENE., by 2 miles wide. Depths are from 50 to 80 fathoms over a bottom of hard clay. Cod are the principal catch in spring, hake in summer. There is virtually no winter fishing.

Newfound.—This ground lies off the northeast edge of Jeffreys Bank and is often considered a part of it, but there seems to be deep water between. This is one of three grounds of the name in these waters. The present piece of bottom lies 20 miles SE. by S. from Matinicus Rock and S. ½ E. from Seal Island (in Penobscot Bay) and has a broken and irregular bottom with depths from 60 to 100 fathoms over blue mud and shells and considerable areas of gravelly ground. It is about 7 miles long, E. by N. and W. by S., and about 4 miles wide.

Fishing here in the summer months is mostly by hand-lining because of the presence of schools of dogfish in these waters at that season. In the spring it is a good ground for cod, and in the fall months cod, hake, and cusk are taken, all by trawling. Perhaps March is the best month for cod fishing here, the cusk being most numerous at the same season, when they are especially abundant in depths of 80 fathoms or more and are then taken by trawling. In spring and early summer halibut are often found in depths of 35 to 60 fathoms on the gravelly parts of the ground.

A small rocky eminence just off the northern edge of the ground rises sharply from the 94-fathom depths surrounding it to reach 48 fathoms. On this are taken market cod (2½ to 10 pounds weight) during the spring months and very large cod (fish reaching 50, 60, and 70 pounds or more) during June, July, and August. Its small area makes this spot somewhat difficult to find.

Jeffreys Bank.—This ground lies east of Cashes Bank and, despite its considerable size, is of comparatively little importance as a fishing ground. It is about 20 miles long, SW. and NE., and 10 miles wide. The northern and southern limits are 43° 30′ and 43° 15′ north latitude. The eastern edge is in 68° 25′, the western in 68° 45′, west longitude. The bottom is somewhat broken—mud, sand, gravel, and pebbles—with a great number of small rocky ridges, upon which good fishing is generally to be had, although these spots are quite difficult to find and accommodate but little trawl gear. There is virtually no fishing upon much of the interior parts of the bank between these spots, where the bottom is mostly of mud. Depths over the bank vary from 35 to 70 fathoms. The Outer Fall and the Inner Fall, generally called Monhegan Fall, are the only parts of Jeffreys Bank thought to be of much importance as fishing grounds. Both these formerly furnished excellent fishing but are not now as much resorted to, although vessels from Portland and Rockland often fish here and bring in fair catches.

Cod, haddock, and cusk are the most important species in the fares from this ground, with a lesser amount of pollock and a few halibut, these latter usually being taken on the small ridges above mentioned. In the main, this bank is a winter ground; good also, in the spring and early summer before the dogfish strike it. It is fished mostly by the smaller vessels—trawlers of from 15 to 70 tons.

The Inner Fall lies SE. ½ S. from Monhegan Island, 21½ miles, west of Newfound 6 miles, and S. by W. ½ W. from Matinicus Rock 17 miles. The Outer Fall lies S. ½ E. from Matinicus Rock 21 miles. These both have hard sharp bottoms, which are good cod and cusk grounds in the spring. The gravelly bottom, both on the Inner Fall and on the Outer Fall, often holds halibut in the spring and early summer (May 1 to July 15) in depths of from 35 to 60 fathoms. The fishing ground of the Inner Fall is somewhat difficult to find, the best portions lying in a narrow strip about 6 miles long by something less than 1 mile wide along the northwestern edge of the bank.

Soundings ranging from 35 to 55 fathoms over the main body of the bank drop suddenly to 85 and even 94 on the edges. The average depth is about 45 fathoms over a rocky bottom, with good cod fishing in summer and cusk on the hard bottom of the deeper water. Haddock usually are abundant on this bank in winter. Along the northern edge of Jeffreys Bank, between the Inner Fall and the Outer Fall, in an average depth of 46 fathoms, cod and halibut are taken in spring and summer. The extreme southern part of the bank is also a fairly good cod ground, while halibut occur in fair numbers in summer. Depths here are from 38 to 45 fathoms over rocks and gravel.

A small circular piece of ground rises about 2 miles W. of the bank, lying between it and Toothaker Ridge. This is about 2 miles across and has depths averaging 50 fathoms over a rocky bottom. This spot is a good summer cod ground.

Toothaker Ridge.—This bank is 26 miles S. ½ E. from Monhegan and lies in an ENE. and WSW. direction. There seem to be two ridges here, the larger being about 5 or 6 miles long by about 1½ miles wide. This inner ridge has a shoal of 35 fathoms on the western end, from which it deepens eastward to about 45 fathoms, which is the general depth elsewhere on this piece of ground.

The outer ridge parallels the inner at about 1½ miles distance and there is a deep, narrow gully between. It apparently has about half the area of the other. This smaller ridge has a 45-fathom shoal of rocks on the western end, deepening the water, like the other, to the eastward to 75 and 80 fathoms over a broken rocky bottom and 90 fathoms on hard mud. This is an all-the-year cusk ground. A few cod are present all the year, but this species is most abundant here and on the other ridge in the spring and through June. Hake occur on the muddy ground in summer and fall.

On both shoals are abundant growths of "lemons" and like species of fish food, and they are good "hand-line spots" over their rocky bottoms. Fishing on both is said to be at its best in the spring and in June, the species taken being cod, cusk, pollock, and hake. As before stated, these are year-around cod and cusk ground, pollock and hake being present in summer and fall, the latter species over the muddy ground. These grounds have been thought to be too rough for trawling, but occasional good fares are taken on them by this method.

Cashes Bank.—Our older reports state that Cashes Bank was not then an important fishing ground except for a short time in the spring, although good fares were often taken there in the fall also. The writer has found it furnishing at least its quota in recent years and in apparently increasing volume. It bears E. ½ S. from Cape Ann (Thacher Island Light, from which point most skippers lay their course), from which its shoaler parts are distant 78 miles, and bears SE. ½ S. from Portland Lightship 69 miles to the buoy upon it, where is a depth of 17 fathoms; and 74 miles SE. ½ S. from Cape Elizabeth eastern light to the buoy. The bank is about 22 miles long, from 42° 49′ to 43° 11′ north latitude, and about 17 miles wide, from 68° 40′ to 69° 03′ west longitude. There are three small shoals upon its western part, of which the southern has a depth of 7 fathoms, the middle one has 4 fathoms, and the northern one has 11 fathoms. The middle shoal lies in 42° 56′ north latitude and 68° 52′ west longitude. From this the south shoal bears S. by E. and the north shoal NNE., each being 3½ miles distant from it. The water breaks on these in rough weather and, though of small extent, they are dangerous to passing vessels bound from Cape Sable to Massachusetts ports, across whose course they lie directly. Except for these shoals, the water ranges from 15 to 60 fathoms. The ground is more or less broken, and the bottom is of sand, pebbles, and rocks.

The principal fishing on these grounds is for cod, haddock, hake, and cusk; the cod and cusk are present the year around, the cod being most abundant in February, March, and April in an average depth of 60 fathoms. The hake are found on the muddy edges in summer, with a lesser number present all the year. Haddock are present in considerable numbers from November to February, and sometimes a good school occurs in 20-fathom depths in April. The arrival of the dogfish usually puts a temporary ending to the fishing here in the last days of June or early in July, to be resumed again when these pests have moved inshore. Formerly halibut were reported as seen rarely, but of late years they have been found among the kelp in 15 to 18 fathoms on the shoal nearly the year around, the fish ranging in size from 5 to 40 pounds, rarely larger. Halibut of larger size are taken occasionally in fairly good numbers in 30 to 50 fathoms in May and June. Perhaps this species is more abundant on this and neighboring grounds than is generally realized. At all events, certain Portland vessels have recently taken good fares of halibut when fishing for them here in the season named. Cusk are present in the deep water the year around. As is the case with most of the detached ridges in this gulf, the cusk is the most abundant of the fish present about the middle of March, continuing in good numbers through May. In herring years these fish usually occur in good numbers on this ground in late May, and a considerable number of these (food fish or large herring) are taken here by seiners at this season. Mackerel are generally abundant on these grounds in those years when these fish occur in normal quantities on this coast.

Vessels operating on Cashes Bank range in size from 15 to 50 tons, principally from Maine ports, with a fair number of them from Gloucester and Boston, especially in winter. Of late years a few gill-netters have fished here, and these craft are using these grounds in steadily increasing numbers.

A comparatively little known and apparently as yet unnamed ridge lies E. by S. 15 miles from the buoy on Cashes Ledge, which is reported to be good fishing ground, especially for cod and cusk. With both species present here the year around, the cod is said to be most abundant in April and May; and the cusk, as is the rule on these outlying ridges, appears in largest numbers in March and April. Haddock seem to be somewhat rare here.

This ridge lies in a SE. and NW. direction, extending somewhat indefinitely but for at least 10 miles by about 3 miles in width. On the ridge the bottom is broken—a hard bottom of black gravel, which usually means a good fishing spot—the depths here being from 85 to 90 fathoms. There are numerous muddy spots between these harder pieces of ground where soundings run to 100 fathoms or slightly more. The surrounding bottom is mostly of mud, and the depths average from 100 to 125 fathoms. There are a number of pieces of gravelly hard ground in the vicinity, each of which probably would furnish equally good fishing for cod and cusk at the same seasons as on the ridge.

Due E. from the buoy on Ammens Rock about 12 miles lies a ridge that rises from the 100 to 120 fathom depths about it to a depth of about 86 fathoms over a bottom of broken ground, mud, and shells. This shoaler piece is some 3 miles long, N. by E. and S. by W., by 1 mile wide. It furnishes good fishing for cod, hake, and cusk in the spring, April being the best season.

A ridge lying NW. of Cashes Bank and nearly parallel with the main bank, only separated by a narrow deep channel, is about 7 miles long by 1½ miles wide. The species and their seasons are the same here as on Cashes Bank.

Big Ridge.—This is a broken and rocky piece of bottom running from the tip of the southeastern part of the ground, at about 10 miles S. from the buoy on Ammens Rock and about 82 miles SE. ½ S. from the lightship at Portland, to a point about 20 miles S. by E. from the buoy named. Its length is not to be stated definitely, and it is probably greater than here shown. The width averages about 1½ to 2 miles. Depths are from 65 to 80 fathoms and more, increasing gradually as it goes away from the main bank. The species and their seasons of abundance here are as on Cashes Bank. Perhaps this is more of a cod and cusk ground than is the main part of Cashes Bank, the cusk being particularly abundant during March and April. Halibut also are found here in May and June in from 50 to 60 fathoms of water. A considerable amount of the fish shown in the table of the catch from the area included in Cashes Bank may very well have come from this piece of ground.

Another big ridge, paralleling the 100-fathom curve of Georges Bank at about 20 miles N. of it, lies SE. by S. from the buoy on Cashes Ledge, 40 miles to its center; SE. by S. 110 miles from Portland Lightship; ESE. 92 miles from Cape Ann to its western end; and E. by S. ½ S. from the ship at Boston 100 miles. This ridge also is of somewhat indefinite area, being perhaps 20 miles long in an ESE. and WNW. direction by 1½ to 3 miles wide. Apparently depths are fairly uniform from 85 to 95 fathoms, the bottom on the ridge being of coarse black sand and having blue mud on the deeper area around it. This is said to be a good cod and cusk ground the year around.

John Dyer's Ridge.—This lies 14 miles S. by E. from Toothakers Ridge, 40 miles S. by E. from Monhegan Island, and 7 miles NE. from Cashes Bank. It is about 5 miles long by 2 miles wide, lying in an ENE. and WSW. direction. The water is shoalest on the western edge, where are from 45 to 50 fathoms over a sharp, pebbly bottom; thence the ground slopes to the NE. into 75 and 80 fathoms over a hard, gravelly, and muddy bottom, in all other directions falling off sharply to 90 and 100 fathom soundings over a muddy bottom.

This is essentially a cod ground for the entire year, the species being most abundant from May 1 to November. It is a cusk ground all the year on the hard bottom of the deeper parts, March and April showing the largest schools. Hake also are abundant in 70 fathoms and deeper on the mud in summer and fall.

Fifty-five Fathom Bunch.—West of Cashes Bank is a rocky ridge extending ENE. and WSW. about 4 miles and having a width of about 1 mile. This is mainly a cod ground, the seasons for the species being as on Cashes Bank.

Fippenies Bank.—This consists of two shoals averaging 30 fathoms in depth with a channel of 90 fathoms between them. These run NE. and SW., the eastern shoal about 8 miles long by 1 mile wide, the western about half as large. Fippenies bears E. ¼ S. from Thacher Island, distant 61 miles; from Portland Lightship, SE. by S. ½ S., 57 miles to the western point of the northern shoal in 35 fathoms. The bank is nearly 10 miles long NE. and SW. and averages 4½ miles wide. The bottom is of gravel, pebbles, and clay, having depths over much of the shoal of about 30 fathoms but also from 36 to 60 fathoms. It is fished by the shore fleet in the spring and early summer. The fish and seasons are as on Cashes Bank. Formerly twice as many haddock were taken here as on Cashes or on Platts Bank, but this has changed in recent years. Halibut are taken here in fair numbers in 45 to 55 fathom depths in June, July, and August on the "black gravel" of the southern and western edge. The "white gravel" on the north shoal is of little account as a fishing ground, since it is composed mostly of the shells of dead scallops.

The Ridge (on the southern part of Fippenies).—This is SSE. from the lightship at Portland 75 miles and has a bottom of yellow mud and pebbles and depths of 75 to 95 fathoms. Cod are present here in December and January; cusk the year around, but most numerous in February and March; haddock in December and January; hake in September and October. The length of this bank is from 4 to 5 miles and the width somewhat less than 2 miles. It lies in an ENE. and WSW. direction.

Maurice Lubee's Ground.—This lies outside of New Ledge (Platts Bank) 47 miles SSE. from the lightship at Portland. Extending in an ENE. and WSW. direction, its boundaries are somewhat indefinite. It is perhaps 8 miles long by 3 miles wide and has depths from 95 to 110 fathoms over a bottom consisting mostly of mud.

Cusk are plentiful here in the spring, with a few in the fall. Cod are taken all the year around, the spring school being the largest. Hake are most numerous in the spring and fall months, and haddock are not common but are most numerous in winter.

Apparently the abundance of cod on this ground is due to the great quantity of shrimps and soft-shelled crabs found on the muddy bottom and on the rocks that compose this ground. There seem to be many of these deep-water grounds between and about the shoaler grounds, as near Cashes, Fippenies, and Jeffreys, which apparently serve as fairways over which the schools of hake, cod, and cusk, move from Georges Bank into the Gulf of Maine in the spring of the year.

Harvey Blacks Ridge.—This is SE. ½ S. from the lightship off Portland, distant 42 miles, and SE. from New Ledge, distant 8 miles. From Glovers Rock, off Small Point, Me., this ridge lies SE. by S. ½ S. 41 miles. It extends in an ENE. and WSW. direction about 4 miles long by 1 mile wide. Depths average 70 to 100 fathoms over a bottom of yellow clay and gravel.

Cod are taken here all the year. Haddock are found in the deep water in the spring; cusk all the year in deep water, together with hake in summer, also on the muddy bottom in deep water. Pollock and other surface-schooling fish are found here in their proper season.

The Cod Ridge (formerly Outer Harris Ground).—This lies NE. from the Northeast Peak of New Ledge, distant 7 miles. It extends in an ENE. and WSW. direction, the ground narrowing and the water deepening to the eastward, the shoal ground having 45 fathoms on a bottom of small pebbles and fine black gravel and sand, depths increasing in all other directions to 100 fathoms on the mud and sloping off somewhat steeply, especially on the southeast side, where the drop is very sharp. The length of the ground is about 5 miles, the width 1 mile. This is an all-the-year cod ground, the season of greatest abundance being from May 1 to November. The haddock are usually in their greatest numbers here from January 1 to April. Apparently no large number of cusk or hake are taken here on the ridge, perhaps because the water is not deep enough for the former, except for the small fish, which are of little value to the fishermen; and the ground is not muddy enough for the latter species. Both species, however, are found about the edges in the deep water, the cusk on the sharpest, hardest part of the bottom (perhaps most common in February and March), the hake; as usual, on the muddy parts about it.

The Three-Dory Ridge.—Outside of New Ledge and about midway between it and Harvey Blacks Ridge is a small ridge about 3 miles long, running NE. and SW., and about ½ mile wide. This lies SE. by S. from the Portland Lightship, 38 miles to the shoal of 55 fathoms, which is near its center. From this the ground slopes away on all sides to 63 and 65 fathom depths, over which area the bottom is made up of sand, gravel, mud, and rocks. At these lower depths are found "pipes" (clay cylinders), where the fishing ends abruptly. All about the ridge are depths of 80 to 100 fathoms on a bottom of mud. This is almost entirely a cod ground, good from May to August.

Platts Bank or New Ledge.—This bears E. by N. ½ N. from Thacher Island, from which the shoal portion of the ledge is distant 53 miles. From Portland Lightship it is 30 miles SSE. to the center of the ground. The bank is about 12 miles long, NE. and SW., and about 8 miles wide. The western shoal, which is of small extent and rocky and which has a considerable amount of dead shells upon it, is situated near the center, its depth being 29 fathoms. From this shoal to the Southwest Peak is about 11 miles SW. by S. Another shoal lies E. 3 miles, having about 30 fathoms over sand and gravel, which is a good fall ground for haddock. East-northeast from the western shoal 3 miles brings us to a rocky ridge, with spots of hard mud and pebbles between, in 65-fathom depth, which is a fine winter cusk ground, these fish remaining here until April. Over much of the bank the depths range from 30 to 35 fathoms with a bottom of rocks and gravel. From the edge of the shoaler area the bottom slopes gradually to 50 or 60 fathoms, beyond which it drops suddenly to 80 or 90 fathoms over a muddy bottom. This was considered one of the very best fishing grounds for cod and haddock in the Gulf of Maine, but the haddock catch here has fallen off recently. Hake also are very abundant during the summer months and often during October on the muddy bottom near the edge. Inside 100 fathoms, on a "punkin" bottom of rocks and gravel, near the mud, haddock are found from December to March. Cod, pollock, and cusk occur from May to October, the former on the rocky and gravelly portions, the latter on the deep soundings, with the Northeast Peak the best summer ground. This is also an especially good fall and winter ground for haddock. Halibut are often found in 35 fathoms (small fish) from September through November; also in spring and early summer. This ground is fished by vessels from Cape Cod, Mass., to Cutler, Me., mainly by trawling, some hand-lining, but no gill netting of importance as yet.

Jeffreys Ledge.—Jeffreys Ledge may be considered one of the best fishing grounds in the Gulf of Maine, although of comparatively small size. It appears to be an extension of the shoal ground that makes off in an easterly direction from Cape Ann. It is about 20 miles long in a NE. and SW. direction and about 4 miles wide. Its southern limits is 42° 54′ and its northern limit 43° 11′ north latitude; its eastern and western boundaries may be placed at 69° 58′ and 70° 18′ west longitude. The bottom is rocky on the shoaler parts, with gravel and pebbles on the edges. Depths on the bank are from 27 to 35 fathoms, falling off to 40 or 50 on the edges. The shoalest water lies from 4 to 5 miles N. by E. from the buoy, where there is 22 fathoms. Ordinarily there is little or no tide, with an occasional current SW. There are, however, strong westerly currents with the heavy easterly winds, and often after a period of mild weather with no strong tides there will suddenly develop a heavy SW. flow, indicating the approach of a strong northwester. This seems a general rule in the Gulf of Maine and is, perhaps, prevalent over much of our North Atlantic coast.

Jeffreys Ledge bears S. ½ W. from the lightship off Portland, 19 miles to the northern edge and 22 miles S. from the buoy on the Hue and Cry to the edge of the shoal.

A small cove makes for a short distance into the western side of Jeffreys Ledge at about 20 miles from Boon Island in a SE. by S. ½ S. direction. The bottom in the cove is broken and muddy, with depths of about 60 fathoms. Thence, the ground slopes away to the mouth, where the edges about the entrance are rocky and have 70 and 75 fathom depths. These rocky areas are cusk grounds in January, February, and March, during which months the cove itself usually furnishes good haddock fishing. Outside these depths the water deepens westward over a muddy bottom, where are from 80 to 90 and even 100 fathoms of water. Fishing here is mainly by trawl and gill nets.

Lying about SE. by S. ½ S. from the Isle of Shoals 20 miles, 13 miles S. by W. from the whistling buoy on Jeffreys, and 43 miles S. by W. from Cape Elizabeth is a broken piece of bottom having from 75 to 85 fathoms of water over it, which is a haddock ground from January to April and a cusk and hake ground all the year.

A small shoal in the western part of the Cove of Jeffreys, having 50 fathoms over a bottom of blue clay and rocks and rising from the 60 and 70 fathom soundings about it, is about 1½ miles long by about ¾ mile wide. This shoal is SSE. from Boon Island 15 miles. It is a winter ground for cod and haddock.

Clay Ridge.—At various points about the edges of Jeffreys Ledge are small detached ridges, which in their season are good fishing grounds. The present piece of ground lies 26 miles S. by W. from the lightship at Portland, which course and distance bring us to the northern edge. There is a 50-fathom shoal of small size upon it, but elsewhere soundings average from 65 to 70 fathoms over a bottom of hard clay. The length of the ground is about 4 miles NNE. and SSW., and the breadth about 1 mile. This furnishes good haddocking in January, February, and March, the latter month showing the best fishing.

Jerry Yorks Ridge.—This lies just inside and parallelling Jeffrys Ledge WNW. from its shoal water and about 5 miles distant from the ledge and about 18 miles SE. by S. ½ S. from Cape Porpoise. This ground has from 45 to 48 fathoms of water on a rocky, broken bottom. It is about 5 miles long, NNE. and SSW., and averages 1½ miles wide. This is a good cod and haddock ground in the fall and up to January, these fish returning here in the spring months.

Howard Nunans Ridge.—Of similar nature to the last, this rises 4 miles inside of and parallel to it, lying 14 miles from Cape Porpoise on the same bearings (SE. by S. ½ S.). This appears to be made up of two shoals, the northern rising to 50 fathoms of water over a rocky, broken bottom about 3 miles long by 1 mile wide, deepening southwesterly to a narrow, muddy gully, where are 80 fathoms, and rising again to 60 fathoms over rocks and broken ground. The whole ground is about 8 miles long with average widths of from 1 to 1½ miles. This also furnishes good cod fishing and haddocking in the fall and early winter and again in the spring months.

Off the southeast edge of Jeffreys, about 24 miles SE. from Boon Island, lies a piece of fishing ground having a hard bottom of sand, gravel, and rocks, where depths slope away gradually from the 50-fathom soundings near the main body of the bank to the 90-fathom mark farther out. This area is a good ground for cod and haddock in the winter and spring and a hake ground in March. This fishing spot is about 3 or 4 miles square and is bounded on all but the western side by muddy bottom, which is of little value as a fishing ground.

Usually there is good haddocking in March on the outside of Jeffreys, on its southeastern edge, and in the cove between it and Tillies in 60 and 70 fathom depths on a broken and muddy bottom. This spot lies SE. ½ S. from the Isle of Shoals, 27 miles to the center.

Eastern Shoal Water of Cape Ann.—This is generally considered a part of Jeffreys and is often spoken of as West Jeffreys by the fishermen. It extends in an ENE. direction from Cape Ann for a distance of from 15 to 18 miles. It is, in fact, a southwest continuation of Jeffreys Ledge, the two forming a nearly continuous ridge running NE. from Cape Ann a distance of about 42 miles. Depths on the so-called Eastern Shoal Water vary from 20 to 45 fathoms, the bottom being of rocks, pebbles, and coarse gravel over most of its extent. Sand and mud occur on the edges. The eastern part of the ground is resorted to by the haddock fleet during the fall and early winter, and other parts are visited more or less during the entire year for cod, haddock, and pollock by vessels and boats from Cape Ann and by craft of various types from Boston and Portland—line trawlers, gill-netters, and a few of the new type of small otter trawlers, this latter fleet of craft constantly growing in number.

On the ledge cod, haddock, and cusk are taken in the fall, winter, and spring—winter, perhaps, furnishing the best fishing. There are also more or less pollock, and hake constitute an important part of the catch. In those seasons when herring make their appearance in these waters the seiners make good catches here, mostly of food fish, as the large herring are termed by the trade. The mackerel, also, appear on these grounds and on the smaller grounds nearer to shore to northward and westward in good-sized schools, usually from July 1 through September. For many years the haddock catch from this bank has been of considerable importance, and this statement remains true for recent years as well.

Formerly this fishery was almost entirely carried on by trawlers and handliners, but the gill-net fishery on these grounds is of great and steadily growing importance. Of late the larger part of the haddock catch has been taken by the "otter-trawl" method, this gear being operated by steamers of considerable size and upon the more distant grounds, such as Georges Bank, the South Channel, and the Western Bank. The same change to fishing grounds farther offshore has to a great extent taken place in the fleet of larger sailing vessels, thus leaving Jeffreys and other inshore banks to the smaller craft; except that, with the high prices of haddock and cod in the winter months, it is often profitable for these larger vessels to run off to near-by banks for one set and return to port the same day.

On the inner parts of this ground, particularly, the gill-net fleet operates extensively, mainly in the fall and spring, on northwest Jeffreys 8 to 12 miles E. and SE. from Thacher Island, where the bottom is sand and rocks. Other gill-netting grounds are 8 to 15 miles NE. by E. from Thacher Island in 22 fathoms on a hard bottom of mud and mixed material of sand and gravel. The Cove of Jeffreys, NE. by E. 12 to 15 miles from Thacher Island, is a favorite haddock ground in the spring (April 20 to May 15) in 45 to 70 or even 80 fathoms, although gill nets are not often fished in more than 50 fathoms because of the weight of the nets in the deeper water. In the spring (in April and May), the haddock come in on Scantum, 10 miles NNE. from Thacher Island between Jeffreys Ledge and the Isle of Shoals, on a broken bottom of rocks and blue clay in 55 to 70 fathoms.

Off Newburyport and N. and SW. of the Isle of Shoals are gill-netting grounds that are much used. Trawling and netting are carried on, beginning in 40 fathoms in February and March and working off to 70 fathoms off Salisbury Beach in May. Cod are on this ground about two weeks in October and in February and March are found in abundance off Boars Head. Hake are present here all the fall and are found all along the southeast side of these grounds in depths of 45 to 60 fathoms. A certain amount of halibut may be taken in most years at various points on a bottom of hard gravel in spring and early summer in 35 to 65 fathoms. In most years a large amount of mackerel is taken on Jeffreys, notably so in 1925. Herring, also, are usually abundant here in "herring years."

The Shoal Ground, stretching easterly from Thacher Island, has depths from 20 to 30 fathoms over a bottom of sand and gravel. This area is about 15 miles long by 5 miles wide and is an important pollock ground in their spawning time as well as a good fall cod-fishing ground. It is about 12 miles E. by N. from Thacher Island to its center and 21 miles SE. by S. from the Isle of Shoals. Flounder draggers also operate here on the Shoal Ground and all around Thacher Island but mostly to eastward and southeastward.

Tillies Bank[18].—This bears E. by S. from Eastern Point Light, just dropping Thacher Island Light, then 3 miles farther for best fishing; and E. by S. ½ S. from Thacher Island, Cape Ann, from which the shoal on the center of the ground is distant 18 miles. This is a small rocky spot with depths of from 25 to 28 fathoms, outside of which the water deepens to 40 fathoms over a considerable area. The length of the entire ground is about 10 miles in an E. and W. direction and the width about 5 miles. At the edge it falls off rapidly to depths of 50 or 60 fathoms before reaching the mud at still greater depths, but an area of shoal water connects this ground with West Jeffreys. The bottom is rocky and rough over the greater part of the bank. Tillies was formerly regarded as one of the best fishing grounds off Cape Ann and is still resorted to for cod and haddock in the spring and fall; for hake in the spring, summer, and fall; and for pollock in the spring and fall. The fishing is mainly by trawling, with the gill-netters operating on the shoal grounds in less than 50 fathoms.

Stellwagen or Middle Bank.—This separates Massachusetts Bay from the open water of the Gulf of Maine and extends from near Cape Ann nearly to Cape Cod. The center of this ground bears S. by E. ½ E. from Thacher Island and N. by W. ½ W. from Highland Light, Cape Cod. The southern point of the bank is distant 5½ miles from Race Point, Cape Cod, and its northwest prong reaches to within 12 or 15 miles of Eastern Point, Cape Ann. The shoaler portion, with depths from 9½ to 19 fathoms, is 17½ miles long in a N. by W. and S. by E. direction and has a width of 4 miles. This part is sandy, but the eastern slope, in depths of from 25 to 55 fathoms, consists of coarse sand, gravel, and pebbles. On this gravelly slope cod and haddock have been taken plentifully over a long term of years, the cod in the fall and spring and the haddock in the winter months. On the southern end of the bank and between this and Race Point cod abound in fall and winter. The whole bank is also a mackerel ground when the fish are in these waters, the best of the season averaging to be from July 15 through September.

This bank is now mainly an Italian boat ground and is used by small craft from Boston and Gloucester. Gill netting here is especially extensive in November and December, mainly for pollock.

Netters operate about 22 miles SSE. from Eastern Point in 22 to 25 fathoms on a hard bottom. Good pollock catches are made in 25 to 40 fathoms on the eastern and southeastern slopes in the latter part of November and early December. Haddock are here from November 1 to March 1 and from April 20 to May 15. Cod are present all the year, the largest school occurring during August, September, and October. It is a cusk ground from November to March in the deeper water. What seems a somewhat unusual occurrence in these later years was the appearance of a considerable school of halibut on the northern slope of Stellwagen during the last half of April, 1926, several small craft getting from 2,000 to 3,000 pounds in their fares.

Wild Cat Ridge.—Very heavy tides sweep over this ground, making it difficult to haul gear in fishing upon it, whence, it is said, comes the name. It lies NNE. from Highland Light, Cape Cod, 18 miles to its southern edge; SE. ½ S. from Thacher Island 31 miles; and is about 7½ miles long in a N. and S. direction by about 3½ miles wide. The bottom is hard, of broken shells and sand, and depths are from 45 to 60 fathoms. There are 100-fathom depths inside of the ground and from 100 to 110 fathoms outside of it. Apparently this is an all-the-year ground for cod, cusk, and haddock, although but little fished at any other than the winter season.

---

[18] There has been some speculation as to the origin of the somewhat unusual name of this bank. The writer would note that there was an Edward Tillie in the company of Capt. John Smith when he explored this region in 1614, and a Tylly (perhaps the same person) who operated a fishing station at Cape Ann during the years 1623, 1624, and 1625.

TABLE 3.—*Outer fishing grounds, showing the principal species taken upon them*

Fishing ground	Cod	Haddock	Hake	Pollock	Cusk	Halibut	Herring	Mackerel	Lobsters	Miscellaneous
Grand Manan Bank	x	x	x	x		x	[1] x			
Middle Ground	x	x	x	x		x	[1] x			
Marblehead Bank	x	x	x	x	x	x				
German Bank	x	x	x	x	x	x				
Newfound	x		x		x					
Jones Ground	x		x	x	x					
Bank Comfort	x		x		x					
Clay Bank	x		x							
Newfound (off Jeffreys Bank)	x		x		x	x				
Jeffreys Bank	x	x		x	x	x				
Toothaker Ridge	x		x	x	x					
Cashes Bank	x	x	x		x	x	[1] x			
Ridge east of Cashes	x				x					
Ridge east of Cashes	x		x		x					
Ridge northwest of Cashes	x	x	x		x	x	[1] x			
Cashes Big Ridge	x	x	x		x	x	[1] x			
Ridge north of Georges	x				x					
John Dyers Ridge	x		x		x					
Fifty-five Fathom Bunch	x									
Fippenies Bank	x	x	x		x	x	[1] x			
Ridge south of Fippenies	x	x	x		x					
Maurice Lubees Ground	x	x	x		x					
Harvey Blacks Ridge	x	x	x	x	x					
Cod Ridge	x	x	x		x					
Three-Dory Ridge	x									
Platts Bank; New Ledge	x	x	x	x	x	x	[1] x			
Jeffreys Ledge	x	x	x	x	x	x	[1] x	x		
Cove west of Jeffreys	x	x	x		x					
Clay Ridge	x	x								
Jerry Yorks Ridge	x	x								
Howard Nunans Ridge	x	x								
Southeast Jeffreys	x	x	x							
Southeast Cove (Jeffreys and Tillies)		x								
Scantum		x								
Eastern Shoal Water	x	x	x	x	x	x	[1] x	x		[2] x
Shoal Ground	x	x		x						[2] x
Tillies Bank	x	x	x	x						
Stellwagen, Middle Bank	x	x	x	x	x	x	[1] x	x		
Wild Cat Ridge	x	x			x					

[1] Food fish. [2] Flounders.

GEORGES AREA

East side of Cape Cod.—The sea bottom off the east side of Cape Cod is mainly sandy and slopes off gradually from the beach, reaching depths of 30 to 40 fathoms at 5 to 7 miles from land. Below Chatham the slope is even more gradual. Within these limits good catches of cod are taken occasionally, and to a less extent the same is true of haddock. Farther from the shore, in from 40 to 80 fathoms and from a point 8 or 10 miles off the Highlands of Cape Cod to another point lying 20 miles or more SSE. from Chatham Lights, is a continuous stretch of excellent haddock grounds for winter fishing. The deep water off Chatham furnishes excellent hake fishing in summer and fall.

This shore furnishes excellent mackerel fishing during most of the season when these fish are in northern waters. Virtually no gill-netters operate here, the distance to market being great and the chance of rough weather and the lack of safe harbor making it dangerous for small craft.

From this stretch of shore (mostly from off Chatham) there were landed at Boston in the year 1923, 66 fares with a total of 1,797,826 pounds valued at $76,875.

Tobins.—A name given to a piece of ground about 20 miles square lying S. by E. from the Highland Light. It runs from about 40 miles to about 60 miles offshore, the depths gradually increasing as the bottom slopes away evenly from the shore from 75 to 95 fathoms over a bottom of clay, sand, and pebbles. Cod are taken here in the spring, summer, and fall, and haddock in February, March, and April. A few hake are taken here in summer, but, as compared with the grounds off Chatham, this is not to be considered a hake ground.

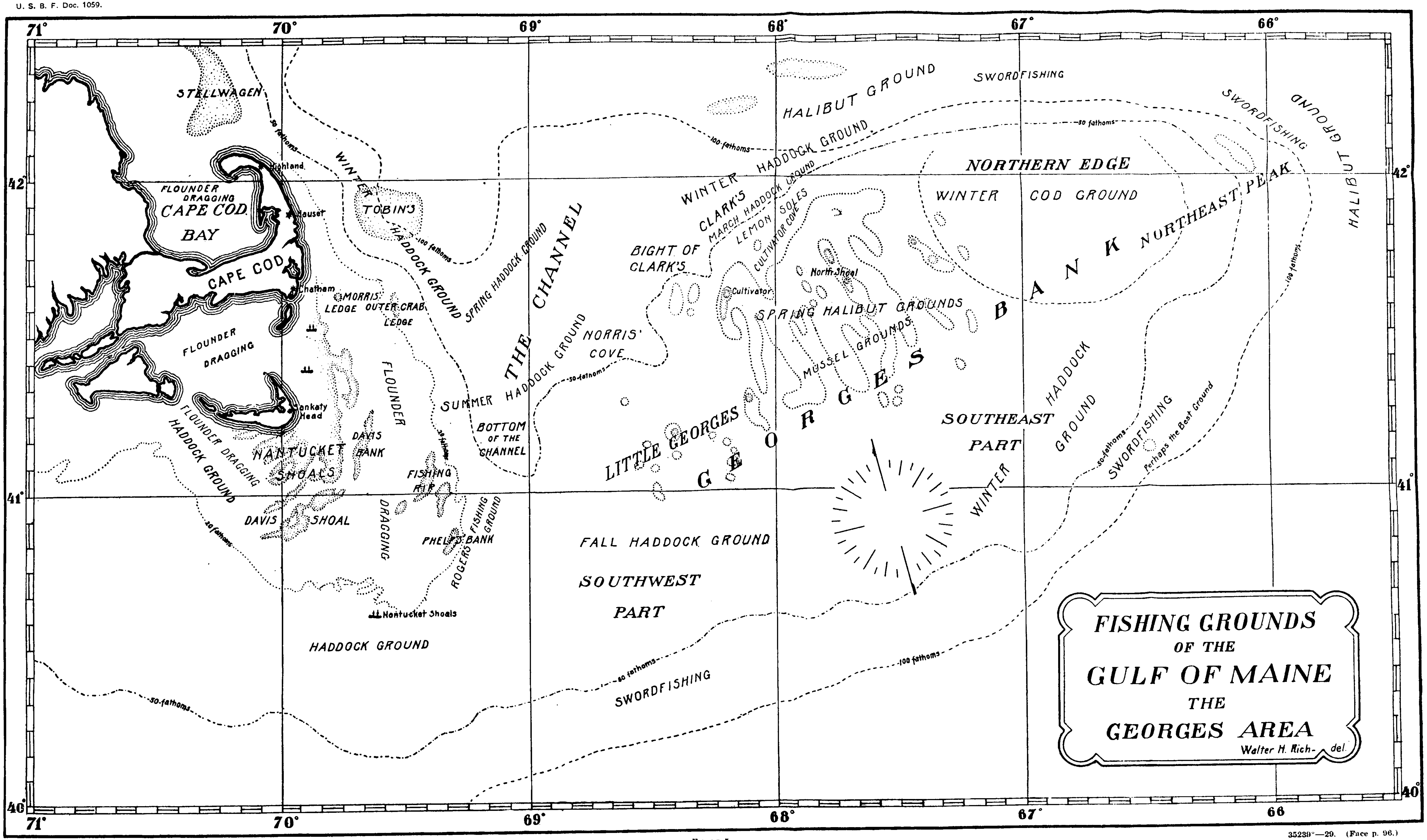

FISHING GROUNDS OF THE GULF OF MAINE THE GEORGES AREA
Walter H. Rich- del.
STELLWAGEN
CAPE COD BAY
FLOUNDER DRAGGING
CAPE COD
FLOUNDER DRAGGING
NANTUCKET SHOALS
DAVIS SHOAL
FLOUNDER DRAGGING HADDOCK GROUND
WINTER HADDOCK GROUND
TOBIN'S
SPRING HADDOCK GROUND
THE CHANNEL
MORRIS' LEDGE
OUTER CRAB LEDGE
FLOUNDER DRAGGING
DAVIS BANK
FISHING RIP
PHELPS' BANK
ROGERS' FISHING GROUND
SUMMER HADDOCK GROUND
BOTTOM OF THE CHANNEL
NORRIS' COVE
BIGHT OF CLARK'S
CLARK'S
WINTER HADDOCK GROUND
MARCH HADDOCK GROUND
LEMON SOLES
CULTIVATOR COVE
HALIBUT GROUND
SWORDFISHING
NORTHERN EDGE
WINTER COD GROUND
NORTHEAST PEAK
SWORDFISHING GROUND
HALIBUT GROUND
North Shoal
Cultivator
SPRING HALIBUT GROUNDS
MUSSEL GROUNDS
GEORGES BANK
LITTLE GEORGES
SOUTHEAST PART
HADDOCK GROUND
WINTER
SWORDFISHING
Perhaps the Best Ground
FALL HADDOCK GROUND
SOUTHWEST PART
HADDOCK GROUND
Nantucket Shoals
SWORDFISHING
Highland
Nauset
Chatham
Sankaty Head
50 fathoms
100 fathoms
71°
70°
69°
68°
67°
66°
42°
41°
40°

Figure 5

Morris Ledge.—This lies eastward of Chatham and is a favorite ground for certain cod fishermen during spring and early summer. Schooners and small craft operate here.

Outer Crab Ledge.—The center lies about 14 miles ESE. from Chatham Lights. It extends about 5 or 6 miles in a N. and S. direction and is about 1 mile wide. Depths run from 19 to 23 fathoms; the bottom is rocky. The fishing is principally for cod in the fall, winter, and spring. Vessel fishing here is principally in the spring.

Nantucket Shoals.—This stretch of bars and deeper waters between, roughly triangular in form with its apex at the north, lies along the western edge of the South Channel, extending S. and SE. from the southern end of Cape Cod and Nantucket Island. From Monomoy Point to Rogers Fishing Ground, on the eastern edge of Phelps Bank, it is SSE. 60 miles. Its width from Southeast Rips to the western edge of New South Shoal is 40 miles. The area includes a number of "fishing spots" and shoals, among which the following are the most important: Pollock Rip Ground, Rose and Crown Shoal, Great Rip, Davis Bank, Fishing Rip, Old and New South Shoal, and Phelps Bank.

On and about all these shoals the sail fleet makes good catches, mainly consisting of cod but with a fair proportion of pollock, also, and in the deeper water close to them, in spring and summer, a considerable amount of haddock. An occasional large halibut is taken, and even good catches have been reported. There were noted in the daily report of the Boston Fish Bureau between May 15 and August 15, 1926, 10 trips made by the smaller vessels of the halibut fleet that landed fares of from 2,000 to 10,000 pounds of this species from this area. Perhaps more would be taken if the halibut fishery were to be followed here as in other areas. "Rip fishing," as conducted here, is done "at a drift," moving over the shoals and, as they move off from them, sailing back to repeat the process. The fish are taken by hand-lining with "cockle" bait or by "jigging" the fish with a shiny piece of metal representing a herring or similar fish, below which are set twin hooks, the fish being struck when it is felt investigating the lure. This fishery generally is carried on during May, June, July, and August.

In the mackerel and herring seasons these grounds usually furnish good fishing for these species, the fish usually striking here from May 15 to July 15.

Pollock Rip Grounds.—These lie between Pollock Rip Lightship and Shovelful Lightship and extend northward to Pollock Rip Shoal. These grounds are 3 miles long, E. and W., by 2 miles N. and S. The depths range from 4 to 12 fathoms. These are fished from Monomoy and in stormy weather from Chatham, instead of going to the Crab Ledge. Late in the spring and early in the fall the cod move inshore. In winter the cod leave Pollock Rip for the deeper water.

Rose and Crown Shoal.—This is a small piece of ground 7 miles ESE. from Sankaty Head. The fishing area lies between the Round Shoal and Rose and Crown buoys, making a stretch perhaps 6 miles long by 1½ miles wide. Sometimes good fishing may be had from 6 to 12 miles from Great Round Shoal bouy. As elsewhere on and about these shoals, the cod is the principal species caught, pollock being next in importance, and a few haddock.

Nantucket Shoals.—Madisons Spot, SSE. 13 miles from Round Shoal buoy, has 9 fathoms over a smooth hard bottom of sand. It is about 3 miles long, from SE. to NW., by 1½ miles wide. This is a flounder ground for the greater part of the year and a good cod ground in October and November. As is the rule elsewhere in this neighborhood, tides are heavy over this ground.

Nantucket Shoals.—Great Rip lies 13 miles E. by S. ½ S. from Sankaty Head Light, Nantucket. It is 5 miles long from N. to S. and 3 miles broad. Over this area the depths are from 9 to 18 feet, but the fishing is done mainly around the edges in 6 to 12 fathoms where the bottom is gravel and shells covered with sponges and kelp. Here, as on all these shoals, the greater part of the fishing is done by that method known as "rip fishing." Cod are taken chiefly by hand-lining in May, June, July, and August.

Nantucket Shoals; Davis Bank; Crab Bank.—This is an irregular piece of bottom lying in a generally ENE. and WSW. direction at about 20 miles distance ESE. from Sankaty Head. It is perhaps 14 miles long by 5 miles wide at its broadest. Depths upon it are from 4 to 9 fathoms, with soundings of 12 to 18 about it, over a bottom of sand and broken shells.

Nantucket Shoals.—Fishing Rip is an elongate bank lying 29 miles SE. from Sankaty Head Light. It is 10 miles long in a NE. and SW. direction and about 1½ miles wide, having depths of from 4¾ to 6¾ fathoms. Soundings about it are from 13 to 23 fathoms over coarse gravel, fine sand, and shells. The seasons and the species are as on the Great Rip.

Nantucket Shoals.—Southeast Rip lies SE. from Sankaty Head 35 miles. It has depths from 6 to 10 fathoms over an area about 10 miles long by 2 miles wide, with from 22 to 30 fathoms over the sandy bottom around it.

Phelps Bank.—This bank lies 38 miles SE. ½ S. from Sankaty Head Light and agrees more or less in size, shape, trend, and character of the bottom with Fishing Rip. Depths are from 10 to 17 fathoms. On the southeast edge of this lies Rogers Fishing Ground, with 24 to 40 fathoms over fine gray sand. It is perhaps mainly a haddock ground.

Nantucket Shoals; South Shoal.—This name is applied to the fishing ground about Nantucket Lightship, which marks the Old South Shoal and the New South Shoal, the two making a continuous reef of irregular form some 10 to 12 miles in length and from 1 to 3 miles wide. The northern end of this lies about 12 miles S. by E. from Sankaty Head (the Old South Shoal), and the southern extremity of the New South Shoal reaches to about 20 miles S. ½ E. from the same point. The fishing ground lies mostly to the S. of these shoals and about the lightship, where otter trawling is carried on in all directions from the ship except from N. to NE., where lie the vessels sunk by the German submarine in the late war. This fishery is also carried on WNW. from the ship for a distance of 40 miles, even into 7-fathom depths near Muskeget Inlet. Elsewhere depths average from 13 to 18 fathoms on the inner parts of the grounds, whence they slope away gradually from the shore soundings into 50, 60, or even more on the outer edge, where the ground falls away rapidly into the deeps. For the most part this area has a bottom of sand, but there are small stretches of coarse gravel, broken shells, pebbles, and a few muddy spots.

Within comparatively recent years this ground has been much used by the otter trawlers, which type of craft has developed a productive fishery here, which is being operated in steadily increasing volume and takes a catch that is predominantly of haddock.

The proportion of cod taken here by these vessels is very small, even smaller than that from other grounds fished by the otter-trawl method. Pollock and hake, too, make a small item in the fares from the neighborhood of the South Shoal. In the average otter-trawl fare haddock makes up the greater part of the catch because, as a rule, this type of gear is operated mostly on the smooth, sandy bottom which this species prefers. The otter-trawl fishery here is at its best from early May through June, July, and the first half of August. Few trips are reported from this ground at other seasons. Perhaps the haddock leaves the shoal grounds here earlier than when it moves out of the same depths in The Channel.

The early fishing for the swordfish generally takes place in this vicinity, and in normal seasons mackerel are found here in abundance from May 15 to August, and, as is the custom with this uncertain fish, it may appear here again in the late fall.

The Channel.[14]—The Channel marks the western edge of Georges Bank. Its boundaries are somewhat indefinite, but the old Eldridge chart states that for the fishermen the 30-fathom curve running southerly from Race Point, Cape Cod, limits its western edge. This ground is much visited by the Boston fleet, both sail and steam, line trawlers and otter trawlers, the fleet of Gloucester, and the otter-trawl fleet that has developed in New York in recent years. This area is all good fishing ground in the proper season, but perhaps the most important is that part lying 25 miles E. ½ S. from Sankaty Head, Nantucket. Here is a level, sandy bottom, where, during May, June, July, and August, the otter trawlers operate successfully in 18 to 30 fathoms of water, making a catch that consists principally of haddock, with a considerable proportion of cod, especially in June and July, and with a fair amount also of pollock, cusk, and

---

[14] Capt. John Smith wrote of this region: "Toward the South and Southwest of this Cape [Cape Cod] is found a long and dangerous shoal of sands and rocks. But so far as I incircled it, I found thirtie fadom water aboard the shore, and a strong current; which makes mee thinke there is a Channell about the shoales; where is the best and greatest fish to be had. Winter and Summer in all that Countree. But the Saluages say there is no Channell; but that the shoales begin from the main at Pawmet, to the ile of Nausit; and so extends beyond their knowledge into the sea." That the captain's reputation for far-visioned wisdom may not be held too lightly, let these figures speak, taken as they are from the bureau's records of the landings at the three ports of Boston, Gloucester, and Portland for the year 1927, when the fares from his "Channell" numbered 2,036, with a poundage of 121,088,693 and a value of $3,607,358.

hake. Small halibut are fairly abundant here, also, these fish being of from 5 to 8 pounds, rarely larger. Flounders are abundant, with a good number of "lemon soles" and "gray soles," which are very popular with the trade. The sail fleet operates here also, but, as a rule, more of these vessels are found on the ground lying some 10 miles farther eastward, on the edge of Georges, in somewhat deeper water (35 to 50 fathoms) on a rougher and rockier bottom, where there is a greater proportion of cod in the catch than on the western area.

The Sankaty Head ground is about 20 miles long by about 8 miles wide, stretching from 55 miles SE. from Highland Light to 78 miles SE. by S. ½ S. from the same point (the bottom of the Channel), and is bounded on all sides by pieces of bottom less favorable to the operation of the otter trawl because of the presence of rocks, sponges, or other obstacles, which interfere with the free passage of the net over the bottom but offer less trouble to the line-trawl fishermen. A good spring haddock ground lies ESE. 65 miles from the Highland in 70 fathoms, best in March and April. As the cold weather advances the fish move away in great part from these grounds, going into the deeper water, the catches of the fall and winter months being taken mainly in depths of from 60 to 100 fathoms. At this season and in these depths the vicinity of the Corner of the Channel, Clarks Side, and the area N. and W. of the Cultivator usually have a good winter school of haddock. This has been particularly large during the past three years (1923 to 1925). Thus, it may be seen that the Channel is an important ground during most of the year.

The figures of the catch from Clarks Bank have been shown, together with those of Georges Bank, of which, in fact, this area is a part.

The larger part of the sail fleet is found fishing on the grounds of the eastern side of the Channel and of the western edge of Georges Bank, in part to escape the damage that the otter trawlers cause to them in dragging away their gear. It is often impossible for these steamers to avoid some damage of this kind: especially is this the case in the thick weather so prevalent on Georges. In the summer months of the "mackerel years" a large catch of this species is taken from the waters of the Channel.

St. Georges Bank, more generally known as Georges Bank.[15]—This is by far the largest and most important fishing ground near the coast of the United States and is second to none in the western Atlantic except the Grand Bank of Newfoundland. It lies eastward of Cape Cod and Nantucket Shoals and is apparently an extension of the latter, since the water is no deeper between the southern part of the shoals and the western part of the bank than in many places upon it. Its southern limit, as shown on the chart, is 40° 40′ north latitude, though the 50-fathom line extends 7 miles farther south. The southern limit, therefore, may be considered to be about 40° 30′ and the northern as 42° 08′ north latitude. The eastern part is in about 66° and the western in about 69° west longitude. The greatest length from the northeastern to the southwestern extremity is about 150 miles; the greatest width, N. and S., about 98 miles, according to the charts of the Coast Survey.

Depths range from 2 to 50 fathoms. On the western part, between the parallels of 41° 10′ and 41° 53′ north latitude and the meridians of 67° 20′ and 68° 37′ west longitude are a number of shoals, known as the East Shoal, North Shoal, Southwest Shoal, Cultivator, etc. The Southwest Shoal is the largest, being 15 miles long SSW. and NNE., with an average width of 2½ miles. The position of the center of this shoal is 41° 39′ north latitude and 67° 48′ west longitude. There are from 2 to 15 fathoms of water on the shoals, and between them are depths of from 12 to 30 fathoms. The tide sweeps over these with great force, causing strong rips, and during rough weather the sea breaks heavily on them, rendering approach to their vicinity extremely hazardous.

Over most of the bank the bottom is sand, although patches of rough ground (gravel, pebbles, and rocks) of greater or less extent are found in some localities. Its position between the Bay of Fundy and the Gulf Stream causes the tide to run swifter than on other banks and to swirl around instead of passing

[15] The earliest record of this name (Saint Georges Shoal) that the writer has found appears upon a map discovered in the library of Simancas, in Spain, where a chart said to have been made by a surveyor sent out to Virginia by James I of England, in 1610, was found in 1885 or 1888, after having long before disappeared from England. This chart is thought to embody, besides the work of Champlain and other foreigners, the information contained in the English charts of White, Gosnold, Pring, and probably of Waymouth's Perfect Geographical Map. It is thought to have been drawn by Robert Tyndall or Captain Powell. (Genesis of the United States. Alexander Brown.)

directly over, back and forth. The writer has seen two men have difficulty in holding an empty dory against the current.

The Report on the Fishery Industry of the United States, in 1887, says that the first attempt at fishing here (of which there is any record) was made in 1821 by three Gloucester vessels. The cod and halibut industry, according to the same authority, began in 1830, although not fully established as a permanent industry until 1835.

The area of the whole bank is approximately 8,050 square miles, all of which, except for the shoals, is available in summer for the taking of cod, haddock, cusk, halibut, and hake, with a considerable amount of mackereling and swordfishing, as well as the taking of other species.

During February, March, and April large schools of cod make their appearance on the bank. At this season these are found most abundantly on the "Winter Fishing Ground," a part of Georges lying eastward and southeastward of the North Shoal between the parallels of 41° 30′ and 42° 00′ north latitude and 66° 38′ and 67° 30′ west longitude. The area of this Winter Fishing Ground is about 1,100 square miles. This part of the bank seems entirely given over to the codfish, since it is too broken, sharp, and rocky to please the haddock. Depths here are from 30 to 40 fathoms, deepening away from the North Shoal. This area is essentially a spawning ground for the cod, which appear to come on the bank from the SE., as they almost invariably, after reaching the ground, move slowly to the N. and W. as spring approaches. This is in the direction of the shoals. As soon as the spawning season is over the schools of cod break up, but more or less fish are caught on different parts of the ground at all times of the year, though rarely are they found so plentiful as when the winter school is on the ground. Cod are found along the Northern Edge virtually the year around, though many of the winter school move on to the inner waters of the gulf and others go over to Browns Bank, where the early comers seem to appear in the first days of April.

In its production Georges Bank itself is rather evenly divided between haddock and cod, the cod showing a slightly larger proportion. The South Channel, on the western edge of Georges, shows predominantly as a haddock ground, and the haddock from The Channel is considered a better fish than that from Georges. Georges Bank itself is also an important haddock ground in the spring and early summer, when this species abounds about the Cultivator Shoal (SE. by S. 88 miles from Highland Light, Cape Cod) in depths from 18 to 30 fathoms; and at the same season along the Northern Edge (140 to 200 miles E. by S. ½ S. from Boston Lightship in about 41° to 42° N. lat. and 66° to 68° W. long.) in 45 to 60 fathoms in summer, the fish moving off into the deeper water (90 to 100 fathoms) in the neighborhood of the Corner of the Channel as the winter comes on. Many are found in March, when they return from the deep water, when fishing is carried on 65 miles SE. from Highland in 70 fathoms; then they come into the 40-fathom depths from the North Shoal westward to the Corner of The Channel along the Northern Edge. In April the Cultivator Cove is good ground even into 20-fathom depths.

The Southwest Part (120 miles SSE. from Highland Light, Cape Cod, with 45 to 80 fathom depths) is a good ground for haddock from the beginning of the fall up to about Christmas, after which the best winter fishing for this species is found on the Southeast Part (reached by steaming 145 miles ESE. from Boston Lightship in order to clear the shoals, then SSE. 40 to 50 miles, depending upon what part of the ground it is desired to fish). January is perhaps the best fishing month upon this portion of Georges.

While not considered a halibut ground, as compared with some of the other offshore banks, Georges can show a very considerable catch of this species. Because of its nearness to the markets it is more intensely fished than any other ground of equal area and by a far greater variety of crafts, most of which take a greater or less amount of halibut. The otter-trawl fleet, both here and in The Channel, takes a large amount of this species when its total catch is considered; and these fish are mainly small, of from 4 to 10 pounds in weight, with only rarely a larger one. The salt fishers, also, and the rest of the market fleet combine to make an imposing total of the poundage of halibut from Georges and its vicinity. The Georges halibut is esteemed by the trade above the halibut from other grounds. Perhaps its flesh may be superior, though for what reason it is difficult to say, unless because, since the trips to this ground average fewer days in length, the fish are received in the markets in a fresher condition than are those from more distant banks.

The principal halibut grounds on Georges for the spring and summer months (April to July) lie between the Cultivator Shoal and the North Shoal in depths from 10 to 18 fathoms, and E., S., and SW. from the North Shoal in the same soundings. This area is sometimes called Little Georges. There are also a number of mussel grounds on the southwest part of Georges, having depths averaging 20 fathoms, all of which furnish good feeding grounds and a substantial catch of halibut in the seasons when these fish are in the shoal water.

During July and August the halibut are found along the Northern Edge, over a stretch of ground about 65 miles long in 60 to 100 fathoms; and from this time until the hard weather of the winter begins the fishing goes on about the Northeast Peak (about 42° 00′ N. and 66° 00′ W.) over the narrow area on the edge of the suddenly deepening water, beginning in from 60 to 70 fathoms, then out to 200 and even 300 fathoms. The winter fishing on Georges is very difficult and somewhat hazardous, so that the halibut fishery in these waters is rarely carried on or, at best, by very few vessels after November or before March.

Mackerel are usually quite abundant on Georges in their season, generally being large or medium fish. Herring also are found there in good number but are somewhat distant from market as fresh fish.

TABLE 4.—*Fishing grounds of the Georges area, showing the principal species taken upon them*

Fishing grounds	Cod	Haddock	Hake	Pollock	Cusk	Halibut	Herring	Mackerel	Lobsters	Miscellaneous
East side of Cape Cod	x	x	x				x	x		
Tobins	x	x	x					x		
Morris Ledge	x									
Outer Crab Ledge	x									
Nantucket Shoals	x	x		x		x		x		
Pollock Rip Grounds	x			x						
Rose and Crown	x	x		x						
Madisons Spot	x									[1] x
Great Rip	x			x						
Davis Bank; Crab Bank	x			x						
Fishing Rip	x			x						
Southeast Rip	x			x						
Phelps Bank	x	x		x				x		
South Shoal	x	x	x	x				x		[2] x
The Channel	x	x	x	x	x	x		x		[2] x
Georges Bank	x	x	x	x	x	x	x	x		[2] x

[1] Soles, lemon and gray. [2] Swordfish and soles.

By far the largest percentage of the swordfish catch landed in the ports of Boston, Gloucester, and Portland comes from Georges Bank. A considerable portion of the fish listed from this ground under the heading "Miscellaneous" is made up of this species.

The swordfish arrive on Georges on the Southwest Part and on the Southern Edge about June 5, and the traveling schools pass over the bank, northward bound, up to August 10. In fact, all through the season when they are present in northern waters, even up to November, they may be found on Georges. Probably the best area of the bank for this species is on the parallel of 41° N., where the shoal rises steeply out of "blue water."

OFFSHORE BANKS

Browns Bank.—This bank lies in a northeasterly direction from Georges and is separated from it by a gully 15 miles wide, in which the depths range from 100 to 450 fathoms. Over the bank the depths range from 25 to 75 fathoms. Its area is about 2,275 square miles. The greatest length, from SE. to NW., is 63 miles, and the greatest width is 43 miles. It is situated between 64° 52′ and 68° 29′ west longitude and 41° 50′ and 43° 02′ north latitude. There is a small, rocky shoal on the northern part, on which, it is said, there is not more than 9 to 15 fathoms. The bank slopes away from the shoal S. and E. to depths of 55 to 75 fathoms, but at a distance of 12 or 15 miles off it again rises to 30 to 50 fathoms. This area of shoal water, within the 50-fathom limit, is 50 miles long and has an average width of 15 miles. North of the shoal the water deepens suddenly to 70 and 80 fathoms. The bottom is largely coarse sand, gravel, pebbles, and rocks and is rich in animal life. The area of the bank is approximately 1,370 square geographical miles.

Tides here are quite as strong as on the eastern side of Georges Bank, the ebb having an average strength of 1⅓ miles an hour and the flood is somewhat stronger. The greatest strength of the flood tide sets NW., the ebb in nearly an opposite direction.

Haddock, cod, cusk, halibut, pollock, and hake are the principal food fishes procured from this bank, ranking in volume in the order named. In value, however, halibut takes third place in the list. Cod are plentiful here in winter, though fewer vessels fish here than on Georges at that season. At other seasons the codfishery on Browns Bank compares favorably with that of other banks in the vicinity. Cod are present the year around, in May and June feeding in depths of about 40 fathoms, going into 60 fathoms in August, and into depths of about 100 fathoms in cold weather.

Haddock, also, are present all the year, the period of greatest abundance being usually January and February. In March and April they are most abundant in 27 to 30 fathoms; at other seasons they are in 50 fathoms and deeper, especially in winter, when generally they can be found in 80 to 100 fathoms. Cusk are present in the deep water all the year.

Older reports say (1880-81): "Halibut were formerly found here in abundance, but at present the fishery is limited to an occasional trip off the southern and western edge." It will be noted that a fair amount of halibut was taken here during 1923, when this bank ranked third in volume of halibut taken, which seems a good showing when the comparatively small size of the ground is considered. Fairly good catches have been made SW. from the Northwest Peak of Browns, about 66° 50′ west longitude and 42° 40′ north latitude, along the 100-fathom curve and following eastward to the southward of La Have and beyond, perhaps to 63° west longitude. The Southeast Peak is perhaps the most productive of the halibut grounds here, "setting" off from the shoaler parts into the narrow deep-water channel between this and Georges perhaps 20 miles distant.

A considerable part of the fish listed under the heading "Miscellaneous" are swordfish, which come upon this bank during their summer wanderings.

It will be noted that the number of otter-trawl fares from this ground is small. It is only in recent years that this method of fishing has been employed here, the bottom having been thought to be too rough for the successful operation of gear of this type upon it.

Seal Island Ground.—This is called also on the charts, on its northwest part, the German Bank and lies off the western part of Nova Scotia. Very few charts show it, as it is somewhat difficult to define its exact limits. It is a direct continuation of the shore soundings, which slope gradually from the land to the S. and W. and continue in a northerly direction beyond what might be considered the bounds of the grounds. To the S. it extends nearly to Browns Bank, from which it is separated by a narrow gully 70 to 80 fathoms deep. To the W. it reaches 38 miles beyond Seal Island and to the NW. about 35 miles from the same island. The southern limit of the ground is in 43° and the northern 43° 45′ north latitude, while the western boundary may be placed at 66° 40′ west longitude. The entire ground outside the 3-mile limit covers an area of 1,250 miles.

There is a small shoal called Pollock Rip, with a depth of 7 fathoms, bearing SW. from Seal Island, distant 9½ miles; but otherwise the ground slopes quite gradually, the depths being from 15 to 70 fathoms.

The bottom is mainly coarse gravel and pebbles with occasional rocky spots of greater or less extent. The tides sweep over this ground with considerable force out from and in toward the Bay of Fundy, the flood running strongest.

In general, the species of fish found here and the seasons of their greatest abundance are much as on Browns Bank. The principal fishes taken are haddock, cod, cusk, halibut, and hake, and a very small amount of pollock. Except for the haddocking, the best fishing season is from March to October. Halibut are said to have been very plenty here in the past but are said to have been comparatively rare in recent years, although occasional good fares are brought from these grounds, perhaps more commonly in the spring and early summer and a few at other seasons. In April they are found most commonly in 80-fathom depths; in May, in 30 to 40 fathoms; in June the best halibuting is had in 25-fathom depths or even in shoaler water. (The halibut catch shown for the year chosen (1927) is unusually small, most years yielding a fair amount of this species from this ground. Apparently no member of the American halibut fleet visited this ground for the year.)

Cod are present here the year around, perhaps the best fishing taking place in May and June, when the fish are found in about 40 fathoms. They go into deeper water, about 60 fathoms, in August and into 100 fathoms as the cold weather advances. This Seal Island ground may be considered essentially as a feeding ground for the cod, which seem to appear here after the spawning season is over, to fatten upon the crabs and mollusks living on the bottom and on the herring and other small fish that swim back and forth in the tide rips.

Haddock are also present all the year, the schools being most abundant and the number greatest in January and February, when the fish are in about 50 to 60 fathoms. Apparently they come into depths of from 27 to 30 fathoms in March and April for spawning.

Cusk are present here during most of the year in 80 fathoms on the hard bottom. Pollock are few on this ground at any time of the year. This species, together with herring and mackerel, are abundant on the "shore soundings" of Seal Island Ground, whence, following the abundant food furnished by the smaller fish, they range a short distance in to the Bay of Fundy. Many mackerel are taken in the traps in the vicinity of Yarmouth, Nova Scotia, which seems to mark the limit of their penetration in any considerable schools on the western shore of Nova Scotia.

What is apparently a gradually deepening extension of Seal Island Ground is found about 65 miles SSE. from Mount Desert Rock and 60 miles W. from Seal Island. There seems to be no distinguishing name for this area.

The depths here are from 90 to 100 fathoms over a broken bottom of mud, gravel, and in places fine sand. The ground falls off rapidly on all sides except toward Seal Island and the Nova Scotia coast, leaving an area at its end of somewhat indeterminate length, perhaps 18 or 20 miles, and having a distance across of about 8 miles at its widest part.

Apparently there is no reason why this should not be an all-the-year fishing ground, but it seems not to be visited much in the winter. It furnishes, however, a very good summer hand-line fishery for cod at dogfish time, and in the spring months it abounds in cod, cusk, and hake, all fish of large size.

Roseway Bank.—This bank lies N. of the western part of La Have and SE. of Shelbourne Light, Nova Scotia; 31 miles SSE. from the whistling buoy off Lockport, Nova Scotia, to the southeastern edge. It is oblong in shape and of small extent—about 270 square geographical miles. Its greatest length is 21 miles and its greatest breadth 15 miles. It extends from 43° 12′ to 43° 33′ north latitude, and from 64° 25′ to 64° 52′ west longtitude, and at the northwest corner is connected with the shore limit of 60 fathoms by a narrow neck. Depths are from 33 to 48 fathoms. The bottom is of sand, gravel, and rocks; on the Northeast Peak the bottom is of yellow mud and gravel.

Currents in this region are not nearly so strong as about Cape Sable and Browns Bank, their general direction being WSW. and ENE., the westerly much the stronger, though the force and direction of both are much influenced by the winds.

The principal fish taken here are cod, haddock, and cusk, but hake, pollock, and halibut occur, the best fishing months being from May to October, when the bank is resorted to by craft from western Nova Scotia. A few New England craft also fish here.

La Have Bank.—Situated eastward of Browns Bank and S. and E. of Roseway Bank. It extends from 42° 34′ to 43° 26′ north latitude a distance of 52 miles, and from 63° 50′ to 65° 07′ west longitude a distance of about 54 miles. The bank is nearly divided into two portions, of which the eastern (La Have Bank proper) extends N. and S. 39 miles and the western portion nearly E. and W. about 35 miles. The total area of the bank is about 1,200 miles.

The bottom is largely coarse gravel, pebbles, and rocks with smaller areas of sand distributed here and there. Depths run from 40 to 50 fathoms. The general set of the currents is to the westward, but this is much influenced by the force and direction of the wind and is generally quite strong during easterly blows.

The principal fishing upon this bank in the past has been for cod and haddock; and while former reports (1880–81) speak of this as having once been a favorite fishing ground for halibut and state that it was not at that time of much importance in that fishery, the figures for this ground for the year 1923 show the halibut catch to have been third in volume and first in value of the species taken there. In fact, the catch of halibut here makes quite an imposing figure when the comparatively small size of the ground is considered.

Little La Have and the La Have Ridges are simply continuations of this bank toward the Western Bank for a distance of about 45 miles. This places the eastern limit in about 62° 50′ west longitude, the northern and southern boundaries being about as those of La Have Bank. The area of the ridges is about 1,575 miles. The bottom here is a succession of ridges of pebbles and gravel with occasional patches of rocks. Depths are from 55 to 80 fathoms. The current, occasionally strong, is weaker here than farther W. on the bank and, except during easterly winds, is but little noticed. The general set is westerly.

"The Ridges," says the report before mentioned, "were for a number of years one of the favorite resorts for halibut catchers in winter, and many good catches of cod were taken here at that season. At present but few halibut are caught except in the deep water along the southern edge of the ground, where they sometimes have been found quite plentiful during nearly the entire year." Apparently there has not been much change in these conditions since the writer's time; fish seem to be present here in about the same quantities as in former years.

One piece of bottom, having depths of 25 to 50 fathoms over red clay, lying approximately in 43° 08′ to 43° 10′ north latitude and about 61° to 63° west longitude, seems a good spring and early summer ground. Apparently red-clay bottom indicates a good halibut ground, as this species is usually present where such a bottom is found.

Hake are found in good numbers in the deep water about the edges of the ground and even on the Ridges.

These waters are quite heavily fished from Canadian ports, and a fair number of American vessels visit them each year, most of them hailing from Boston or Gloucester.

Scandinavian Bank.—Eighteen miles SSW. from Shelbourne Light, Nova Scotia. It is about 3 miles long in an E. and W. direction by about ½ mile wide. In general, the bottom is level, with depths from 50 to 70 fathoms; the shoal parts are sharp and rocky, the bottom over the deeper portions being composed mostly of small black and yellow pebbles.

This is a summer halibut ground (July and August) in depths from 45 to 60 fathoms, and halibut occur in October in the deeper waters about it. It is also a fair summer cod ground, and cusk are present in the deep water about the edges during most of the year. In general, species and seasons are much as on Roseway.

Western Bank.—This is one of the most important fishing grounds of the western Atlantic, whether as regards size or the abundance of its product. It lies S. of Cape Breton Island and the eastern part of Nova Scotia between the parallels of 42° 55′ and 44° 46′ north latitude and the meridians of 59° 04′ and 62° 35′ west longitude. It has a length of 156 miles and a width, including the Middle Ground, of 76 miles. It is about 420 miles E. ½ S. from Boston to the southwestern edge, which means about 48 hours' steaming for the otter-trawl fleet.

The general contour of the bank within the 65-fathom line, as laid down on the Admiralty chart, approaches somewhat a very elongated ellipse, the longer axis running NE. by E. and SW. by W.; but over a broad area to eastward of the center of the bank soundings of less than 50 fathoms connect it directly with the Middle Ground, which we have here included in the same bank. The total extent of the bank thus defined is about 7,000 square geographical miles. Off its eastern end lies Banquereau (the Quereau of the fishermen) with The Gully between, and a short distance off the western edge are the Le Have Ridges.

The depths off the southern edge of the bank increase rapidly from 60 to 700, 1,200, and even 1,400 fathoms. At the eastern end is Sable Island,[16] graveyard

---

[16] "Pedro Reinel, a Portuguese pilot of much fame" (Herrera), made a map in 1505 showing Sable Island, feared and dreaded by all fishermen even in those days, where he called it "Santa Cruz." Jacomo Gastaldi, an Italian cartographer, in 1548 shows it "Isolla de Arena." Sir Humphrey Gilbert, or his historian, says that the Portuguese had made an interesting settlement here for shipwrecked mariners. This, "Upon intelligence we had of a Portugal who was himself present when the Portugals, above thirty years past [thus before 1553] did put upon the island neat and swine to breed, which were since exceedingly multiplied."

of ships, a long, narrow, crescent-shaped elevation seemingly lessening in area each year, formed entirely of sand that has been blown into innumerable hummocks and dunes. Off both ends of the island are long and dangerous sand bars. The length of the island is 20 miles; its greatest width is about 1½ miles. It is said that the Northwest Light has been moved three times due to the fact that the western end of the island has been literally blown away. It lies in an E. and W. direction, and the depth of water over the bars for a distance of 7 to 10 miles out does not exceed 2 fathoms, and even 10 miles farther out the depths do not exceed 10 to 11 fathoms. Within recent years fishermen have reported the appearance of a sand shoal about 5 or 6 miles SE. from the Northeast Light. This is said to appear at low water.

In general, the bank slopes S. and W. from the island, depths ranging from 18 to 60 fathoms. The bottom is mostly sandy with patches of gravel and pebbles. Currents are sometimes very strong about Sable Island and are somewhat irregular; apparently they are much influenced by the winds. On the other parts of the bank usually there is but little current, whatever there is usually tending toward the west.

Formerly the cod and halibut were the food fishes most taken here, but with the changed methods in the fishery (as the growth of the otter-trawl fleet) and a changed taste in our public the haddock catch has become the second most important in the receipts of fish from these waters. The halibut fishery stands third in the list. Other bottom feeders occur in less numbers, the pollock and the cusk perhaps being next in order of importance, with hake and a considerable amount of the various flatfishes in the otter trawls. These latter are marketed as sole.

Noting the small amount of haddock in the fares taken from these waters in former years, the writer asked a number of old-time fishermen as to its abundance in the old days. The reply was usually "Oh, yes, there were always haddock there; sometimes they bothered us a lot." Then, noting my surprise at so putting it, "You know, the haddock isn't much as a salt fish."

It will be noted that in 1923 the haddock catch here was a very good second to the cod catch in poundage, though not so valuable proportionately. In the otter-trawl catch from this ground it will be noted that the positions of the two species are reversed. As a rule, these steamers certainly take more than 2 pounds of haddock to 1 of cod on other offshore grounds—perhaps the result of operating in the shoaler waters and on the smoother bottom because of the difficulty of dragging over the rocky and kelp-covered ground, which the cod seems to prefer. But the bottom on the Western Bank is of such nature as to offer little obstruction to the passage of the net, so that virtually all parts of it may be fished by this method; and this, added to the known movements of the cod schools, makes it possible at certain seasons of the year to catch a larger proportion of this species if it is so desired.

Haddock are found about the bars at both ends of the island in March and from that time to about June 1 in from 15 to 22 fathoms. They are also abundant 18 miles W. from the Northwest Light at the same seasons and at the same depths. During April, May, and June they come in close to the island in from 10 to 17 fathoms—even to 1 fathom. Through the rest of the year (except for the colder months, when they have moved off into deeper water) they may be found all over the bank on sandy bottom in 28 to 30 fathoms, where most of the beam-trawl fishing is carried on.

There is a good cod school each year on the comparatively level bottom along the western and southwestern edges of the ground in 70 fathoms and more from February 1 to May 1, and in most years a certain amount of this species is taken on this area. In May this school seems to have moved on to a piece of bottom about 20 miles long lying SW. from the Northwest Light and having depths averaging 27 fathoms. With fair fishing for cod on the Western Bank during most of the year, they seem to be most abundant from the first of March to June. The winter school here appears to be smaller than that on Georges, but apparently this species visits this ground in considerable numbers during the spawning season. In winter the cod are mainly found upon the western part of the bank, moving into the shoaler waters toward Sable Island as the spring advances (during March and April), the "Bend" of the island and the neighborhood of the bars in 2 to 4 fathoms, where they can be seen taking the hook or can be "jigged," being favorite grounds. The ground lying W. from the Northwest Light, on and about the Northwest Bar (18 miles W. from the light), is a favorite cod ground in May and June. The shoal water over the rocky bottom WNW. from the Northwest Light furnishes good cod fishing from June 10 to July 1. This piece begins just outside the 3-mile stretch of breakers running out from the land and extends offshore in a generally westerly direction to 24 fathoms. Much hand-lining is done here. In the shoal water, in April and May, the fish seem to be feeding on the "lant," (*Ammodytes americanus*). It is said that the fish taken on the bottom close to the island are smaller than those found farther west. The shoal water of the northern shore of the island is said to have good cod grounds and favorite spots for "dory hand-lining." The cod schools seem to arrive on the Northern Peak (SE. from the Northeast Light 40 miles to SE. by S. ½ S. from same point 28 miles) in late March and the first of April, moving N. and W. to the island. The cod of Sable Island are said to be fine, firm fish, perhaps due to the abundance of the "red clams" (bank clams) on these grounds.

The cod and haddock fishery is carried on by American and Canadian sailing vessels and otter trawlers, an increasing number of English and French vessels of the latter class engaging in the fishery of this ground each year.

Halibut are found on the Western Bank virtually all the year at depths varying with the seasons. As a halibut bank, this, with The Gully and Quereau—in fact, all one piece of ground—ranks second only to the Grand Bank itself. The best fishing here for halibut is found from January to October. There are numerous places on and about the bank that the halibut seems to prefer, as the Peak of Pike, 65 miles W. by S. from the Northwest Light of Sable Island; S. and SW. of Sable Island from 12 to 38 miles; SW. 20 miles in 60 fathoms in May; thence out into 100 and 150 fathoms in June; in fact, following the 100-fathom curve along the edge of this bank, past the Northeast Peak (40 miles SE. from the Northeast Light), into the Gully and around the Southern Prong of Quereau to the Middle Prong. Apparently they leave this piece of bottom in July. Often the fish are close to the island in the spring, where the water is so shoal that they can be seen taking the bait or playing with the hook before taking. In April, May, and June a good halibut ground is in 18 fathoms 24 miles WNW. from Sable Island.

The Western Bank seems to be a good feeding ground for both cod and halibut, as it abounds in shellfish and crustaceans, and at certain periods there are many smaller species of fish upon it, such as the lant and herring, on which these species and the haddock, also, especially prey. A considerable amount of swordfish is taken here in August and September, mainly by American vessels.

Banquereau.—Separated from the Western Bank by The Gully, this has a very irregular form—the main bank roughly rectangular, with a narrow westerly extension of comparatively regular form. Its length, E. and W., is about 120 miles, its greatest width about 47 miles, and its total area about 2,800 miles.

The main portion of the bank lies between 44° 04′ and 45° 01′ north latitude and 57° 10′ and 59° 00′ west longitude, and the western prolongation lies between 44° 24′ and 44° 42′ north latitude and 59° 00′ and 60° 05′ west longitude. North of Banquereau lies Artimon, distant 3 miles, and Misaine, distant from 2 to 15 miles according to the places from which measurements are taken. The currents here are of varying force, much influenced by the wind, so that several days of strong tides may be followed by intervals when there is little if any current.

On the eastern part of Quereau is an area of shoal ground called the Rocky Bottom, having a depth of about 16 fathoms; elsewhere depths run from 18 to 50 fathoms. For the most part the bottom is rocky, but there are scattered patches of sand and gravel.

Cod and halibut are the principal food fishes taken, hake, haddock, and cusk being taken in small numbers. The Rocky Bottom, a shoal ground of 20 to 25 fathom depths on the eastern part, was much resorted to by dory handliners in summer. The cod are most plentiful on the eastern part of the bank, though occasional good fares are taken toward the west. The best cod fishing on this bank is from May until September, when the schools gather to feed upon the lant, squid, crustaceans, and shellfish, then very abundant.

Halibut are found here all the year off the edges in 100 to 400 fathoms. Apparently these are feeding and breeding grounds for this species, and it is not unusual for a school to remain for weeks and even months in one locality, though some of these may be fish in migration northward.

The principal halibut grounds are along the southern and eastern borders of the bank—the Southwest Prong and the Southwest Cove (in about 44° N. lat.

and between 58° 30′ and 58° 55′ W. long), the Middle Prong 44° 14′ N. lat. and 58° W. long.), and the Eastern Slope (44° 28′ to 45° 00′ N. lat.)—in depths of 150 to 400 fathoms. These deep-water areas are rocky and support a very rich growth of gorgonians, corals, sea anemones, etc. The Eastern Slope has an abundance of bank clams in depths of 25 fathoms. These beds are good hand-line grounds for cod. The halibut, too, feeds to a considerable extent upon these red clams.

The Stone Fence off the eastern slope of Quereau is a very rocky piece of ground full of "trees" (corals) in 250 fathoms. This is a good halibut ground, although it is almost impossible to haul the gear by hand and the use of the "gurdy" (a roller turned by a crank and fastened to the dory's bow for winding up the trawl) becomes necessary. Occasional fares of halibut are taken on and about the Rocky Bottom in 20 to 25 fathoms from July 1 to August 1.

The Gully.—This is the deep waterway between Banquereau and Sable Island or Western Bank. It extends in an WNW. and an ESE. direction north of Sable Island, turning somewhat abruptly S. at its eastern end and continuing down between the eastern end of Western Bank and the Southwest Prong of Banquereau. The entire length is about 60 miles, the greatest width about 20 miles. Depths range from 66 to 145 fathoms over a bottom of rocks, gravel, sand, and mud. The rocky and gravelly portions form several ridges separated by areas of finer materials, except in the eastern section, where the intervals between are mostly covered by pebbles and sharp rocks. Ocean currents are generally westerly, of varying strength, much affected by the easterly winds.

The Gully is a very important halibut ground. The halibut are not found in great numbers all over the ground, perhaps the best of the fishing being on the rocky and gravelly ridges and slopes included between the meridians of 59° and 60° west longitude. This rocky bottom is rich in food, and the lant and herring are usually plentiful here in their season. In the spring the halibut seem to be especially numerous in the northern and northwestern parts of the bank, later, in June and July, moving farther out. Some are found here in winter. While the cod is sometimes found in The Gully in 60 to 90 fathoms, it does not seem to be of regular occurrence; and apparently there are almost no haddock here, probably because of the depth of the water and the nature of the bottom.

Artimon Bank.—Has an area of some 120 square miles with a bottom of gravel and rocks and depths of 38 to 50 fathoms. It is but little known because of the tendency of the fishermen to use the larger grounds close at hand. Cod are known to be present here, however. The bank lies N. of the eastern part of Quereau, separated from it by a narrow, deep-water channel.

Misaine Bank.—Lies N. of the western two-thirds of Quereau, at one place very near, but in general the banks are separated by some 20 miles of deep water. Its greatest length is 80 miles and its greatest width 40 miles. Depths are from 40 to 60 fathoms over a bottom broken and rocky. It is not of much importance as a fishing ground, although a few halibut trips are landed from it in most years.

Canso Bank.—A long, narrow extension of Misaine Bank, lying in an E. and W. direction; its length is 45 miles and its greatest width 13 miles, its area being about 425 square miles. Depths range from 30 to 65 fathoms over a bottom of sand, with spots of gravel and pebbles. It is not of much importance as a fishing ground, especially as judged by the use of it by the American fleet, though more fished by vessels from Nova Scotia; perhaps it is overshadowed by the presence of its larger neighbors, Western and Quereau Banks, with which grounds it forms virtually one piece of bottom, only narrow, deep-water channels separating them. These larger grounds are heavily fished both by American vessels and by those from Nova Scotia ports as well as by French and English otter trawlers.

The statistics given here and elsewhere in this report are taken from the published bulletins of the United States Bureau of Fisheries, and include only the landings of vessels of 5 tons net, or over, at the ports of Boston and Gloucester, Mass., and Portland, Me.

Table 5.—*Fishing grounds of the offshore North Atlantic, showing the principal species taken upon them*

Fishing ground	Cod	Haddock	Hake	Pollock	Cusk	Halibut	Herring	Mackerel	Lobsters	Miscellaneous
Browns Bank	x	x	x	x	x	x				[1] x
Seal Island Ground	x	x	x		x	x	[2] x	[3] x		
Roseway	x	x	x	x	x	x				
La Have Bank	x	x			x	x				
La Have Ridges; Little La Have	x		x			x				
Scandinavian Bank	x	x	x	x	x	x				
Western Bank	x	x		x		x				
Banquereau	x					x				
The Gully	x					x				
Artimon	x									
Misaine	x									
Canso	x	x	x	x	x	x				

[1] Swordfish makes a considerable part of this.
[2] Food fish; very little taken by United States crafts.
[3] On shore soundings.

Table 6.—*Distance from Boston or Gloucester, Mass., to the center of certain of the more important offshore banks*

Bank	Miles	Bank	Miles
Georges	172	Emerald	375
Browns	220	Sable Island	470
Roseway	290	Quereau	555
La Have	315	Grand	928

Table 7.—*Distance from Portland, Me., to the center of certain of the more important offshore banks*

Bank	Miles	Bank	Miles
Georges	180	Emerald	340
Browns	200	Sable Island	438
Roseway	250	Quereau	508
La Have	262	Grand	884

Table 8.—*Landings by fishing vessels at Boston and Gloucester, Mass., and Portland, Me., from inner or shore grounds, 1927*

Species	Boston			Gloucester		
	Trips	Pounds	Value	Trips	Pounds	Value
Cod		398,737	$14,782		5,060,590	$246,839
Haddock		2,203,170	70,025		1,630,750	62,441
Hake		193,005	4,254		80,050	1,564
Pollock		30,963	741		3,481,835	70,510
Cusk		60,464	1,898			
Halibut		11,609	2,472			
Mackerel		198,445	20,154		9,958,445	392,166
Miscellaneous		2,940,109	118,889		1,700,240	54,508
Total	605	6,036,502	233,215	3,282	21,911,910	828,028

TABLE 8.—*Landings by fishing vessels at Boston and Gloucester, Mass., and Portland, Me., from inner or shore grounds, 1927*—Continued

Species	Portland			Total		
	Trips	Pounds	Value	Trips	Pounds	Value
Cod		1,204,112	$50,091		6,663,439	$311,712
Haddock		1,101,831	34,528		4,935,751	166,994
Hake		161,941	3,487		434,996	9,305
Pollock		286,665	4,361		3,799,463	75,612
Cusk		155,945	5,043		216,409	6,941
Halibut		3,643	769		15,252	3,241
Mackerel		198,379	6,246		10,355,269	418,566
Miscellaneous		960,238	22,590		5,600,587	195,987
Total	876	4,072,754	127,115	4,763	32,021,166	1,188,358

NOTE.—The catch from these inner or shore grounds represents 46.87 per cent of the total number of fares, 12.14 per cent of the total poundage, and 12.63 per cent of the total values of the catch from all grounds at the 3 ports for the year 1927.

TABLE 9.—*Landings by fishing vessels at Boston and Gloucester, Mass., and Portland, Me., from the outer grounds of the Gulf of Maine, 1927*

Species	Platts Bank			Cashes Bank			Jeffreys Ledge		
	Trips	Pounds	Value	Trips	Pounds	Value	Trips	Pounds	Value
Cod		187,515	$8,547		284,204	$11,190		1,007,016	$44,340
Haddock		601,021	30,851		268,318	11,479		2,260,950	96,198
Hake		210,940	6,296		110,863	4,488		550,437	14,617
Pollock		87,480	1,382		19,235	392		459,726	8,195
Cusk		86,542	3,249		331,914	10,731		231,565	7,191
Halibut		2,057	491		15,760	2,942		4,647	905
Mackerel								243,792	8,486
Miscellaneous		76,788	1,396		11,591	347		1,623,888	25,762
Total	123	1,252,343	52,212	63	1,041,885	41,569	652	6,382,021	205,694
Boston				8	256,604	12,826	99	1,515,386	67,749
Portland	123	1,252,343	52,212	55	785,281	28,743	553	4,866,635	137,945

Species	Fippenies Bank			Tillies Bank		
	Trips	Pounds	Value	Trips	Pounds	Value
Cod		37,555	$1,751		500	$38
Haddock		129,679	7,086		6,220	491
Hake		16,154	564		2,800	168
Pollock		11,200	203		135	5
Cusk		14,870	687		250	10
Halibut		2,461	527			
Mackerel					138,975	12,185
Miscellaneous		2,725	122		115	19
Total	24	214,644	10,940	10	148,995	12,916
Boston				10	148,995	12,916
Portland	24	214,644	10,940			

TABLE 9.—*Landings by fishing vessels at Boston and Gloucester, Mass., and Portland, Me., from the outer grounds of the Gulf of Maine, 1927*—Con.

Species	Middle Bank[1]			Total		
	Trips	Pounds	Value	Trips	Pounds	Value
Cod	-------	90, 910	$4, 583	-------	1, 607, 700	$70, 449
Haddock	-------	567, 290	27, 656	-------	3, 833, 478	173, 761
Hake	-------	99, 155	3, 580	-------	990, 349	29, 713
Pollock	-------	19, 930	597	-------	597, 706	10, 774
Cusk	-------	34, 220	1, 234	-------	699, 361	23, 102
Halibut	-------	1, 204	442	-------	26, 129	5, 307
Mackerel	-------	1, 001, 588	35, 719	-------	1, 384, 355	55, 850
Miscellaneous	-------	20, 965	1, 048	-------	1, 736, 072	28, 694
Total	74	1, 835, 262	74, 319	946	10, 875, 150	397, 650
Boston	69	1, 616, 302	68, 972	186	3, 537, 287	162, 463
Gloucester	5	218, 960	5, 347	5	218, 960	5, 347
Portland	-------	-------	-------	755	7, 118, 903	229, 840

[1] Known also as Stellwagen.

NOTE.—In the totals for the year 1927 the catch for this group of grounds represents 9.39 per cent of all ares, 4.12 per cent of the poundage, and 4.23 per cent of the value at the 3 ports.

TABLE 10.—*Landings by fishing vessels at Boston and Gloucester, Mass., and Portland, Me., from the fishing grounds of the Georges Bank area, 1927*

Species	Georges Bank			South Channel			Nantucket Shoals		
	Trips	Pounds	Value	Trips	Pounds	Value	Trips	Pounds	Value
Cod	-----	24, 273, 869	$752, 145	-----	12, 238, 525	$468, 133	-----	868, 280	$29, 228
Haddock	-----	8, 801, 380	229, 635	-----	94, 978, 623	2, 509, 331	-----	6, 246, 280	185, 462
Hake	-----	87, 570	2, 262	-----	3, 993, 676	107, 296	-----	72, 755	1, 850
Pollock	-----	984, 010	21, 746	-----	1, 888, 632	56, 193	-----	50, 885	1, 002
Cusk	-----	295, 765	5, 459	-----	459, 515	14, 621	-----	1, 150	40
Halibut	-----	1, 066, 760	204, 361	-----	268, 999	58, 593	-----	14, 889	2, 092
Mackerel	-----	934, 420	96, 114	-----	4, 078, 460	176, 777	-----	168, 470	5, 555
Miscellaneous	-----	1, 709, 012	354, 079	-----	3, 782, 283	216, 414	-----	1, 054, 708	71, 825
Total	963	38, 152, 786	1, 665, 801	2, 036	121, 688, 693	3, 607, 358	216	8, 477, 417	297, 054
Boston	786	31, 004, 619	1, 477, 364	1, 918	112, 095, 440	3, 470, 255	189	7, 606, 212	276, 440
Gloucester	164	6, 855, 508	162, 628	102	6, 625, 205	91, 065	24	640, 560	16, 996
Portland	13	292, 659	25, 809	16	2, 968, 048	46, 038	3	230, 645	3, 618

Species	Off Cape Cod			Total		
	Trips	Pounds	Value	Trips	Pounds	Value
Cod	-------	107, 640	$3, 952	-------	37, 488, 314	$1, 253, 458
Haddock	-------	1, 866, 970	63, 252	-------	111, 893, 253	2, 987, 680
Hake	-------	40, 820	1, 645	-------	4, 194, 821	113, 053
Pollock	-------	12, 675	349	-------	2, 936, 202	79, 290
Cusk	-------	11, 160	339	-------	767, 580	20, 459
Halibut	-------	1, 364	274	-------	1, 352, 012	265, 320
Mackerel	-------	4, 471, 641	237, 637	-------	9, 652, 991	516, 083
Miscellaneous	-------	205, 523	11, 532	-------	6, 751, 506	653, 850
Total	284	6, 717, 783	318, 980	3, 499	175, 036, 679	5, 889, 193
Boston	284	6, 717, 783	318, 980	3, 177	157, 424, 054	5, 543, 039
Gloucester	-------	-------	-------	290	14, 121, 273	270, 689
Portland	-------	-------	-------	32	3, 491, 352	75, 465

NOTE.—In the totals showing value, poundage, and number of fares from all grounds, as taken out at Boston, Gloucester, and Portland for the year 1927, the catch from the Georges Bank area represents 34.43 per cent of the fares, 62.62 per cent of the value, and 66.34 per cent of the poundage.

TABLE 11.—*Landings by the otter-trawl fleet at Boston and Gloucester, Mass., and Portland, Me., from the fishing grounds of the Georges Bank area, 1927*

Species	Georges Bank			South Channel			Nantucket Shoals		
	Trips	Pounds	Value	Trips	Pounds	Value	Trips	Pounds	Value
Cod	------	178, 987	$6, 435	------	3, 709, 688	$144, 123	------	88, 230	$3, 275
Haddock	------	1, 360, 685	42, 933	------	63, 593, 777	1, 651, 498	------	3, 908, 690	119, 757
Hake	------	1, 895	49	------	947, 110	27, 543	------	45, 225	1, 045
Pollock	------	15, 840	727	------	1, 077, 545	38, 987	------	14, 100	443
Cusk	------	------	------	------	11, 440	440	------	175	6
Halibut	------	2, 405	712	------	94, 796	23, 542	------	1, 556	380
Miscellaneous	------	34, 720	2, 612	------	2, 000, 773	127, 196	------	86, 982	5, 142
Total	17	1, 584, 532	53, 468	736	71, 435, 129	2, 013, 329	39	4, 144, 958	130, 048

Species	Off Cape Cod			Total		
	Trips	Pounds	Value	Trips	Pounds	Value
Cod	------	6, 000	$240	------	3, 982, 905	$154, 073
Haddock	------	111, 700	6, 612	------	68, 964, 852	1, 820, 800
Hake	------	500	40	------	994, 730	28, 677
Pollock	------	240	17	------	1, 107, 725	40, 174
Cusk	------	------	------	------	11, 615	446
Halibut	------	10	2	------	98, 767	24, 636
Miscellaneous	------	21, 570	1, 436	------	2, 144, 045	136, 386
Total	1	140, 020	8, 347	793	77, 304, 639	2, 205, 192

NOTE.—In the year's totals from all grounds at these ports the catch from this area by otter trawls represents 29.30 per cent of the poundage, 23.42 per cent of the value, and 7.80 per cent of the number of fares. In the totals for this area the otter trawl accounts for 44.16 per cent of the poundage, 37.44 per cent of the value, and 22.66 per cent of fares. Apparently but 1 other otter-trawl fare was reported at these ports for the year, and that was from the Western Bank and totaled 178,987 pounds of haddock, valued at $3,410.

TABLE 12.—*Landings by fishing vessels at Boston and Gloucester, Mass., and Portland, Me., from the offshore grounds adjacent to the Gulf of Maine, 1927*

Species	Browns Bank			Seal Island Ground			La Have Bank		
	Trips	Pounds	Value	Trips	Pounds	Value	Trips	Pounds	Value
Cod	------	6, 334, 143	$203, 047	------	52, 265	$2, 836	------	4, 148, 851	$133, 889
Haddock	------	4, 168, 035	120, 458	------	35, 440	1, 511	------	2, 185, 471	57, 069
Hake	------	50, 380	1, 203	------	1, 200	12	------	104, 055	1, 634
Pollock	------	175, 335	3, 443	------	875	14	------	85, 635	1, 775
Cusk	------	684, 670	13, 462	------	7, 400	204	------	243, 075	5, 356
Halibut	------	204, 237	40, 742	------	130	39	------	216, 015	38, 968
Miscellaneous	------	473, 421	79, 915	------	------	------	------	72, 909	8, 272
Total	226	12, 090, 221	462, 270	2	97, 310	4, 616	119	7, 056, 011	246, 963
Boston	183	9, 673, 691	412, 118	2	97, 310	4, 616	81	3, 979, 418	192, 872
Gloucester	37	2, 091, 964	34, 778	------	------	------	36	3, 015, 737	50, 415
Portland	6	324, 566	15, 374	------	------	------	2	60, 856	3, 676

TABLE 12.—*Landings by fishing vessels at Boston and Gloucester, Mass., and Portland, Me., from the offshore grounds adjacent to the Gulf of Maine, 1927*—Con.

Species	Cape Shore			Sable Island area					
				Western Bank			The Gully		
	Trips	Pounds	Value	Trips	Pounds	Value	Trips	Pounds	Value
Cod		308,770	$14,187		6,032,690	$131,798		3,981	$129
Haddock		122,885	4,679		1,383,400	18,876		320	6
Hake		6,370	235		43,385	786		2,300	92
Pollock		9,745	206		54,205	648		360	14
Cusk		10,545	149		26,725	402			
Halibut		1,142	338		142,898	23,024		61,965	12,564
Mackerel		197,400	4,381						
Miscellaneous		254,577	58,324		5,048	290			
Total	48	911,434	82,499	95	7,688,351	175,824	2	68,926	12,805
Boston	34	732,492	65,309	42	1,083,260	51,053	1	42,767	7,665
Gloucester				49	5,880,905	111,896			
Portland	14	178,942	17,190	4	724,186	12,875	1	26,159	5,140

Species	Sable Island area			Total		
	Quereau Bank					
	Trips	Pounds	Value	Trips	Pounds	Value
Cod		384,706	$12,751		17,265,406	$498,637
Haddock		34,350	675		7,929,901	203,274
Hake		19,060	304		226,750	4,266
Pollock		1,640	31		327,795	6,131
Cusk		59,892	1,059		1,032,307	20,632
Halibut		909,838	149,072		1,536,225	264,747
Mackerel					197,400	4,381
Miscellaneous		12,307	781		818,262	147,582
Total	53	1,421,793	164,673	555	29,334,046	1,149,650
Boston	33	891,194	132,842	376	16,500,132	866,475
Gloucester	24	419,653	14,164	146	11,408,259	211,253
Portland	6	110,946	17,667	33	1,425,655	71,922

NOTE.—The totals for the group of grounds shown here represent 11.12 per cent of the poundage, 12.22 per cent of the value, and 5.46 per cent of the number of fares from all grounds at these 3 ports for 1927. For the Sable Island area, 9,179,070 pounds, valued at $353,302; 160 fares make 3.48, 3.75, and 1.57 per cent, respectively.

TABLE 13.—*Landings by fishing vessels at Boston and Gloucester, Mass., and Portland, Me., from all grounds, 1927*

Species	Boston			Gloucester		
	Trips	Pounds	Value	Trips	Pounds	Value
Cod		40,309,673	$1,458,930		20,249,074	$574,540
Haddock		109,860,353	3,149,069		11,312,771	187,989
Hake		4,779,441	131,285		228,280	3,283
Pollock		3,201,525	86,112		3,645,570	72,258
Cusk		1,680,124	44,905		356,232	4,906
Halibut		4,320,036	764,079		42,882	3,492
Mackerel		20,444,080	863,185		10,554,395	416,970
Miscellaneous [1]		10,345,557	873,977		6,163,336	230,497
Total	4,684	194,940,789	7,371,542	3,772	52,552,540	1,493,935

[1] Under this heading various species are listed, mostly in small amounts. The most important are flounders, 8,359,131 pounds, valued at $419,744; herring, 7,145,436 pounds, valued at $200,736; and swordfish, 2,245,493 pounds, valued at $513,582.

TABLE 13.—*Landings by fishing vessels at Boston and Gloucester, Mass., and Portland, Me., from all grounds, 1927*—Continued

Species	Portland			Total		
	Trips	Pounds	Value	Trips	Pounds	Value
Cod	-------	2, 795, 982	$113, 033	-------	63, 354, 729	$2, 146, 503
Haddock	-------	7, 419, 559	194, 655	-------	128, 592, 683	3, 531, 713
Hake	-------	824, 905	21, 977	-------	5, 832, 626	156, 545
Pollock	-------	815, 266	13, 479	-------	7, 662, 361	171, 849
Cusk	-------	690, 861	21, 563	-------	2, 727, 217	71, 374
Halibut	-------	416, 365	72, 374	-------	4, 779, 283	839, 945
Mackerel	-------	531, 416	15, 392	-------	31, 529, 891	1, 295, 547
Miscellaneous [1]	-------	2, 831, 890	86, 561	-------	19, 340, 783	1, 191, 035
Total	1, 706	16, 356, 244	539, 034	10, 162	263, 849, 573	9, 404, 511

[1] Under this heading various species are listed, mostly in small amounts. The most important are flounders, 8,359,131 pounds, valued at $419,744; herring, 7,145,436 pounds, valued at $200,736; and swordfish, 2,245,493 pounds, valued at $513,582.

TABLE 14.—*Landings by fishing vessels from the various fishing grounds at Boston and Gloucester, Mass., and Portland, Me., 1927*

Fishing ground	Trips	Pounds	Value	Fishing ground	Trips	Pounds	Value
Labrador	2	101, 268	$10, 608	Georges Bank	963	38, 152, 786	$1, 665, 801
Belle Isle	1	7, 500	246	Off Highland	55	812, 797	79, 479
Off Newfoundland	17	4, 533, 284	177, 051	Off Chatham	229	5, 904, 986	239, 503
Grand Bank	40	953, 717	134, 134	South Channel	2, 036	121, 688, 693	3, 607, 358
Green Bank	7	173, 105	25, 059	Nantucket Shoals	216	8, 477, 417	297, 054
St. Peters Bank	22	720, 177	113, 884	Cashes Bank	63	1, 041, 885	41, 569
St. Anns Bank	1	32, 958	4, 817	Fippenies Bank	24	214, 644	10, 9[illegible]0
St. Lawrence	2	63, 261	8, 810	New Ledge	123	1, 252, 343	52, 212
Quereau Bank	63	1, 421, 793	164, 673	Jeffreys Ledge	652	6, 382, 021	205, 694
The Gully	2	68, 926	12, 805	Tillies Bank	10	148, 995	12, 916
Western Bank	95	7, 688, 351	175, 824	Middle Bank	74	1, 835, 262	74, 319
La Have Bank	119	7, 056, 011	246, 963	Shore, general	4, 763	32, 021, 166	1, 188, 358
Cape Shore	48	911, 434	82, 499	South	306	9, 962, 886	301, 547
Roseway	2	84, 358	3, 504				
Browns Bank	226	12, 090, 221	462, 270	Total	10, 162	263, 849, 573	9, 404, 511
Seal Island Ground	2	97, 310	4, 616				

TABLE 15.—*Landings by fishing vessels from all grounds at Boston and Gloucester, Mass., and Portland, Me., 1916 to 1927*

Year	Boston			Gloucester		
	Trips	Pounds	Value	Trips	Pounds	Value
1916	3, 089	98, 331, 038	$3, 702, 365	2, 864	66, 680, 548	$2, 159, 894
1917	2, 962	98, 650, 139	5, 166, 440	3, 074	58, 134, 944	2, 451, 484
1918	2, 830	109, 476, 041	6, 587, 754	3, 414	74, 175, 499	3, 062, 605
1919	2, 754	103, 391, 370	4, 713, 350	2, 965	71, 370, 957	2, 145, 592
1920	3, 342	118, 558, 902	6, 136, 569	2, 381	46, 740, 296	1, 460, 336
1921	3, 078	104, 368, 629	4, 190, 135	2, 073	33, 016, 166	920, 250
1922	2, 893	106, 190, 403	4, 020, 105	1, 653	37, 751, 223	813, 353
1923	3, 368	124, 215, 034	5, 433, 731	1, 579	35, 029, 848	910, 739
1924	3, 735	130, 966, 256	5, 401, 590	2, 157	35, 845, 920	1, 041, 476
1925	4, 404	149, 038, 498	6, 104, 278	2, 491	49, 471, 943	1, 390, 580
1926	4, 569	167, 317, 826	7, 002, 602	2, 665	54, 900, 824	1, 479, 312
1927	4, 684	194, 940, 789	7, 371, 542	3, 772	52, 552, 540	1, 493, 935

TABLE 15.—*Landings by fishing vessels from all grounds at Boston and Gloucester, Mass., and Portland, Me., 1916 to 1927*—Continued

Year	Portland			Total		
	Trips	Pounds	Value	Trips	Pounds	Value
1916	2,992	20,812,839	$521,647	8,945	185,824,425	$6,383,906
1917	3,248	18,645,503	743,408	9,284	175,430,586	8,361,332
1918	2,506	21,849,613	881,189	8,750	205,501,153	10,531,548
1919	2,550	21,718,943	689,441	8,269	196,481,270	7,548,383
1920	1,883	12,981,503	630,108	7,606	178,280,701	8,227,013
1921	2,055	13,480,311	612,244	7,206	150,865,106	5,722,620
1922	1,803	15,933,765	632,474	6,349	159,875,391	5,465,932
1923	1,588	15,696,587	706,684	6,535	174,941,469	7,051,154
1924	1,583	16,136,018	549,886	7,475	182,948,194	6,992,952
1925	1,509	18,358,824	620,712	8,404	216,869,265	8,115,570
1926	1,461	16,207,573	575,760	8,695	238,426,223	9,057,674
1927	1,706	16,356,244	539,034	10,162	263,849,573	9,404,511

Index to grounds

Index to grounds—Continued

Index to grounds—Continued

Index to grounds—Continued

CARE AND DISEASES OF TROUT[1]

By H. S. Davis

In Charge, Aquicultural Investigations, U. S. Bureau of Fisheries

CONTENTS

INTRODUCTION

During recent years there has been a continually increasing demand for more and larger trout for stocking purposes. A decade ago most of the trout were planted as advanced fry, or at least before they reached a length of 3 to 4 inches, and outside of the commercial hatcheries very few fingerlings were fed for more than two or three months. To-day the tendency is to hold the fish for much longer periods, and several States are already planting thousands of 6 to 12 inch trout annually.

This change in stocking policy is due primarily to the fact that in thickly populated sections, where the streams are fished intensively, it has been found that even moderately good fishing can be maintained only by liberal plantings of large fingerlings and legal-size fish. It has been estimated by Embody (1927) that in the streams of New York State 95 per cent of the advanced fry and 50 per cent of the fingerlings die before reaching legal size. If this be true, it is obvious that much better results can be attained by planting large fish, provided excessive losses in the hatchery and rearing pools can be avoided.

It is a comparatively simple matter to produce advanced fry in large numbers with little loss, but if fish are to be held over the summer the trout culturist is confronted with quite a different problem. Difficulties of various kinds, undreamed of by the early

[1] Appendix IV to the Report of the U. S. Commissioner of Fisheries for 1929. B. F. Doc. No. 1061. Submitted for publication Apr. 27, 1929.

trout culturists, must be met and overcome if the fish are to be kept healthy and growing rapidly through the summer.

Unfortunately, there has been a tendency in some quarters to minimize the difficulties and to give the impression that trout can be reared to a length of 6 inches or more with very little trouble. It is very difficult to obtain accurate figures on the losses sustained by the average hatchery, but it is believed that under present conditions they are considerably greater than is usually realized. Owing to the careless methods of recording losses practiced at many hatcheries, their true extent is often not appreciated.

On the other hand, there is every reason to believe that such heavy losses are unnecessary and, to a considerable extent, can be easily prevented. There are well-authenticated instances of small lots of trout that have been carried through the first year with a total loss of less than 10 per cent from the time the eggs were taken. No doubt this represents an exceptional condition that can not be duplicated on a large scale, but there is no reason why we should not try to approach this record.

There is always some loss among the eggs, especially before they are "eyed," which in many cases reaches 20 to 30 per cent and in some instances may be even higher. But from the time the eggs are "eyed" until the young fish begin to feed there is usually very little loss. The final absorption of the yolk sac, which compels the advanced fry to seek its food from other sources, marks a critical period in the life of the young trout, which is sometimes attended with heavy losses. From this time until late summer or fall the mortality is often heavy, and it is during this period that there is the greatest opportunity to cut down losses through the adoption of better methods of caring for the fingerlings. Usually little difficulty is experienced in carrying the fish through the following winter if they are carefully graded according to size so as to allow no opportunity for cannibalism.

The various species of trout differ more or less in certain respects, and consequently they should not all be handled in precisely the same manner if best results are to be obtained. Since the writer has had more experience with brook trout (*Salvelinus fontinalis*), the present paper is based primarily on this species. In some respects brook trout are less adaptable to hatchery conditions than rainbow and brown trout, and it is probably for this reason that many hatcheries experience more difficulty with brook trout than with other species.

CARE OF FINGERLING TROUT

The conditions under which fingerling trout can be reared to best advantage, both from the economic and biological standpoints, is a problem worthy of more attention than it has received. Before discussing this question, however, it will be advisable to digress for a moment and consider the natural habitat of young trout during the first few months of their lives.

As is well known, brook trout normally spawn in small, swift streams, and the young remain near the spawning grounds or work their way up into even smaller streams during the first summer. These small brooks usually contain few pools of any size, and there

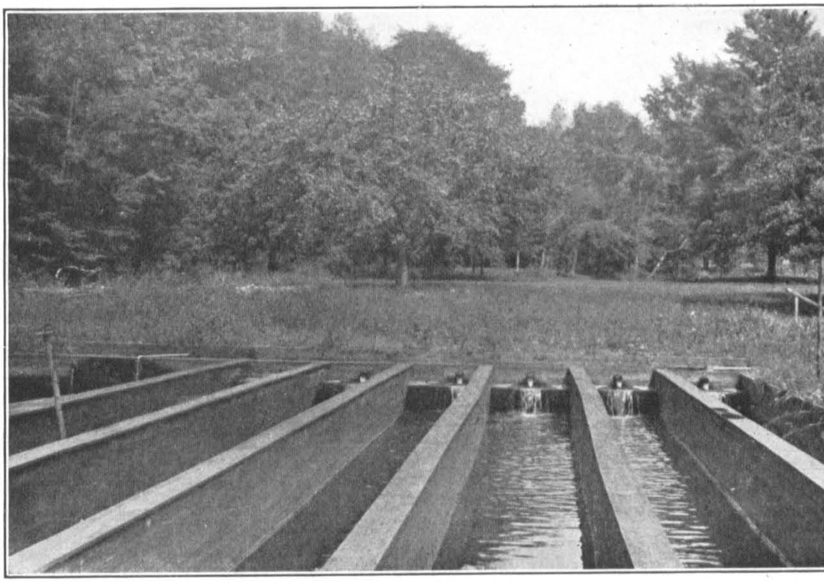


FIGURE 1.—Raceways for fingerling trout at the Pittsford (Vt.) experimental hatchery

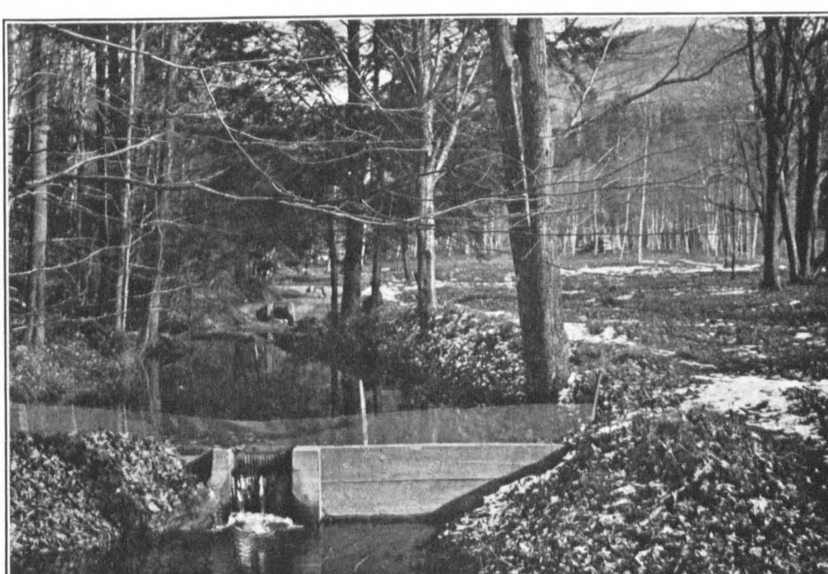


FIGURE 2.—Rearing ponds at the Pittsford experimental hatchery

is a perceptible current almost everywhere. Even in the larger brooks, where there may be occasional quiet pools, one does not find the small fingerlings in such places; on the contrary, they are almost invariably in the shallow riffles, where there is a decided current and the water is well aerated. I have emphasized this point because it is self-evident that the more nearly we can simulate natural conditions in holding fingerlings the better will be our chances of success. This means that, if possible, the fish should be held where they can be furnished an abundant supply of well-aerated water, and, furthermore, the water should show a perceptible current. In other words, conditions similar to those that obtain in hatchery troughs should be provided in order to obtain the best results.

Many trout culturists hold the fingerlings during the first summer in the troughs in which they were hatched or provide larger troughs for the purpose. While good results are often obtained under these conditions, there are several serious objections to this practice.

Probably no better method than the standard hatchery trough can be devised to insure that all the fish will be provided with an adequate supply of fresh water. It provides an ideal means of hatching the eggs and holding the fry, but after the fish begin feeding other factors must be taken into consideration. In the first place, the rapidly growing fish constantly require additional space if they are to be kept in a vigorous condition. Consequently, if the fish are to be held for several months it will be necessary to have many times the number of troughs required to hold the eggs and fry. Troughs are expensive, and to provide a sufficient number to hold the fingerlings through the summer will greatly increase the overhead. In fact, if the fish are given sufficient room for best results, the cost of rearing them will be increased out of all proportion to the results attained. For this reason the troughs usually are overcrowded, with the result that the fish are stunted and not infrequently contract diseases, which cause a heavy mortality.

For the reasons given above I believe that raceways (fig. 1) provide a much more satisfactory means of holding fingerling trout than troughs. Of course, the raceway is only a development of the fundamental idea embodied in the hatchery trough but, considering the number of fish it will support, is much cheaper to construct and operate. It has the further advantage that, if properly constructed, it provides an environment closely simulating that of fingerlings in nature. This is especially true if the raceway has a sand or gravel bottom, as should be the case wherever practicable.

The size of the raceways may vary widely, dependent on local conditions, but in all cases they should be much longer than wide and supplied with sufficient water to insure a good circulation. Unless there is an exceptionally large flow of water it is believed that the raceways should be not over 3 to 5 feet wide with a maximum length of 50 to 75 feet. Only a very slight slope on the bottom is necessary, and the water in the lowest part should be not over 12 to 15 inches in depth. In such a raceway it will be found that the fish will be scattered quite uniformly along its length, and there will be little danger of the majority collecting at one end.

Many trout culturists use much deeper water than is advocated here, and where there is a sufficient volume flowing through the raceway this may prove satisfactory; but it is believed that with a relatively small supply more fish can be held safely in shallow than in deep raceways. This is due to the fact that it requires a greater flow to produce a current in a deep raceway than in a shallow one. It is true that it may not be possible to hold quite as many fish per unit area of water surface, but, on the other hand, it requires less water to provide a satisfactory circulation. This being the case, by spreading the water over a greater area a larger number of fish can be reared with a given water supply.

After the fingerlings reach a length of 3 to 4 inches they may be held safely in small pools in which there is a less rapid circulation than in raceways. Smaller fingerlings are often held in pools successfully if given plenty of room, but our experience indicates that in most cases it will prove more economical to hold such fish in raceways and, if thought advisable, remove them to pools later in the season. A very good arrangement is to provide pools to which the surplus fish can be transferred when the raceways become overcrowded.

Of course, the type of pools or raceways to be employed will depend more or less on local conditions. Where there is danger of the water becoming overheated this fact must be taken into consideration and the pools so constructed that there will be no possibility of this occurring. In rapid, well-aerated streams brook trout can withstand temperatures as high as 75° F. for a short time without serious injury. Under similar conditions rainbow and brown trout can survive considerably higher temperatures. However, such high temperatures may produce disastrous results in hatchery waters. Where the fish are crowded together in small pools there is very likely to be a deficiency in dissolved oxygen when the water becomes warm, and under such circumstances high temperatures are much more injurious. Furthermore, hatchery fish are usually not as strong and vigorous as those living in a natural environment and consequently succumb more quickly to adverse factors.

Ordinarily, a temperature higher than 60° F. should not be allowed in rearing pools, and, where practicable, the water should be kept below that temperature. Trout appear to grow most rapidly at 55° to 60° F., and at higher temperatures their vitality is lowered and they are more liable to contract some disease.

Overheating of the water can often be prevented by partially shading the pools and raceways. In fact, this is advisable even where there is no danger of overheating, as it has been found that small fingerlings usually do better when given an opportunity to escape from the intense heat of the sun.

Where the soil is light and porous it is usually necessary to construct wooden or concrete sides for the raceways, but, unless absolutely necessary in order to retain the water, it is not believed that the bottom should be of concrete. A dirt bottom is to be preferred, although it is usually best to cover this with a layer of sand or gravel.

In addition to providing more natural conditions for young trout, raceways have a distinct advantage over troughs in that they require much less attention. Troughs must be cleaned at least once a day, but with raceways this is by no means true. In fact, even in heavily stocked raceways it is usually unnecessary to clean them oftener than once or twice a week, and I have known of instances when they were allowed to go for several weeks without any attention other than to clean the screens so that the water could circulate freely, and this without any apparent injury to the fish. In an experiment conducted at the bureau's Pittsford (Vt.) experimental hatchery, fingerling brook trout were allowed to remain in a raceway from April to October without its being cleaned during that time, and there was virtually no mortality throughout the summer. Moreover, the fish were more vigorous, better colored, and made more rapid growth than those held in troughs. There were about 6,000 fingerlings in the raceway, which was 4 feet wide, 37 feet long, and had an average depth of 10 to 12 inches. The water supply fluctuated somewhat but averaged from 20 to 30 gallons per minute. This experiment is mentioned not with the intention of advocating that raceways should not be cleaned frequently, but simply to show that extreme cleanliness is unnecessary under such conditions.

As a matter of fact, raceways, like polluted streams, have a remarkable capacity for self-purification, which is accomplished in much the same way. The excrement accumulates on the bottom and supports a luxuriant growth of small organisms, including bacteria, algæ, Protozoa, and insect larvæ, which quickly causes its disintegration, so that the organic compounds are reduced to nontoxic, inorganic substances. The decaying excrement contains large numbers of chironomid larvæ, of which trout are very fond, and these, together with algæ, form a not inconsiderable portion of the food of the young fingerlings. It is not improbable that this "natural" food is largely responsible for the greater vigor of fish reared under such conditions.

There is considerable difference of opinion among trout culturists with respect to the age at which the fingerlings should be removed from the troughs. Personally, the writer is strongly inclined to the opinion that under ordinary circumstances the sooner the fish are removed to raceways after they begin to feed the better.

Probably the most common practice at the present time is to hold the fish in troughs for several months and then transfer them to raceways or pools in early summer. This practice appears to be predicated largely on the fact that while in the troughs the fish are under more immediate control and can be watched more carefully than when in raceways. While this is undoubtedly true, it is questionable if this outweighs the obvious advantages that fish in raceways enjoy.

It is held by those who believe in keeping the fish in troughs for the first few months that when they are transferred to raceways early in the season there is always considerable loss, which can not be accounted for by the number of dead fish recovered. Consequently, when the fish are finally removed their number is always much less than is indicated by the mortality record. This is undoubtedly true, but if the raceways are properly constructed and the fish graded frequently (as they should be) and protected from enemies, it is believed that this discrepancy will be not much greater than if the fish were held in troughs over the same period. In virtually all cases the so-called "uncounted mortality," which has been emphasized so much, is due either to improper construction of the raceways, so that many of the fish are able to escape; to the attacks of enemies, such as fish-eating birds; or to cannibalism. The first two of these factors can be virtually eliminated by proper construction at comparatively small expense. It should be remembered that young fingerlings can wriggle their way through an almost inconceivably small opening, and all head and foot screens should be constructed accordingly. Protection from birds and other enemies can be secured by covering the raceways with wire netting.

In most cases it is probable that most of the "uncounted losses" are due to cannibalism, which is doubtless more rampant in raceways or pools than in troughs. It may seem paradoxical, but our experiments have shown that cannibalism is greatest among well-fed, rapidly growing fish rather than among those that are weak and underfed. Fortunately, cannibalism can be prevented by grading the fish at frequent intervals, so that only those of approximately equal size are held in the same compartment.

It is probably best in most cases not to transfer the fish to raceways until after they have learned to feed, although we have found in our experimental work that they can be taught to take food in raceways nearly as readily as in troughs. As previously pointed out, when the fingerlings reach a length of 3 to 4 inches they may be removed to pools that should be so designed as to simulate natural conditions as closely as possible. Pools with dirt bottoms are much superior to concrete, and unless the soil is of such a nature as to require wood or concrete sides these should also be dispensed with.

The size of rearing pools (fig. 2) will be largely dependent on local conditions, but in general it is believed that comparatively small pools are preferable. They should also be quite shallow, with a maximum depth of 3 to 4 feet, unless it is necessary to use a greater depth to prevent the water becoming too warm during hot weather. Needless to say, it is essential that the ponds have a copius supply of pure cold water, and they should be so constructed as to insure a good circulation throughout. The deepest part of the pond should be at the outlet, toward which the bottom should slope gradually from all sides, so that the pond can be easily drained and the fish removed with little trouble.

When the water supply is limited the ponds may be arranged in series, one below the other, which allows the same water to be used several times. Of course, this is objectionable from the sanitary standpoint, since a disease breaking out in the upper ponds would be transmitted immediately to fish in those below. For this reason it is not advisible to resort to such an arrangement unless it is made necessary by a limited water supply. However, with the exception of furunculosis, yearlings and older fish are seldom seriously affected by infectious diseases, and therefore the danger is not as great as would at first appear. It is well to bear in mind that, whenever ponds are arranged in series, fingerlings should never be placed in those receiving the drainage from ponds containing older fish. Yearlings and brood fish often harbor parasites, which, while not seriously affecting them, may produce disastrous results when transmitted to fingerlings.

CARE OF PONDS AND RACEWAYS

It is scarcely necessary to point out that raceways and rearing ponds should always be kept in a good, sanitary condition. No food should be allowed to collect on the bottom, and the excrement should be removed frequently enough to prevent the water from becoming polluted. It is difficult to give detailed advice, since the care necessary to keep pools and raceways in sanitary condition will vary widely with conditions.

As previously pointed out, ponds and raceways do not require such close attention as troughs, because a certain amount of filth is taken care of automatically without detriment to the fish. The efficiency of self-purification naturally will vary with the number of fish contained in the pools. If the fish are relatively few, it may be necessary to clean the ponds only at infrequent intervals. The writer has known of instances when fish were kept in ponds with a dirt bottom which was cleaned only at intervals of several months. Although there was an average of one 6 to 8 inch fish per square foot of surface area, there was no evidence that the fish were affected unfavorably.

Under ordinary conditions, however, the accumulated filth should be removed more frequently to prevent any injurious effects from the decaying excrement. When cleaning the pools every precaution should be taken to avoid injury to the fish. The practice of going over the bottom with a broom or some similar implement, and thus stirring up the material that has accumulated, is highly objectionable, as it always results in considerable injury to the fish. Moreover, this practice necessarily removes most of the algæ, which is in itself inadvisable. Unless unduly abundant, algæ have a beneficial effect, and their growth should be encouraged. There are no more efficient agents in keeping the ponds in a sanitary condition than the algæ and associated organisms. Not only do they aid in aerating the water and keeping it free from objectionable substances, but it is found that trout feed on them to a considerable extent, and they, no doubt, perform much the same function in the trout's metabolism as do vegetables in the human diet.

A much better and more logical way to remove the excrement and other filth on the bottom of the pools and raceways is to employ some suction device that will avoid stirring up the material or injuring the fish. If this is not feasible, the lowest part of the pool should be connected with a drain, through which most of the filth can be drawn off with little trouble.

In this connection a word of caution should be addressed to those who are about to clean pools in which excrement and, more especially, surplus food has been allowed to accumulate for some time. Under such circumstances a layer of decomposing material may form on the bottom, which does not appreciably affect the overlying water as long as it is undisturbed. This layer contains noxious gases and other toxic substances, which are liberated as soon as the material is moved, and if the fish remain in the pool there is danger that they may be killed. In such cases the fish should be removed from the pond before any attempt is made to disturb the filth on the bottom. Even after the pond has been cleaned it is best to allow the water to flow through it for a short time before the fish are returned. When practicable, it is best to drain all ponds occasionally and allow them to remain dry for several days. If this is done once or twice a year, the ponds will be in better condition than if kept filled continuously.

TROUT FOODS

There is probably no question on which fish culturists differ more widely than in regard to what is the most satisfactory food for trout. During recent years this problem has received much attention, but we are far from reaching any general agreement as to the best and most economical diet for fish of various ages.

It is safe to say that, with the exception of the water supply, no single factor is of more importance in determining the success or failure of a hatchery than the daily diet of the fish. If we are to have strong, healthy fish they must be provided with suitable food, and it is no small problem to determine what food or what combination of foods may be relied upon to give the best results under average conditions.

In any consideration of trout foods it should be remembered that rapidity of growth is not the only factor to be considered. Too often in the past this has been virtually the only criterion used in evaluating a trout food. Rapid growth is very desirable, but it should not be procured at the expense of the health and vigor of the fish. The Federal and State hatcheries are raising fish to be liberated in natural waters, where they will be obliged to fend for themselves. It is very doubtful if the fat, lazy, pot-bellied fish so often seen in hatcheries are as well able to care for themselves, when thrown upon their own resources, as are fish that have not been pampered or subjected to an abnormal forcing process. For stocking purposes we need hardy, vigorous fish that can adapt themselves quickly to their new environment.

It is important to bear in mind that the trout culturist does not have an unlimited number of foods at his disposal, from which he can pick and choose. He is, in fact, bound hand and foot by considerations of cost and supply. Any food to be considered seriously must be obtainable at a reasonable cost, and there must be an adequate supply available at all times.

Available trout foods can be divided into three groups. In the first group are included fresh meats, such as horse meat and the liver, lungs, and spleen of cattle, sheep, and hogs. The second group embraces various dried products of animal origin, while in the third group we have the vegetable products, including wheat middlings, low grades of flour, shorts, soy-bean meal, Mexican pinto beans, etc. In a recent survey conducted by the Bureau of Fisheries it was found that sheep plucks are used to a greater extent than any other single food. Horse meat, which is used chiefly in the West, ranks next to sheep plucks. Other products that are fed in large quantities are beef liver, beef lungs, pig liver, cereal products, and fish.

As in the case of higher animals and man, fish require a certain amount of proteins, carbohydrates, and fats in their diet as well as various inorganic substances, such as lime and salt. These mineral constituents, of which there are a large number, are just as necessary as the proteins and fats. In addition, fish, like higher animals, require vitamins, which, although present in very minute quantities, are necessary for their well-being. It has not been determined definitely whether or not fish require all the vitamins that are essential to the health of man, but until it is proved otherwise it is certainly advisable to assume that this is the case. A well-balanced diet should include these food constituents in the proper proportions to assure their being used efficiently and economically by trout.

Another factor that is essential to any trout food is its palatability. Obviously, if a food is to produce rapid growth it must be taken readily by the fish, and any attempt to force them to subsist on a food that is unpalatable will only result in failure. True, hunger may drive them to eat such foods in small quantities, but vigorous, rapidly growing fish can never be produced on such a diet. Our own experience has convinced us that this is the reason for the failure of some apparently good foods to yield satisfactory results. They may contain the proper proportions of proteins, carbohydrates, and fats as well as sufficient vitamins, but if they are not palatable the fish will suffer from partial starvation even though there is always a supply of the food available.

In any discussion of trout foods it is well to bear in mind that each species of trout presents a more or less independent problem, and that what may be true of one species does not necessarily apply to others. This is well illustrated by some recent experiments conducted by the Bureau of Fisheries, in which it was found that the addition of small amounts of cod-liver oil and yeast to the diet always proved beneficial in the case of rainbow trout, while with brook trout the results have just as consistently failed to show any benefit from the addition of these vitamin-rich products. Possibly the explanation of these diverse results may lie in the fact that rainbow trout appear to be more susceptible to vitamin deficiency than brook trout, and that the ordinary meat foods contain sufficient vitamins for the needs of the latter.

The following discussion of trout foods is based primarily on the requirements of brook trout, as this is the species used in most of the feeding experiments.

Although, as stated above, there is much difference of opinion among trout culturists as to the relative value of various food products, all agree that trout will not do so well for any length of time unless some fresh meat is included in the diet. This fact, which has been demonstrated time and time again, has recently led McCay and Dilley (1927) to postulate a hypothetical factor H, which is present in virtually all raw meats but is not found to any extent in cooked or dried products. The evidence for the occurrence of this hypothetical substance, which is easily destroyed by heat, is at present entirely indirect. Since there are other explanations that may be advanced to account for the failure of trout to flourish unless raw meat is included in the diet, it is believed that the presence of factor H should not be assumed without more conclusive evidence than has yet been forthcoming.

It has been the universal experience of fish-culturists that trout can be reared successfully on a straight meat diet, although there has been much difference of opinion as to which meat has given the best results. Everything considered, probably no food has given better results with young fingerlings than beef liver, and undoubtedly it would be used much more extensively were it not for the fact that its cost has more than doubled in the past two or three years. However, our own experiments with both brook and rainbow fingerlings have shown that, in general, a mixed diet is preferable to one composed of a single meat product, and that better results are obtained when beef liver is mixed with beef heart than when it is used alone.

There can be little doubt that the results attained with various meat products are dependent on both their chemical and physical structure, and the latter should not be ignored by any means. This probably accounts for the fact that beef heart has been found to be superior to beef liver as a food for advanced fry and very young fingerlings. The heart can be ground into very fine particles, which are easily swallowed by the young fish, while the liver forms a thick, mushlike material not so readily separable into discrete particles. Furthermore, a considerable percentage of the ground liver is readily soluble in water, and there is therefore quite a loss in food value from this source.

As the fish increase in size they are naturally able to ingest larger particles, and the food is devoured more quickly. Consequently, there is less loss from solution, and liver will now produce a faster growth than heart, although there is usually a higher mortality. By combining heart and liver in a mixed diet we find that the growth is virtually as great as with liver alone, while the mortality is comparable to that of fish kept on a straight heart diet.

Pig liver and sheep liver, when fed straight to young fingerlings, has not given good results in our experiments. However, sheep liver produced a better growth with rainbow than with brook trout, although even with this species the results were not as satisfactory as with beef liver and beef heart. Both pig and sheep liver give better results when mixed with other products than when fed alone.

Horse meat, although used in large quantities by commercial growers in the West, has not been tested in carefully controlled experiments, so we have no means of comparing it directly with other trout foods. However, many growers report excellent results in feeding this product.

While only a few meats have been fed successfully to small fingerlings, a considerably greater variety is available for fish 3 to 4 inches long and upward. Fish of this size do much better on pig and sheep liver than very young fingerlings, and beef lungs and sheep plucks may also be fed successfully. Here again, however, a mixture of two or more kinds of meat usually gives better results than one alone.

Fresh fish of the coarser and cheaper grades have been utilized to a considerable extent for trout food, but in most cases the results have not been entirely satisfactory. It usually requires about twice as much fish as meat to produce an equal growth, and the trout are often not as healthy as those on a meat diet. Furthermore, it is much more difficult to keep fresh fish in good condition than meat, and several instances of trout having been killed by eating decayed fish have come to the writer's attention.

Owing to the marked increase in the price of most fresh meats during recent years it is believed that it is not economical to feed a straight diet of fresh meat to fish over 3 to 4 inches long, as fish of this size will thrive on a ration composed partially of dried products. Such a ration is much cheaper than one made up solely of fresh meat and in many cases will give virtually as good results and possibly even better.

The dried products that have given best results when substituted for part of the fresh meat in the diet are those of animal origin. Quite a variety of such products are now available, although, unfortunately, some of the best can be obtained only in limited quantities at present. Among the animal meals that have given sufficiently encouraging results in the bureau's experiments to justify their further consideration as trout food may be mentioned clam meal, shrimp meal, haddock meal (also called white fish meal), cod-liver meal, and dried skim milk. Probably there are other animal meals that should be included in this list but that have not been tested sufficiently in trout rations to justify an expression of opinion as to their probable value.

With the exception of clam meal and dried skim milk, the advisability of feeding these substitutes to small fingerlings is still somewhat questionable, and the writer would not advise using them on an extensive scale without a preliminary trial. Clam meal, which is composed of the dried refuse from clam canneries, has yielded by far the best results of any dried product used in our experiments. When mixed with beef liver and fed to small fingerlings the fish made a better growth than those fed beef liver and beef heart, which, with this exception, have given us the best results of any diet we have tried. The superiority of the clam-meal and beef-liver mixture was noticeable, both as regards growth and mortality; and the fish in this lot closely resembled wild fish in appearance, except that the coloration was not quite as brilliant.

Dried skim milk also produced excellent growth and low mortality when mixed with beef heart, and McCay and Dilley (1927) report equally good results with this product when combined with beef liver.

When combined with fresh meat, all of the substitutes mentioned above form a satisfactory food for larger trout, and the growth is often nearly, if not quite, as good as with a straight-meat diet. Moreover, there is no evidence that the health and vigor of the fish are impaired as a result of the use of these substitutes in the diet.

As previously pointed out, the cheaper meat products, such as pig liver, sheep liver, and sheep plucks, can be advantageously fed to large fingerlings and older fish instead of the more expensive beef liver and beef heart. These, when combined with animal meals, often give better results than when fed alone.

Below are shown the results of feeding experiments with yearling brook trout conducted at the experimental hatchery at Pittsford, Vt., for a period of 91 days. The dry meals were first mixed with water and then combined with ground meat in the proportions given.

Ration:	Per cent increase in weight, July 10 to Oct. 9
Pig liver 33⅓, clam meal 33⅓, shrimp meal 33⅓	209
Sheep plucks 50, clam meal 50	200
Sheep plucks 33⅓, clam meal 33⅓, shrimp meal 33⅓	190
Pig liver 50, clam meal 50	183
Pig liver	117
Sheep liver	112
Sheep plucks	51

A glance at the table will show that pig liver, sheep liver, and sheep plucks produced a much greater growth when mixed with clam meal and shrimp than when fed alone. Probably similar results could be obtained with haddock meal, cod-liver meal, or dried skim milk.

When using substitutes for meat, one of the most important problems is to determine the proportions of fresh meat and dry meals that will give the best results. Undoubtedly this will vary with the size and age of the fish and possibly with the species. Of course, from the standpoint of cost alone the smaller the percentage of fresh meat the better, but obviously there are limits to the extent to which meat may be replaced by a cheaper product; nor is it purely a matter of nutrition, since the physical consistency of the mixture must be taken into consideration. This factor has an important bearing on the readiness with which the food is eaten and also on the amount of nutriment lost in solution.

In preparing mixtures of fresh meat and meals it has been found best in most cases to first mix the dry meal with water to the consistency of a thick mush and then to incorporate it with the ground meat. When this mush is mixed with an equal quantity of fresh meat it forms a mixture of about the right consistency for feeding to small fingerlings. As most meals absorb from one and one-half to two times their weight of water, such a mixture contains about 15 to 20 per cent of the substitute, based on the dry weight. Our experiments indicate that this is about the maximum percentage of dried products that can be used successfully in the diet of young fingerlings.

Some trout culturists mix the dry meals directly with the ground meat, but it is believed that in most cases it is advisable to moisten the meal first. This is particularly true when a large percentage of the dried product is to be used. Owing to the ease with which dried skim milk dissolves in water it is necessary to add the dry milk directly to the meat, otherwise most of it will be lost.

It is well to bear in mind that, since fresh meats contain from 70 to 80 per cent of water, the addition of even a small percentage of dry meal directly to the meat greatly increases the amount of proteins, carbohydrates, and fats without a proportionate increase in bulk. In other words, such a mixture forms a more concentrated food than when the meals are moistened before mixing, and this fact should be taken into consideration in evaluating the mixture.

It is interesting to note that the animal meals that have been found to be of most value for trout are all rich in minerals and thus provide a class of food accessories in which meats are often deficient.

While it is not believed that it is advisable to use more than 50 per cent of moistened meals in the diet of young fingerlings, our experiments show that with older fish the percentage of fresh meat can be reduced considerably. As shown in the preceding table, a mixture of one-third meat with two-thirds clam and shrimp meal produced fully as rapid growth as when meat formed 50 per cent of the ration. Doubtless the percentage of meat could be reduced still further without affecting the fish adversely.

The vegetable products that have been used in trout foods include cereals and beans. Wheat middlings and low grades of flour are probably fed to a greater extent than other cereal products, although bran, shorts, and other meals also are utilized. These cereals are used to a much greater extent by commercial growers than by the State and Federal hatcheries. The reason for this is evident, as commercial growers are forced by stern necessity to use the cheapest food available with which they can obtain satisfactory results.

There is much difference of opinion as to the relative value of cereals and animal meals in the diet of trout and, unfortunately, we have but little experimental evidence bearing directly on the problem. Nevertheless, it is the writer's belief that the use of cereals in the diet of young fingerlings is inadvisable. This opinion is based on experimental evidence and also on the experience of years at the bureau's hatcheries. With such products as dried skim milk, shrimp meal, and haddock meal available at a reasonable cost it is not believed that it will prove economical in the long run to feed cereals to fingerlings. Such rapidly growing fish need relatively large quantities of food rich in proteins, which can be easily digested and assimilated.

In the case of older fish the evidence regarding the advisability of incorporating cereal products in the ration is not so clear. However, the fact that cereals are used to a much greater extent at commercial than at State and Federal hatcheries is in itself an indication that other foods are to be preferred where the comparative cost is not the deciding factor.

There is no doubt that trout can utilize cereals both for growth and maintenance, but to what extent they are able to do this has not been determined. While they are unable to digest raw starches, there is evidence that they can assimilate cooked starches to some extent, at least, as well as the proteins and mineral salts. When mixed with fresh meat cereals act as a "binder" and also absorb the meat juices, thus preventing waste by solution, and undoubtedly the results attained with cereals are partially due to this fact.

My own observations have led me to the conclusion that usually fish reared on a diet composed largely of cereals are not as strong and vigorous as those kept on a meat diet. There is a distinct tendency on the part of cereals to produce soft, fat fish, which may be satisfactory for market purposes, but it is doubtful if they are as suitable for stocking as trout that have been reared on a diet more nearly resembling their natural food.

There is also evidence that some species of trout may give better results with cereals than others. In our experiments rainbow trout have shown a distinct superiority over brook trout in this respect.

Experiments at the Pittsford (Vt.) hatchery with Mexican pinto beans, which are used to a considerable extent by western commercial hatcheries, gave satisfactory results with yearling rainbows, but with brook trout the growth was decidedly inferior to that produced by other substitutes. On the other hand, soy-bean meal gave much better results with brook trout than with rainbows. This meal is characterized by a high percentage of protein, which more closely resembles animal protein than other proteins from vegetable sources. It would, therefore, appear to be ideal for use in trout rations, but so far our experiments have failed to show that it is superior to some of the other vegetable products.

All cereals and beans should be cooked thoroughly before being mixed with meat. Cooking increases the digestibility and improves the consistency, so that these products can be fed to better advantage after cooking than before.

As previously mentioned, the use of cod-liver oil to supply vitamin deficiencies in the diet has given diverse results with brook trout and rainbow trout. Experiments with rainbow fingerlings have shown that the addition of 1 to 2 per cent of cod-liver oil to the ration almost invariably produces beneficial results. With brook-trout fingerlings the results have just as consistently failed to show any benefit from the addition of the oil to the diet (Davis and James, 1924). Many trout culturists, however, make a practice of adding regularly a small percentage of cod-liver oil to the diet of both brook and rainbow trout and believe that the results are beneficial. At some hatcheries the oil is used only two or three times a week, but in larger amounts. It is claimed that in this way a greater laxative effect is obtained, which is considered a desirable feature. When trout are fed a well-balanced diet containing a considerable percentage of fresh meat it is believed that the use of dried yeast with the oil is unnecessary.

FEEDING METHODS

Meat and other foods should always be ground fine enough to be readily swallowed by the fish, but this is a matter that can be easily overdone. When the advanced fry begin feeding there is little danger of getting the food too fine, and it should be forced through the finest plate of the grinder several times in succession. As the fish increase in size they are able, of course, to swallow larger particles, and, if the food is not ground so fine they will take it more readily and less will be lost in the surrounding water.

In feeding small fingerlings most fish-culturists add a small amount of water to the food, so that the particles will separate readily in the water. However, some insist that it is better to place small portions of food at intervals on the bottom of the troughs, where the fish can break it up at their leisure. If carefully done, there is probably less loss by the latter method, but it is questionable if all the fish have an equal opportunity to obtain food.

When the fish begin feeding it is customary to feed at least five to six times a day, but as they grow older the number of feedings may be decreased gradually, and two meals a day are sufficient for the larger fingerlings. Older fish usually are fed once a day, although when a very rapid growth is desired it is probably better to feed both in the morning and at night. Of course, when the fish are fed twice a day it is not advisable to feed as much at one time as when they receive only one meal in 24 hours. Needless to say, the food should always be distributed over a considerable area, so that the fish will all have an equal opportunity to get their share. In feeding fish of any age it is always a good rule to give them only as much food as they will eat readily. It is very poor practice to allow food to accumulate on the bottom, because not only is such food a total loss but it will soon begin to decay and cause trouble.

Experiments at the Pittsford hatchery indicate that there is virtually no danger of overfeeding brook fingerlings under ordinary circumstances. In fact, it was found that the mortality was greater among fish that were slightly underfed than among those that were given all they would eat at each meal. There is evidence, however, that this does not necessarily apply to yearlings and older fish and that there is actual danger of overfeeding fish of this age, especially if the temperature of the water is relatively high and the fish sluggish. There is also probably a difference in different species in this regard. As every trout-culturist knows, rainbow trout are usually much heavier feeders than brook trout, and consequently there is more danger of overfeeding.

When trout are to be handled or transported any distance it is always advisable not to feed them for some hours previously. This serves a twofold purpose: There will be less excrement to accumulate in the cans and cause trouble, and the fish will stand handling better than if they had been fed recently.

IMPROVEMENT OF STOCK

One of the most important phases of trout culture and one that, remarkably enough, has received relatively little attention, is the necessity for improvement of the brood stock if we are to get the best results. Everyone recognizes that continuous and rigid selection is necessary in the case of domesticated animals and plants, but few seem to have realized the importance of this principle in trout culture. Indeed, the tendency in many cases has been in the opposite direction, for some of our commercial growers have marketed their best and largest fish and saved the remainder for breeding purposes.

On the other hand, some trout culturists have taken pride in building up a superior stock of brood fish, but usually the selection has not been carried on systematically for a term of years, as must be the case if permanent results are to be obtained.

Embody and Hayford (1925) have published a preliminary report on some breeding experiments with brook trout carried on at the New Jersey State hatchery. These experiments were conducted for the purpose of increasing the resistance of the fingerlings to disease and also to increase the rate of growth. By rigid selection they were able, in three generations, to produce an apparent increase in the resistance to disease and also marked improvement in the rate of growth. As a result of selection the average size of the fingerlings on July 1 jumped from 2 to 4 inches in length. This is certainly a remarkable result for only three generations of selective breeding and indicates what may be accomplished if the experiments are continued for a term of years.

The Bureau of Fisheries has recently embarked on an extensive program of selective breeding at its experimental hatchery at Pittsford, Vt. This work is to be carried on by mating individual fish rather than by mass selection as practiced by Embody and Hayford. The experiment has not been under way long enough to have yielded definite results, but there is no reason to doubt that it will be possible in this way to build up strains of fish much superior to the ordinary hatchery stock.

It has been found already that the young from a single pair are usually much more uniform in size than fish of mixed parentage, and that the offspring of different pairs show marked differences in the rate of growth under practically identical conditions. This was true even though the parent fish might differ but little in size or other characters. It is also notable that the young of certain parents showed much smaller losses than the young from other pairs that were apparently equally vigorous.

There is considerable evidence to show that, in general, much better results can be obtained when a hatchery produces its own eggs than when the eggs are obtained from outside sources. This appears to be due to differences in the environment and indicates that eggs produced under certain conditions will develop much better and produce more vigorous young under the same conditions than when transferred to a different environment. Conditions at trout hatcheries vary widely as regards temperature of the water, dissolved minerals and gases, and other factors. In spite of such variations, experience has shown that most of them provide favorable conditions for trout, and it would be impossible in many instances to say which conditions are the best for trout culture. Undoubtedly, trout can flourish under a wide range of environmental conditions, but it does not follow that fish that have become acclimatized to one set of conditions can withstand an abrupt change to a quite different environment without detrimental effect.

This has been very noticeable at the Pittsford experimental hatchery, where brook-trout eggs from several sources have been hatched in adjoining troughs and the young reared under virtually identical conditions. In nearly every instance the local fish have suffered much smaller losses from various diseases than those hatched from eggs produced elsewhere. There have also been noticeable differences in this respect among fish hatched from eggs from different outside sources. There is no reason to believe that the diseases in question were brought in with the eggs, as they have been prevalent at this hatchery for years. The most logical explanation is that the vigor and vitality of the fish were affected by the changed conditions.

In view of these facts it is evident that for the best results the trout culturist should produce his own eggs from carefully selected stock. Of course, it is recognized that in many instances this may be impracticable for one reason or another. In such cases it will probably be found that eggs from certain sources usually do better than those from others, and the trout culturist can govern himself accordingly.

PARASITES AND DISEASES

The parasites and diseases of trout constitute one of the most important problems with which the fish culturist has to deal. Wild trout are only rarely seriously affected by disease caused by the presence of parasitic organisms. No doubt this is due primarily to the conditions under which they live in nature. The swift, cold waters of the typical trout stream are about as poorly adapted to the development and diffusion of trout parasites as could be imagined. When wild trout are injured by parasites and infectious diseases it is ordinarily fish living in ponds or lakes, where conditions are more conducive to the spread of parasites, that are affected.

When trout, or other fish for that matter, are herded together in hatcheries, conditions are reversed, and exceptionally favorable opportunities are afforded for the development and spread of the numerous parasites and diseases to which trout are susceptible. Of course, this is simply another application of the well-known principle that in the domestication of animals and plants we are, to a certain extent, running counter to natural laws, with the penalty of eternal vigilance, which this entails.

There is no reason to believe that the various parasites and diseases that are found at hatcheries have developed as a result of the domestication of trout. Undoubtedly, they all occur to some extent in wild fish, to which they ordinarily cause little or no injury; but when the fish are crowded together in hatchery troughs or pools there is every opportunity for the rapid increase and spread of parasitic organisms, resulting in the outbreak of epidemics with consequent heavy losses.

The control of these parasites and diseases is a problem of the greatest importance, and no trout culturist can hope to cope with them successfully unless he is familiar with the more essential facts. In the following pages no attempt has been made to deal with the subject in a technical or exhaustive manner. On the contrary, the sole object has been to give the essentials regarding each disease in as nontechnical terms as possible, so that the fish-culturist may be prepared to deal with it intelligently should the necessity arise, as, no doubt, will frequently be the case.

The great majority of the infectious diseases of trout are caused either by bacteria or Protozoa. As is well known, the bacteria are very minute organisms usually classified as plants, although they possess many characteristics that differ widely from those ordinarily associated with plants in the popular mind. On the other hand, the Protozoa are regarded as animals; but here, again, we must note that they are very different from the popular conception of an animal. The Protozoa are all very small, although much larger and more highly organized than the bacteria. Some of the larger Protozoa are visible to the naked eye, but the great majority are strictly microscopic, and some are visible only under a comparatively high magnification. The only characteristic that the Protozoa can be said to possess in common is that they are all composed of only a single cell, although even here, as in the case of the Myxosporidia, which are characteristic fish parasites, the distinction sometimes breaks down. Of more importance from the practical standpoint is the fact that the Protozoa are usually very delicate organisms easily killed by drying or by chemical agents. Many of them have a very complicated life history, a knowledge of which is essential to the devising of effective methods of control.

In addition to bacteria and Protozoa, the parasites of trout include several species of worms; but these are usually not as injurious as the former. In fact, Gyrodactylus is the only parasitic worm that ordinarily has to be considered by the trout culturist. Belonging to quite a different group is the parasitic copepod Salmincola, which is a member of the great group of Crustacea, a group that includes the "water fleas," crabs, crayfish, and shrimp.

Among the plants the only parasites, aside from bacteria, that affect trout are the water fungi, or Saprolegnia, which may attack fish under certain conditions. As fungus is always easily recognized, infections by this parasite have assumed an importance among fish-culturists out of all proportion to its actual potentialities for harm. Usually the appearance of fungus is an indication of the presence of some less conspicuous and more insidious agent, which is the real cause of the trouble. In other words, the appearance of fungus is a warning signal that no fish-culturist should disregard, but which in itself is relatively unimportant.

It not infrequently happens that fish may be affected at one time with two or more entirely distinct diseases. This, of course, complicates the situation and results not only in a much higher mortality than would otherwise be the case, but also greatly increases the difficulties of control.

From the practical standpoint it is of the greatest importance whether any particular parasite is external or internal. If it is an external parasite—that is, lives on the body, fins, or gills of the host—it is possible in most cases to apply some chemical that will destroy the parasite without serious injury to the host. Many substances have been employed for this purpose, the most widely used being a solution of common salt (sodium chloride). This is a very effective treatment for such delicate organisms as Protozoa and fungi but is ineffective when dealing with bacteria and such resistant animals as worms and copepods. In hatchery practice the salt is usually simply distributed throughout the trough, the water supply having previously been cut off. When the fish begin to show signs of distress and turn on their back or side the water is again turned on and the fish quickly recover. As it is impossible to control accurately the strength of the solution under such conditions, a better method in some instances is to dip the fish for a short time in a 3 per cent solution. This method requires less salt and the treatment can be controlled more readily.

Other chemicals extensively used for killing external parasites are copper sulphate and potassium permanganate. These chemicals are especially indicated when dealing with bacterial infections but are also effective against Protozoa. They are sometimes used in a very weak solution (1 part of the chemical to 50,000 to 100,000 parts of water), in which it is necessary to allow the fish to remain some time in order to kill the parasites. Weak as they are, these solutions will also kill the fish if they are allowed to remain immersed too long.

Owing to the labor involved and the danger of seriously injuring fish by leaving them for too long a time in a weak solution, the writer believes that in most instances it is preferable to use a much stronger solution, in which the fish are immersed for a very short time. Since the fish must be closely watched during the process, it is felt that there is less danger of their being badly injured than when a weaker solution is used, and the treatment is certainly as efficient, if not more so, in its effect on bacteria or other parasites.

In treating trout with copper sulphate, a solution of 1 part copper sulphate (by weight) is dissolved in 2,000 parts of water. The fish should be dipped in the solution for one or two minutes and then transferred at once to running water. They will at first show very evident signs of distress but in most cases will recover fully in a short time. Even small fingerlings, unless they have been weakened previously by disease, are not permanently injured by the treatment if it is carried out properly. If the disease is well established, many of the fish may be so weakened as to be killed by the treatment, but such fish would undoubtedly have died in any event. Healthy, vigorous trout will survive immersion in a 1 to 2,000 solution of copper sulphate for several minutes.

If a galvanized vessel is to be used for the solution, it should first be painted on the inside with asphaltum or some similar substance to prevent any chemical action between the copper sulphate and the walls of the vessel. It is more convenient to use the pulverized form of copper sulphate, which dissolves very rapidly, so that the solution is immediately ready for use. To guard against deterioration it is always advisable to make up a fresh solution immediately before it is to be used. The solution rapidly becomes weakened with use and consequently should be renewed frequently.

Probably the most convenient method of treating the fish is to handle them in a dip net, which can be lowered into the solution, taking care that the fish do not escape from the net. By this method it is possible to treat a large number of fish in a comparatively short time.

The control of diseases caused by internal parasites presents quite a different problem, because in most cases it is impracticable to attempt the use of medicines. Good results sometimes follow a change in the diet or the addition of some such substance as cod-liver oil to the food, but in general the successful control of such diseases must depend almost entirely upon prophylactic measures. It is most important to keep the fish in as healthy and vigorous condition as possible by providing suitable quarters with an abundant supply of cold, well-aerated water. Overcrowding should be avoided, and, of course, the greatest care should be exercised to provide a suitable diet. Every precaution should be taken to guard against infection from any source, and any implements or vessels that might possibly carry infection should never be used with healthy fish unless they have been thoroughly sterilized. It is especially important in the case of fingerlings that the water supply should not have come in contact previously with older fish. *Under no circumstances should fish of any kind be allowed in the spring from which a hatchery obtains its supply of water.*

Of course, the precautionary measures just mentioned are fully as important in the case of external parasites as in combating diseases caused by internal parasites, but they are emphasized here because they are virtually the only measures we have of dealing with diseases of the latter type. In the treatment of diseases the trout culturist must exercise eternal vigilance and be quick to recognize the first indication of an outbreak. Half the battle lies in the ability to diagnose a disease in its early stages and adopt appropriate measures for its control before it is too late.

For the sterilization of ponds and raceways, where large quantities of a disinfectant are required, either "bleaching powder," also known as chloride of lime, or freshly slaked lime (calcium hydroxide) should be used. Owing to its cheapness, the latter is ordinarily employed for the purpose and when properly applied is as effective as the "bleaching powder." The unslaked lime or "quicklime" may be used if preferred, but if the lime is first slaked by the addition of water it can be distributed much more evenly over the bottom of the pond. It can be applied in the form of a powder or as "milk of lime" (1 part of slaked lime to 4 parts of water). It should be kept in mind that calcium hydroxide unites with carbon dioxide in the air or water to form calcium carbonate, which has no antiseptic value, and for that reason it should be freshly prepared shortly before it is to be used.

Needless to say, solutions of slaked lime or of "bleaching powder" should never be allowed to come in contact with fish, as they are quickly fatal. On exposure to the air for a time the lime becomes converted into the carbonate, and in this form it is no longer injurious to fish. When practicable, a pond, after having been sterilized, should be allowed to dry out and be exposed to the sun for several days or, better, weeks. If it is not possible to do this, water should be allowed to flow through the pond for some time before it is used again for fish.

EXTERNAL ANIMAL PARASITES

GYRODACTYLUS

There is probably no external animal parasite that is more common and causes more injury to trout than the small trematode worms belonging to the genus Gyrodactylus. These worms occur at virtually all hatcheries, although only occasionally do they become sufficiently abundant to cause serious injury. It is probable that more than one species of these worms may infest trout, but, unfortunately, little attention has been paid to their specific characters. From the practical standpoint, however, it is of little importance whether there is one or several species, for there is no reason to believe that they differ essentially in their habits or in their effects on the fish. They are not confined to trout, by any means, but may occur on various species of fresh-water fishes, although some of these are more susceptible than others.

DESCRIPTION OF PARASITE

Gyrodactylus may occur almost anywhere on the host but is usually most abundant on the fins, especially the dorsal and caudal fins. The affected surfaces become covered with a bluish-gray slime due to an increased secretion of mucus. Later, if the parasites are very abundant, the fins become badly frayed and may eventually be worn down to mere stubs, while open sores may appear at the base of the fins. These lesions often become infected with fungus, so that in late stages of the disease there is frequently a considerable growth of fungus on the fins and body. Gyrodactylus can be found easily by scraping off some of the slime from the affected parts and examining it under the microscope. The worms will be seen in rapid movement, twisting and squirming about in every direction.

If the fish is examined in water with hand lens, the worms can usually be seen without difficulty, attached by one end to the fish and waving the body back and forth, or they may be crawling about slowly in the same manner as a "measuring worm." Fish infested with Gyrodactylus can often be seen rubbing themselves against the sides or bottom of the pond in an evident effort to rid themselves of the worms. In fact, this is one of the most reliable indications of the presence of the parasite.

When examined under a low magnification (fig. 3) the worm appears as a small, transparent object armed at one end with a pair of large recurved hooks. Surrounding the paired hooks is a flattened,

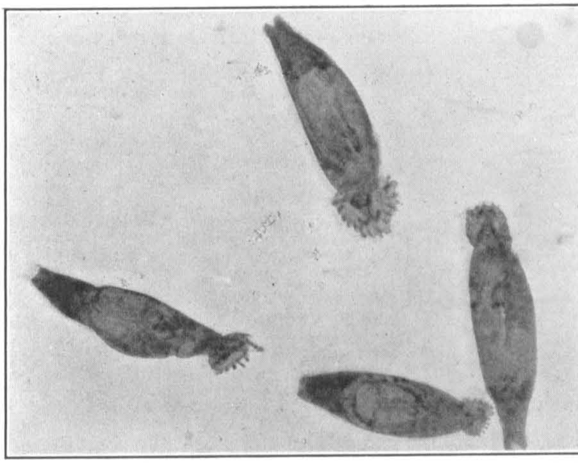


FIGURE 3.—Photomicrograph of Gyrodactylus from trout. Magnified 85 diameters

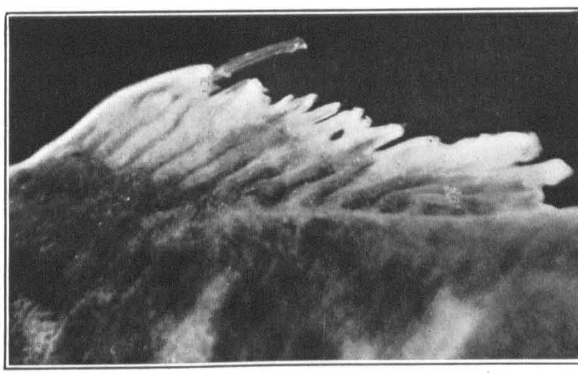


FIGURE 4.—Dorsal fin of fingerling trout infected with fin rot. Magnified 7 diameters

FIGURE 5.—Parasitic copepods (*Salmincola edwardsii*) attached to gill filaments of adult trout. Magnified 7 diameters

disk-shaped structure bearing a number of small hooks on its outer margin. It is by means of these hooks at the posterior end of the body that the worm is able to cling to the host, the hooks being embedded in the epithelium. At the anterior end the body terminates in two short lobes.

Unlike most parasitic worms, Gyrodactylus does not lay eggs. On the contrary, it gives birth to living young, which are already well developed and immediately attach themselves to the host. The young in various stages of development can usually be seen within the body of the mother, the large paired hooks being especially prominent.

CONTROL MEASURES

Although Gyrodactylus probably occurs at all trout hatcheries, for some unexplained reason many hatcheries appear to experience little trouble from the parasite while others suffer from frequent outbreaks. Fortunately, the parasite is easily controlled by dipping the fish in an acid bath. Salt solutions, which are frequently resorted to, are ineffective, although the fish may be benefited temporarily.

The late George A. Seagle, superintendent of the Wytheville (Va.) hatchery, first developed a successful treatment, in which the fish were placed in a solution composed of 1 part vinegar to 16 to 20 parts of water. This solution will kill the parasites without serious injury to the host, but since the effective agent is acetic acid, the concentration of which varies considerably in different samples of vinegar, it is better to make up a solution of acid of known strength. This treatment has been worked out carefully by Dr. G. C. Embody (1924), who used a solution containing 1 part glacial acetic acid to 500 parts water. When the fish are immersed in this solution for one minute virtually all the worms are killed without permanent injury to the fish. Doctor Embody found that an ordinary washtub about half filled with the solution was sufficient to treat about 1,000 trout 3 to 6 inches long. Since the solution rapidly becomes diluted with use after 400 to 500 fish have been treated, the rest should be allowed to remain in the solution for one and one-half to two minutes. If the fish are also affected with fungus, it is advisable, after a short time, to follow the acetic-acid treatment with a salt bath.

DISCOCOTYLE SALMONIS

Discocotyle salmonis is a trematode worm somewhat similar to Gyrodactylus but can readily be distinguished by its much larger size and dark brownish color. Unlike Gyrodactylus, it occurs only on the gills, and the worms are usually crowded in among the filaments, where they are not easily seen unless a careful examination is made. The worms, which are about 3 to 5 millimeters long, are easily visible to the naked eye. The posterior end of the worm is modified into a flattened disk, which bears on each side a row of four suckers armed with small hooks. This forms an efficient attachment organ, by means of which the parasite clings to the gills and is very difficult to dislodge.

The parasite injures the fish by sucking blood from the gills and through irritation of the tissues at the point of attachment. The gills of infested fish are usually light colored, with an excessive secretion of mucus. When abundant the parasites may cause an acute anemia, which eventually results in the death of the host.

Nothing is known of the life history of this worm, but from analogy with related forms it is probable that the eggs, surrounded by a tough resistant shell, are laid between the gill filaments of the host, where they remain until hatched. There is no evidence that Discocotyle has an intermediate host, as is the case with internal parasitic trematodes. It is not impossible, however, that the eggs may occasionally drop from the gills and develop on the bottom of the pond. The worms apparently develop very slowly, since trout do not become infested to any extent until they are 2 years old.

This parasite was first described by Elmer Schaffer in 1916 from rainbow trout at the State hatchery, Cold Spring Harbor, N. Y. Later it was found on brook and rainbow trout at other hatcheries, but so far as the writer is aware it has been reported only from Long Island, where it is evidently firmly established.

CONTROL MEASURES

The acetic-acid treatment, which is so effective in the case of Gyrodactylus, is of no value in combating Discocotyle. The latter is much more resistant to the acid solution than the former species, and a solution strong enough to kill it usually causes the death of the host as well. Furthermore, the great majority of the worms lie between the gill filaments, where they are more or less protected from contact with any solution.

According to Laird (1927), the parasites can be successfully controlled by the use of Zonite. A solution composed of 1 part Zonite to 5 parts water is sprayed directly on the gills of infested fish by means of an atomizer. In using this treatment it is necessary to handle each fish individually, the lower jaw being bent back so that the gills are separated. If this is not done, many of the worms will not be reached by the spray.

In Europe it has been found that a closely related species occurring on the gills of trout can be destroyed by immersing the fish for one to one and one-half minutes in a saturated solution of common salt. It is claimed that the worms are virtually all killed, while the fish are not seriously injured by the short immersion in the salt solution. Apparently this treatment has not been tried in America.

PARASITIC COPEPODS

Several species of parasitic copepods occur on trout and salmon, but by far the most common form is *Salmincola edwardsii*, which is widely distributed throughout the East and Middle West. This species is the only one whose life history has been worked out, but since the other species occurring on trout are very closely related it is not probable that their behavior and life history is essentially different from that of *S. edwardsii*.

The copepods are small Crustacea, the majority being free-living forms abundant in both fresh and salt water, where they form an important item in the diet of many food and game fishes.

DESCRIPTION AND LIFE HISTORY

Salmincola edwardsii occurs only on brook trout, rainbow and brown trout being immune. The parasites are attached to the gills, where they can easily be seen with the naked eye. (Fig. 5.) They are quite large, measuring several millimeters in length, and are yellowish white in color. The anterior end of the parasite is attached to the gills by means of a special organ developed from the mouth parts. The end of this attachment organ bears a bulb-shaped enlargement, which is inserted in the gill filaments, firmly anchoring the parasite in place. Posteriorly each copepod bears a pair of long egg sacs, within which the embryos undergo complete development. The parasites ordinarily seen attached to the gills are all females. The males are much smaller and are not seen unless specially looked for.

When the young are fully developed the egg sacs break open and the larvæ escape into the water as minute, free-swimming organisms closely resembling the free-living copepods, which form such an important constituent of the plankton. They are less than a millimeter in length, very active, and swim about with rapid, darting movements. They may remain in this free-swimming stage for about two days, constantly searching for trout on which to attach themselves. If a suitable host is not found within this time, they are unable to develop further and soon perish.

Each larva possesses powerful mouth parts and a peculiar attachment filament, by means of which it is able to rasp a hole in the gill tissues, in which the enlarged end of the filament is inserted and soon becomes embedded. After attachment the parasite undergoes rapid degeneration, in which it loses its swimming feet and all evidence of segmentation, the abdomen becoming converted into a rounded, saclike structure.

About two or three weeks after attachment the parasites become sexually mature. Mating then takes place, after which the diminutive males drop off and die. The female, however, lives on for several weeks, increasing enormously in size and undergoing still further degeneration. The young are liberated in about a month after the eggs are fertilized. Each female ordinarily lays two batches of eggs, after which she dies and gradually disintegrates. Under ordinary conditions the entire life cycle is completed in about two and one-half months.

While attached to the gills the parasite injures the fish by sucking large quantities of blood and also by mechanical injuries to the tissues, which sometimes result in secondary infections with fungus. When only a few parasites are present they do comparatively little harm, but when they become very abundant, as is likely to be the case under the crowded conditions in hatchery ponds, the fish are greatly weakened and large numbers eventually succumb.

Usually adult fish are more heavily parasitized than fingerlings or yearlings, and the heaviest losses occur during the spawning season, when the vitality of the fish is low and they are consequently unable to resist the heavy drain on the system caused by the presence of the parasites.

Copepod parasites have been found frequently on wild trout in various parts of the country but are apparently rarely abundant enough to cause serious injury. This can be readily understood, since under natural conditions it is evident that only a very small percentage of the larvæ would be able to attach themselves to the proper host. In hatchery ponds conditions are different. Here the fish are crowded closely together in a limited area with a relatively small flow of water, so that there is every opportunity for the free-swimming larvæ to find a suitable host, even though this must be accomplished within a comparatively short time.

CONTROL MEASURES

When once firmly established at a hatchery this parasite is very difficult to control. The chief difficulty lies in the fact that, like most Crustacea, the copepods are covered with a tough, resistant, chitenous membrane, which is not penetrated easily by chemicals. Consequently the parasites are uninjured by solutions that seriously affect the more delicate gill tissues to which they are firmly attached. It is therefore impossible to kill them by treating the fish with chemical solutions, as in the case of most external parasites. There is one exception to this statement that may be utilized to advantage: The larvæ are comparatively delicate and are killed in a few minutes by a strong salt solution; consequently, they can be killed while in the free-swimming stage or shortly after becoming attached, without injury to the host, but this treatment is obviously of only limited application. Owing to the large volume of water flowing through trout ponds, the cost of treating them with salt is usually prohibitive, since to be effective the treatment must be continued for some time. In the case of fingerlings frequent salt baths may be used successfully to prevent the fish from becoming parasitized, but even here it can be considered only a temporary expedient.

Fasten, to whose investigations we are indebted for most of our knowledge of this parasite, strongly recommends the installation of sand filters in all cases in which the parasites occur in the water supply. This will effectually prevent the larvæ from being carried into the ponds. Since adult trout are most heavily parasitized, Fasten also recommends that in badly infested hatcheries only 2-year-old fish be used for egg production, and that these fish be discarded immediately after spawning. Of course, this would necessitate rearing a new lot of brood fish each year, which would greatly increase the cost of the eggs.

The introduction of predacious minnows into the brood ponds has also been recommended. These fish feed on the larvæ of the parasite before they have an opportunity to become attached to a new host.

Since in most cases, at least, such methods would be only palliative and would not result in the eradication of the parasite, it would seem that in the long run it would be less expensive to get rid of all parasitized fish and start anew. Of course, in the case of hatcheries having a contaminated water supply such extreme measures would not be justified, unless at the same time an efficient sand filter is installed.

References: Fasten, 1912, 1918, 1921.

ICHTHYOPHTHIRIUS MULTIFILIIS

Ichthyophthirius is a parasitic protozoan that is quite common on pondfishes but is rarely injurious to trout. This is due to the fact that the parasite is unable to complete its life cycle where there is a rapid flow of water, so that it rarely becomes established in trout hatcheries. In a few instances, however, where the conditions were somewhat unusual this parasite has caused serious losses among fingerling trout.

The most characteristic symptom of the disease caused by this parasite, and known as ichthyophthiriasis, is the occurrence of small, grayish-white, sharply defined pimples or pustules on the body and fins. These pimples also occur on the gills but, of course, are not as readily observed as those on the body. The infected fish usually rub themselves against the sides or bottom of the pond in an effort to rid themselves of the parasite. As this is also a characteristic action of fish infested with Gyrodactylus, it should not be interpreted as a specific symptom of the disease. Heavily infested fish lose their appetite and float listlessly in the water.

The parasite can be identified easily by scraping off some of the pimples and examining the contents in water under a low magnification. They are exceptionally large for protozoans, attaining a diameter of nearly 1 millimeter, and can be distinguished with the naked eye as minute, rounded, whitish bodies swimming slowly about. Under the lens the parasites can be seen to be round or ovoid in shape and covered with an immense number of fine hairlike cilia arranged in rows, by means of which the animal is propelled through the water. At the anterior end is a small, circular mouth opening, while scattered throughout the body are numerous opaque granules and a number of small contractile vacuoles. Near the center of the body is a large, crescent-shaped nucleus.

Ichthyophthirius has a very interesting and complicated life history (Fig. 5a), a knowledge of which is essential in order to combat the disease intelligently. The young parasite is very small and quite different in appearance from the adult. It swims about actively in search of a host, and when it comes in contact with a fish it bores into the epidermis, attaching itself by one end of the club-shaped body and rotating rapidly so that it quickly displaces some of the epithelial cells. In this way the young parasite gradually works its way into the deeper layers of the epidermis, which grow over it, so that it finally lies in a closed space. If the young parasite is unable to find a fish, it dies within a few days.

Once embedded in the skin or gills of the host the parasite begins to grow rapidly and soon appears to the naked eye as the little white spot or pimple previously referred to. When full grown the parasite leaves the fish and drops to the bottom, where it soon forms a cyst by secreting a thin membrane around itself. Within the cyst it multiplies rapidly by division, and eventually a large number of minute young are produced, which are invisible to the naked eye. When reproduction is completed the cyst wall breaks open, releasing hundreds (in some instances thousands) of young, which immediately swim off in search of a new host.

CONTROL

Owing to the fact that during most of its life the parasite is embedded in the epidermis of the host, where it can not be reached by chemicals, Ichthyophthirius is more difficult to combat than most external parasites. When not embedded in the skin or gills it is easily killed by various chemicals, such as a 3 per cent salt solution or a 5 per cent solution of aluminum sulphate. In using salt, the

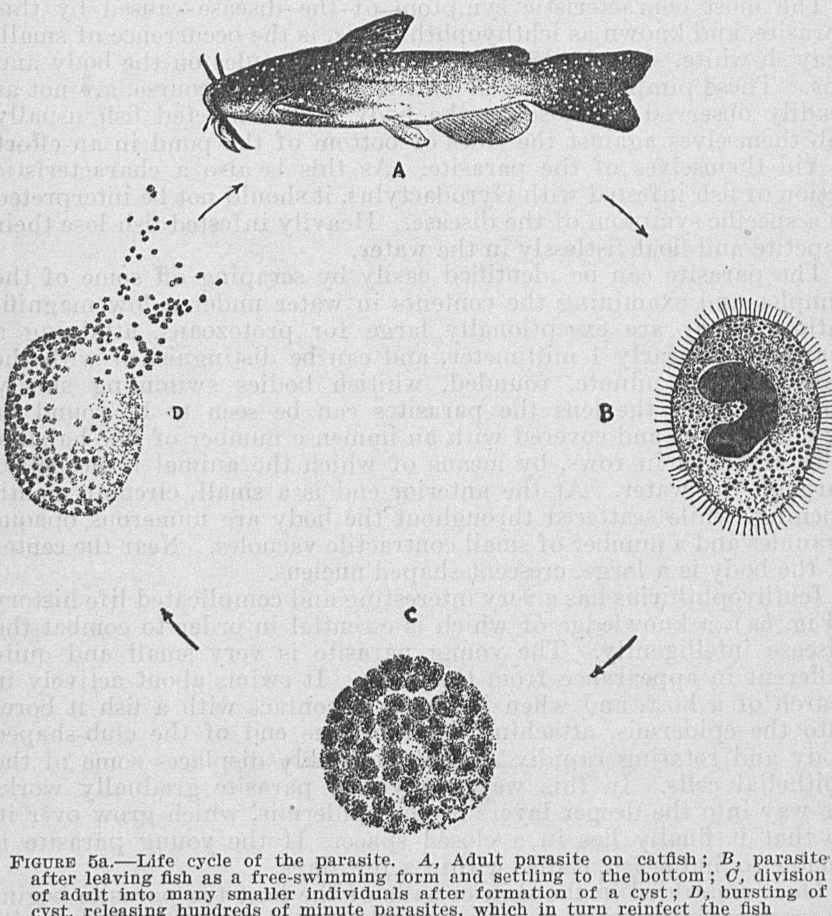


FIGURE 5a.—Life cycle of the parasite. *A*, Adult parasite on catfish; *B*, parasite after leaving fish as a free-swimming form and settling to the bottom; *C*, division of adult into many smaller individuals after formation of a cyst; *D*, bursting of cyst, releasing hundreds of minute parasites, which in turn reinfect the fish

fish may be dipped in the solution until they show signs of distress, or the salt may be added to the troughs in the usual manner. If aluminum sulphate is used, the fish should be dipped in the solution for one minute. Of course, it will be necessary to treat the pond in which the diseased fish have been held with salt or quicklime to kill any parasites that may be lying on the bottom. Since parasites embedded in the skin are not affected by the solution, it is necessary to treat the fish on several successive days in order to kill them as they emerge.

EXPLANATION OF FIGURES 6 TO 17

FIGURE 6.—Ventral view of *Chilodon cyprini*. The mouth opening leading into the pharynx is shown at the anterior (upper) end. Below the pharynx is the large nucleus, on each side of which is a small contractile vacuole. Magnified 740 diameters

FIGURE 7.—Ventral view of *Costia necatrix*, showing the two pairs of flagella. The only internal structures shown are the contractile vacuole and the smaller rounded nucleus. Magnified 1,600 diameters

FIGURE 8.—Side view of *Costia necatrix* showing attachment of flagella to wall of ventral groove. The internal structure is not shown. Magnified 1,600 diameters

FIGURE 9.—Mature cyst of *Octomitus salmonis*. Magnified 2,100 diameters

FIGURE 10.—View of Cyclochæta from the ventral side. A row of long hairlike cilia are attached to the outer margin of the ventral disk. Midway between the outer margin and the center of the disk is a complex skeletal structure composed of chitenous plates. Magnified 850 diameters

FIGURE 11.—Side view of Cyclochæta drawn on a smaller scale. Magnified 700 diameters

FIGURE 12.—Flagellate form of *Octomitus salmonis*. The deeply stained paired nuclei, surrounded by a lighter area, can be seen at the anterior end. Extending the length of the body are a pair of axostyles, to which are attached three pairs of flagella at the anterior end and a fourth pair at the posterior end. Magnified 2,100 diameters

FIGURE 13.—Epithelial cell, from the pyloric cæca of a fingerling trout containing an intracellular stage of *Octomitus salmonis*. Below the parasite can be seen the nucleus of the epithelial cell with its deeply stained chromatic network. Magnified 1,230 diameters

FIGURE 14.—Ameboid stage of *Schizamœba salmonis* from stomach of trout. Two large vesicular nuclei can be seen within the ameba. Magnified 1,640 diameters

FIGURE 15.—Cyst of *Schizamœba salmonis* showing method of division into several distinct parts, each of which contains several small deeply stained nuclei. Magnified 1,640 diameters

FIGURE 16.—Trophozoite of *Chloromyxum truttæ* from gall-bladder of trout. Magnified 800 diameters

FIGURE 17.—Mature spore of *Chloromyxum truttæ*. The pear-shaped polar capsules, each containing a small coiled filament, can be seen at one side of the spore. Magnified 2,500 diameters

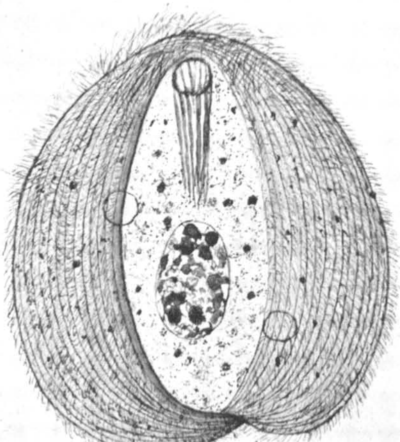


Fig. 6.

Fig. 7.

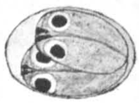


Fig. 9.

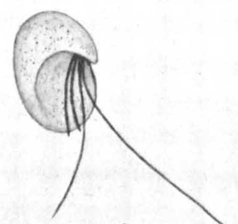


Fig. 8.

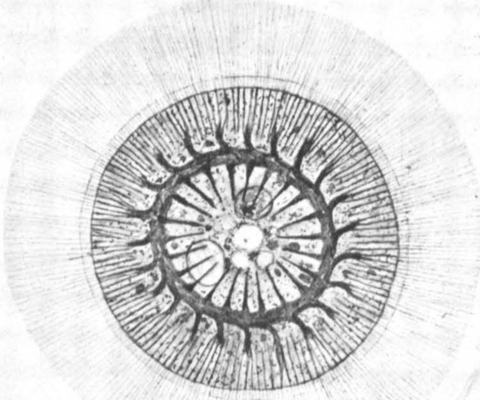


Fig. 10.

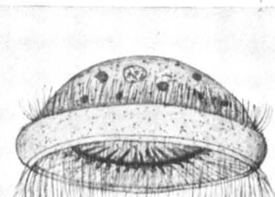


Fig. 11.

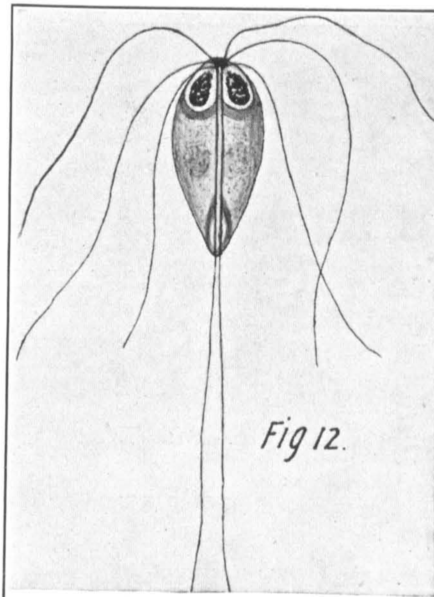


Fig 12.

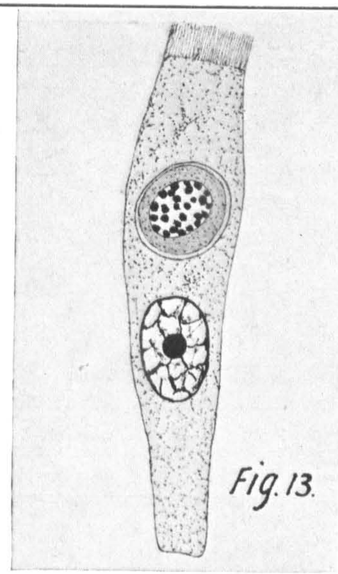


Fig. 13.

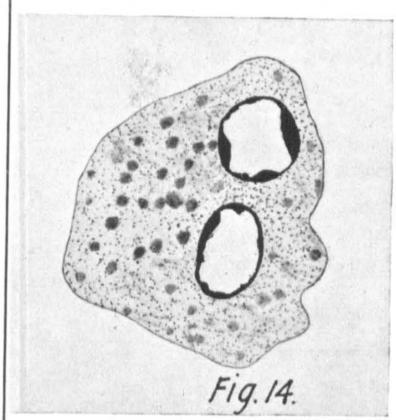


Fig. 14.

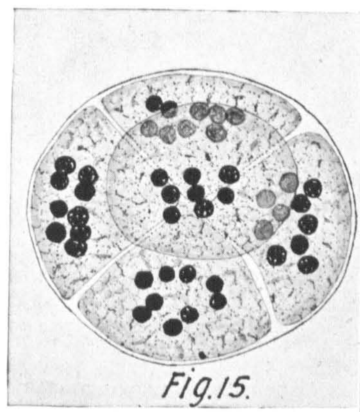


Fig. 15.

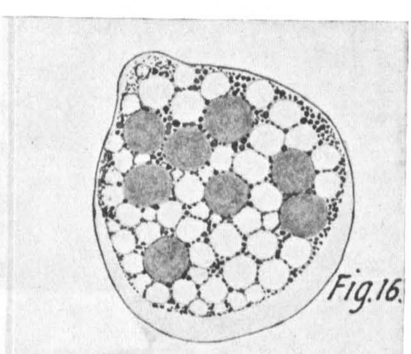


Fig. 16.

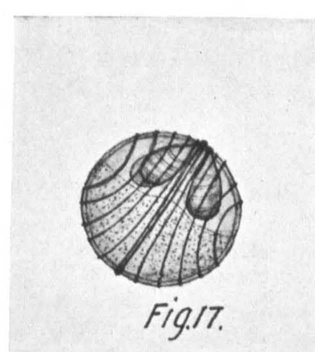


Fig. 17.

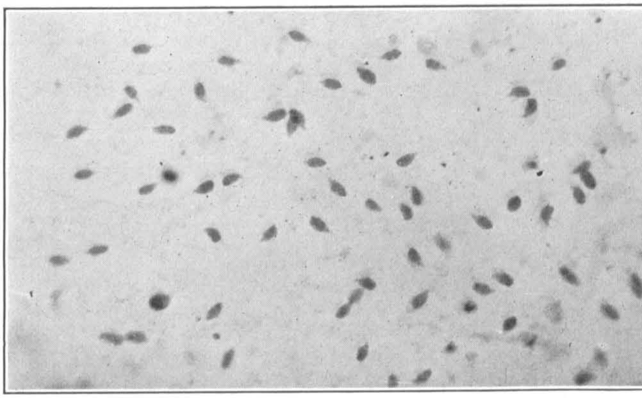


FIGURE 18.—Photomicrograph of a small drop of the intestinal contents of a trout infected with *Octomitus salmonis*. Magnified 360 diameters

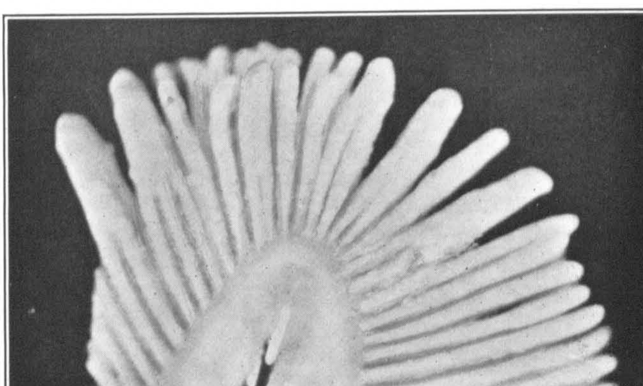


FIGURE 19.—Gills of fingerling trout affected with gill disease. Note that the gill filaments are enlarged at the ends, and in many instances adjoining filaments have become fused for some distance. Magnified 14 diameters

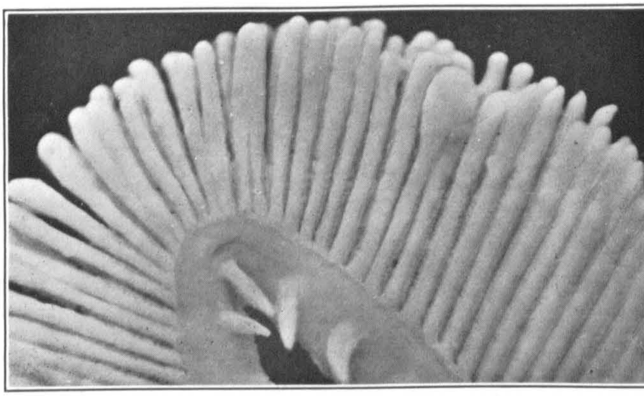


FIGURE 20.—Same as Figure 19

Owing to the difficulty of killing the parasites by means of external application of chemicals, a more practical method is to remove the adults as they leave the fish. This may be accomplished by holding the fish in swiftly running water, which carries the parasites away before they have an opportunity to multiply and reinfect the fish. This method can be adopted easily at any trout hatchery, as it is only necessary to hold the infected fish in troughs or raceways, through which a current of water is kept flowing. Of course, it will be necessary to hold the fish under these conditions for several days until all white pimples have disappeared.

Reference: Prytherch, 1924.

CYCLOCHÆTA

Cyclochæta, like Ichthyophthirius, is a ciliate protozoan. Unlike Ichthyophthirius, however, it does not burrow into the epithelium and is found only on the surface of the body, fins, and gills. Although usually present only in small numbers, it may occasionally become so abundant as to cause considerable injury to the host. It is frequently associated with Chilodon and Gyrodactylus.

Cyclochæta is different from any other parasite found on trout and can be recognized very easily. It is a small microscopic organism, discoidal in shape, with a flattened ventral side, by means of which it is attached to the surface of the fish. Under a hand lens it appears as a small, transparent, circular disk crawling rapidly about over the surface of the body and fins.

Cyclochæta has in reality a very complicated structure, which can only be made out under a comparatively high magnification. The flattened ventral surface, which is applied to the epithelium of the host, has a very remarkable chitenous skeleton composed of a series of chitenous plates forming a ring with processes extending from both the inner and outer side (fig. 10). A row of long, hairlike cilia is attached to the margin of the ventral disk, by means of which the animal moves about over the body of the host.

When the parasite is viewed from side (fig. 11) an additional row of cilia can be seen arising from a circular groove about midway between the dorsal and ventral surfaces. At one side this groove merges into a funnel-shaped mouth, which is not shown in the figure.

Cyclochæta multiplies by means of binary fission, in which the animal divides into two similar individuals of equal size. There is no evidence that it has an encysted stage, and the parasite is probably unable to live off the host for any length of time.

Cyclochæta is killed very easily; one treatment with a 3 per cent salt solution or with a 1 to 500 solution of acetic acid is ordinarily sufficient to entirely rid the fish of this parasite.

Reference: Plehn, 1924.

CHILODON CYPRINI

This is a protozoan parasite that occasionally occurs on trout and in some instances has been known to cause serious injury to fingerlings. It is a much more common parasite of pondfishes than of trout and is frequently very abundant on goldfish, causing serious mortality both among the young and adult fish. According to Moore (1924), two distinct species of Chilodon occur on trout.

Infested fish show little evidence of the presence of the parasite until they become very abundant, when the fish lose their appetite and show a tendency to lie on one side on the bottom of the trough. When the fish are examined with a hand lens the parasites can be seen as minute, colorless, flattened organisms creeping rapidly about over the surface of the fins, body, and gills. Under a higher magnification Chilodon appears distinctly heart-shaped (fig. 6), the anterior end being somewhat pointed, while at the posterior end there is a distinct indentation. This indentation is formed by a shallow groove, which extends forward on the ventral side to the mouth opening near the anterior end. The mouth opens into a short tube, the pharynx, the walls of which are supported by a number of chitenous rods. The surface of the body is covered with short, hairlike cilia, which are much longer at the anterior end. It is by means of these cilia that the parasite moves about over the body of the host. The cilia originate from a number of concentric lines extending from the anterior to the posterior end and which give the parasite a very characteristic appearance. The animal is about 75 microns long with a maximum width of about 50 microns.

Chilodon reproduces by binary fission, each individual dividing into two by a transverse constriction. Since under favorable conditions successive divisions may occur within a few hours, the parasites frequently increase very rapidly.

While Chilodon is often abundant over the entire body of a goldfish, in the case of trout it appears to be confined largely to the gills and fins. It does not appear to injure the host to any appreciable extent unless present in large numbers, but when abundant the parasite may be the cause of serious mortality among small fingerlings.

Chilodon can be controlled easily by dipping the fish for a short time in a 3 per cent solution of common salt or in a 1 to 500 solution of acetic acid. Usually one treatment is sufficient, but in bad cases it is advisable to give a second treatment on the following day. Since the parasites readily leave the fish, especially after the death of the host, the troughs or raceways should also be given a thorough treatment with the salt solution.

References: Moore, 1924; Plehn, 1924.

COSTIA NECATRIX

Costia necatrix is a small protozoan parasite that is not uncommon on pondfishes and occasionally may become so abundant on trout as to cause serious injury. When very abundant it produces a disease known as costiasis, which may be quickly fatal.

SYMPTOMS

Probably the most characteristic symptom of the disease is the appearance of a light bluish or grayish film, which spreads over the body and fins. The fish lose their appetite, become rapidly weakened, and die in a short time. These symptoms, however, are not sufficiently distinctive to enable one to recognize the disease with certainty without a microscopical examination. This can be made easily by scraping a small quantity of slime from the body and examining it in a drop of water under the microscope, using a comparatively high magnification. The parasites, if present, can be seen as minute oval bodies darting here and there with great rapidity.

DESCRIPTION OF PARASITE

Although very small, Costia has a complex structure, which can only be made out with considerable difficulty. The body is much flattened, with definite dorsal and ventral surfaces. When viewed from above it is oval in shape (fig. 7), with rounded anterior and posterior ends. The ventral surface is concave, with a deep oral groove extending obliquely from left to right across the body (fig. 8). This groove is much deeper on the left side, where it leads into the gullet near the anterior end. Two pairs of flagella arise from the groove where it opens into the gullet. One pair of flagella is much shorter than the other, extending only a short distance beyond the posterior margin of the body. The longer pair is two or three times the length of the body and of unequal length, one being about two-thirds the length of the other. These flagella are used for propelling the animal through the water and also for clinging to the epithelium of the host.

The parasites live on the skin and gills of the fish, where they destroy the epithelial cells, apparently feeding on the fragments. They multiply very rapidly and under favorable conditions quickly overspread the entire surface of the body and gills.

Since the parasites can leave the fish at will and swim about, for a short time, at least, it is obvious that under the crowded conditions at a hatchery there is every opportunity for them to spread rapidly from one fish to another. They may also form resistant cysts, which enable them to live for some time off the host.

CONTROL

Like all protozoan parasites that live on the surface of the body, Costia can be killed by salt baths. Since many of the parasites are embedded in the mucus, it is necessary to subject the fish to a somewhat longer exposure to the solution than in the case of Chilodon or Cyclochæta. An immersion of about 10 minutes in a 3 per cent salt solution will kill most of the parasites, but it is advisable to follow this with two or three baths at intervals of about three days to kill any that may have escaped the first treatment. The acetic-acid treatment may also be used and has the advantage that it requires only a short immersion in the solution, one minute in a 1 to 500 solution of glacial acetic acid being sufficient.

References: Moore, 1923; Plehn, 1924.

INTERNAL ANIMAL PARASITES

PARASITIC WORMS

Although quite a number of parasitic worms are known to occur in trout, they are, fortunately, very rarely so abundant in hatchery fish as to cause appreciable injury. This is in striking contrast to other types of parasites, which are almost invariably more abundant in trout at hatcheries than in those living under more natural conditions. The answer to this seeming paradox is, no doubt, to be found in the fact that almost all endoparasitic worms require at least two distinct hosts for the completion of the life cycle. The adult worm lives in an animal known as the primary host, whereas the larva is found in a very different animal known as the secondary or intermediate host. In some cases the worm requires more than one secondary host for its complete development. The larvæ can only develop to a certain stage in the secondary host, but should this animal be eaten by the primary host they are then able to complete their development in the latter.

Trout may serve either as a primary or as a secondary host but never as both with the same species of worm. Worms for which trout form the primary host usually occur in the larval stage in some crustacean, whereas those worms that utilize trout as the secondary host usually occur in the adult stage in fish-eating birds. This being the case, it is easy to understand that there is little opportunity for these parasites to complete their life cycle in hatchery fish that, for the most part, are fed on artificial foods and protected from predacious enemies.

All types of parasitic worms occur in trout, including flukes (Trematoda), tapeworms (Cestoda), roundworms or threadworms (Nematoda), and spiny-headed worms (Acanthocephala). The flukes are so small that they are seldom noticed, although they may occur occasionally in the intestine. A larval fluke (possibly a species of Holostomum) may form cysts in the skin. Since these cysts are surrounded with pigment, they appear as minute black spots, which, when abundant, are quite conspicuous. Similar cysts are common in the skin of yellow perch, minnows, and other pondfishes.

Ward and Mueller (1926) have recently described a form of "popeye" in black-spotted trout at one of the Oregon State hatcheries, caused by heavy infestation with the larvæ of a trematode worm. The larvæ formed minute cysts in various parts of the body and were so abundant as to cause heavy mortality. The protrusion of the eyes was apparently due to the presence of cysts in the optic nerve, as only those fish in which cysts were found embedded in one or both nerves showed the popeye condition. The enormous number of cysts found in this instance can probably be accounted for by the presence of snails in the nursery ponds. From our knowledge of the life history of closely related worms it seems very probable that this parasite requires two secondary hosts. The first is a mollusk (probably a snail) in which the parasite multiplies rapidly, after which it becomes encysted in fish, which form the second intermediate host.

A number of tapeworms have been reported from trout, probably one of the best known being the species described years ago by Leidy under the name *Dibothrium cordiceps*. The larvæ of this species are very common in the muscles and body cavity of trout in Yellowstone Lake and for that reason have attracted considerable attention. The adult tapeworm is found in the pelican, which is abundant at certain seasons. Fasten (1922) has found a similar worm to be very abundant in trout from certain lakes in Washington.

Another tapeworm, *Abothrium crassum*, which is common in salmon in both this country and Europe, has recently been found in considerable numbers at one of the Vermont State hatcheries. Only the adult worm is found in trout and salmon, where it lives in the pyloric region of the intestine.

Roundworms or nematodes are comparatively rare in trout. One species, *Cystidicola stigmatura*, has been reported frequently from salmonid fishes from the Great Lakes, and a similar parasite (probably the same species) has recently been found in brook trout from several streams in Pennsylvania. The small, white, threadlike adult worms, about 1 to 1½ inches long, live in the air bladder and are sometimes present in large numbers. The larvæ occur in the fresh-water shrimp (Gammarus).

The spiny-headed worms are characterized by a retractile proboscis, armed with numbers of recurved hooks, which is embedded in the intestinal wall, sometimes resulting in infection followed by severe inflammation. Like the tapeworms, the spiny-headed worms have no digestive tract, but unlike the former the body is small and unsegmented. One of these worms is sometimes quite abundant in European trout and is reported to have caused considerable mortality. The writer has seen specimens of brook trout from Newfoundland that were so badly infested with spiny-headed worms that they must have suffered considerable injury.

References: Fasten, 1922; Linton, 1891; Ward and Mueller, 1926.

OCTOMITUS SALMONIS

Octomitus salmonis is a small protozoan parasite that occurs in the intestine of trout and salmon. This parasite has received considerable attention during recent years because it has been shown to be the cause of serious mortality among fingerling trout in our hatcheries.

The parasite is widely distributed throughout the country, having been reported from trout hatcheries in many different localities, and it is probable that there are very few hatcheries at which it does not occur. It has not been found in wild fish except under circumstances that indicate that the infection was probably derived from hatchery fish. There is, however, no reason to doubt that the parasite does occur naturally in wild trout, but it is probably rarely sufficiently abundant to cause noticeable injury under such conditions. It is only when the fish are crowded together in the hatchery that Octomitus becomes a serious problem.

Octomitus salmonis has been found in all species of trout and salmon propagated artificially. In most cases it is more injurious to brook trout than to either rainbow or brown trout, although at a few hatcheries the rainbow appears to be more susceptible than the brook trout. It is notable that this is true only at hatcheries where rainbow trout are reared, and it is not improbable that under such conditions a physiological strain of the parasite has been developed that is more virulent for rainbow than for brook trout.

SYMPTOMS

Octomitiasis is not characterized by well-defined symptoms by means of which it can be distinguished readily from other ailments of trout. There are no external lesions, and the most common indication of the presence of the disease is the appearance of very emaciated fish commonly referred to as "pinheads." Many of the "pinheads" may improve after a time and eventually resume their normal rate of growth, but others gradually grow weaker and weaker until death supervenes.

More rarely the disease may occur in an acute form accompanied by heavy mortality. In such cases the fish may exhibit a whirling or corkscrew motion in the water, and in some instances they have been observed to lie on the bottom of the trough and bend the body from side to side with quick, spasmodic movements.

Often a prominent feature of the disease is the "spotty" nature of the outbreak. Instead of appearing simultaneously in all the troughs containing a certain lot of fish, the disease may first break out in one or in several troughs that may not be connected in any way. It frequently happens that all the troughs containing fish from the same lot of eggs will eventually show the disease, although by the time it appears in the last of the troughs it may have run its course already in the troughs first affected.

The simplest and most reliable method of diagnosing the disease consists of a microscopical examination of the contents of the anterior end of the intestine. This material should be mounted on a slide in a drop of water, in which the parasites will remain alive and active for 10 to 15 minutes. Since no other parasites are likely to be encountered that could be confused with Octomitus, an examination with the low power of a compound microscope is usually sufficient. At this magnification the parasites can be seen easily as colorless, minute, pear-shaped organisms (fig. 18) darting rapidly about in every direction. In some instances the parasites do not occur in the cavity of the intestine but are found only in the intestinal lining. This condition, however, usually occurs only in very young fingerlings.

ETIOLOGY

As stated above, the parasite is a small protozoan belonging to the Flagellata. The members of this group are characterized by the possession of one or more long, whiplike locomotor organs known as flagella. In the case of Octomitus there are four pairs of these flagella, three of which are attached to the broader anterior end of the body while the fourth pair arises from the posterior end. In life it is very difficult to distinguish the flagella, because they are very transparent and usually in rapid motion.

Octomitus is colorless and transparent, and in order to make out the details of its structure it is necessary to kill and stain the organism (fig. 12). It is then found that there is a pair of chitenous rods, known as axostyles, extending throughout the length of the body, to which the flagella previously referred to are attached. On each side of the axostyles near the anterior end is an elongated nucleus, each nucleus being connected with the nearest axostyle.

The flagellates reproduce by a process known as binary fission, during which the organisms become rounded and the various cell structures, with the exception of the flagella, divide into two equal parts. New flagella are quickly developed, so that the daughter flagellates are identical with the mother in every respect but size.

Since the process requires but a short time, it follows that under favorable conditions the flagellates may multiply very rapidly.

At certain times cysts are formed, which can live for a considerable period outside of the host, and it is probably by this means that the parasites are ordinarily transmitted from fish to fish. The cysts (fig. 9), which are ovoidal to spherical in shape, are formed by flagellates becoming surrounded by a thin transparent membrane. Shortly after the membrane is formed the inclosed organism divides into two, and in this condition the cysts pass out of the intestine in the feces. They can remain alive in the water for days, probably for weeks, and when accidentally ingested by another fish may set up a new infection. In this they are aided by the tough, resistant membrane, which enables the cysts to withstand conditions that would quickly kill the flagellated forms.

In addition to the flagellates in the intestinal cavity, there is another stage of the life cycle (fig. 18) that is found only in the epithelial cells that line the intestine and pyloric cæca. This stage is very different from the flagellated stage previously described. It first appears as a small rounded cell, which increases rapidly in size and soon divides into a number of small cells similar to the original. These daughter cells in their turn invade other epithelial cells and repeat the cycle. Under certain conditions these intracellular stages may multiply very rapidly, so that a large percentage of the epithelial cells become infected. After a time some of the intracellular parasites develop into the flagellated form and then quickly emerge into the cavity of the intestine.

PATHOLOGY

The effects of the parasites on the host undoubtedly vary widely under different conditions, and there is still much to be learned in this regard. The evidence at hand is quite contradictory in some respects, but it is believed that much of this apparent discrepancy can be explained on the basis of the two cycles of development within the host.

It is undoubtedly true that fish may harbor large numbers of flagellates without exhibiting any noticeable ill effects. This, however, appears to be largely a matter of age and probably also of acquired immunity on the part of the host. Ordinarily, trout over 3 to 4 inches in length show little or no ill effects, even when the parasite is abundant in the intestine, while younger fish may exhibit every evidence of malnutrition under the same conditions.

Among young fingerlings the effects of a severe infestation by the flagellates are usually quite marked. The fish lose their appetite and become greatly emaciated, the large head and attenuated body suggesting the term "pinhead," by which they are commonly known among fish culturists. Such fish are usually weak and listless and in late stages of the disease may become too feeble to fight the current and are swept against the screen, where they soon expire.

This chronic form of octomitiasis is usually most prevalent during the spring and early summer, when the fingerlings are from 2 to 3 inches long. While the mortality is usually not very heavy at any time the disease may persist for several weeks, so that the total loss may be as high as 50 to 75 per cent. Chronic octomitiasis is probably prevalent to a greater or less extent at most trout hatcheries where the fingerlings are held until summer or later, although the severity of the mortality appears to be dependent on a number of environmental factors, among which unsuitable food and overcrowding appear to be especially important.

Although the chronic wasting disease just described is undoubtedly the most common result of infection by octomitus, there is another form of octomitiasis, previously referred to, which manifests itself as an acute infection accompanied by a high mortality. Such epidemics occur only sporadically and are usually not of regular recurrence year after year as in the case of the chronic form of the disease. In the majority of cases acute octomitiasis occurs early in the season shortly after the fish begin to feed, breaking out first in one trough and then in another without any apparent connection between the two.

Acute octomitiasis is caused by a rapid multiplication of the intracellular stages of the parasite, the flagellated stages frequently being entirely absent. As a result there is considerable injury to the intestinal lining, accompanied by more or less inflammation, which quickly causes the death of the fish.

While there are thus two distinct forms of the disease, it is nevertheless true that in most instances we have to deal with a combination of the two types. It is very probable that even in the chronic wasting type of octomitiasis the mortality may be due largely to the intracellular parasites, which are invariably present in greater or less numbers. In fact, a comparison of dying fish with emaciated but fairly vigorous individuals from the same lot has shown that in most instances the intracellular stages were more numerous in the former.

CONTROL MEASURES

Since *Octomitus salmonis* is so widely distributed and may occur in fish of all ages, it appears to be impracticable to eliminate the parasite from a hatchery. In fact, there is no doubt that many fish harbor small numbers of the parasite and are consequently "carriers" of the disease.

All attempts to destroy the parasites by means of drugs administered with the food have been unsuccessful, and it is believed that the control of the disease must be based on prophylactic measures. Happily, there is good reason to believe that this is entirely feasible.

All available evidence points to the conclusion that, if the fry and fingerlings can be kept in an otherwise healthy and vigorous condition, there is comparatively little danger of heavy losses from this disease; but if the vitality of the fish is lowered or they are subjected, even for a short period, to unfavorable conditions, there is great danger of a rapid increase in the abundance of the parasites, with correspondingly detrimental effects on the host.

In some respects the disease may be compared to pneumonia in man. The causative organisms are usually present in small numbers in hatchery fish and under these conditions produce no detrimental effects, but, just as in the case of pneumonia, if the vitality is lowered from any cause or the natural resistance weakened, the factors that hold the organism in check are no longer effective. Consequently, the parasites break out of bounds and increase very rapidly, with dire results to the host.

There are many factors that may directly or indirectly cause an outbreak of octomitiasis. Among those that are most conducive to the development of Octomitus are overcrowding, unsuitable water supply, especially a deficiency of dissolved oxygen, and improper food. Owing to the inherent defects of artificial propagation it is almost impossible to avoid entirely the unfavorable effects of these factors, but certainly in most instances much can be done to improve present conditions.

It is a natural tendency to attempt to increase the output by overloading the equipment. In some cases this may succeed for a time, but sooner or later it is likely to result in disaster. The evil effects of overcrowding are, no doubt, in part due to an insufficient supply of dissolved oxygen, and this, of course, is especially noticeable when the water is not properly aerated before entering the troughs or raceways. Often the water from springs is deficient in this gas, and it should always be made to flow over an efficient aerating device to obviate any danger from this source.

A promising method of control, which has received comparatively little attention as yet, is the production of immune races of trout. There is considerable evidence that this is entirely feasible but, of course, will require rigid selection for several generations before conclusive results can be obtained. As a matter of fact, owing to the prevalence of octomitiasis there has necessarily been more or less involuntary selection in this respect at many hatcheries that rear their own brood stock. This may be a partial explanation of the well-known fact that fingerlings from hatchery eggs usually grow faster and suffer smaller losses than those hatched from eggs obtained from wild fish.

References: Davis, 1924, 1925; Moore, 1923, 1924.

SCHIZAMŒBA SALMONIS

This is one of the most common parasites of hatchery trout, but there is no evidence that it is ever seriously harmful to the host. It is usually most abundant in healthy, vigorous fish and is ordinarily not common in those that are not in good condition. This is probably due primarily to the fact that the parasite rarely occurs in numbers in fish that have been without food for any length of time.

Schizamœba salmonis lives in the stomach and intestine of all species of trout and salmon, but, like *Octomitus salmonis*, it has thus far been found only in hatchery fish or fish that might readily have become infected from hatchery fish. The amebæ (fig. 14) occur in the stomach as small, colorless organisms, more or less irregular in shape. The transparent protoplasm has a finely granular structure containing one or more vesicular bodies, the nuclei. The amebæ are found in the mucus that covers the lining of the stomach and are often very abundant. This vegetative ameboid stage disintegrates quickly when removed from the stomach and for that reason is rarely seen unless special search is made for it.

The parasite is most commonly seen in the encysted stage, which is frequently very abundant in both the stomach and intestine. In the latter the cysts are usually found in the core of gelatinous mucoid material that forms the major part of the intestinal contents. The cysts are spherical and vary greatly in size, the average diameter being about 20 to 25 microns. They are surrounded by a thin, transparent membrane and, in addition to a number of nuclei, usually contain numerous spherical refringent bodies composed of fat. The cysts gradually increase in size and after a time divide into 4 to 11 cells of approximately equal size (fig. 15). At this stage they have a remarkable resemblance to a segmenting egg, but, of course, this similarity is only superficial.

The cysts provide a means by which the parasite may be transmitted from one fish to another. Protected by the surrounding membrane they pass out of the intestine in the feces and may live for some time in water. If eventually taken into the stomach of another trout, the life cycle is repeated.

As previously pointed out, this parasite has not been observed to injure the host appreciably, although when excessively abundant it would seem that it must have some deleterious effect, even if it is limited to the consumption of food that would otherwise be utilized by the host.

Schizamœba salmonis is much more common in fingerlings than in older fish, although in several instances the writer has found it abundant in adult trout. It is probable that most hatchery fish harbor a few of these parasites, which would explain the ease with which the fingerlings become infected.

Reference: Davis, 1924.

CHLOROMYXUM TRUTTÆ

This parasite is a protozoan belonging to a group of typically fish parasites known as the Myxosporidia. This group includes a large number of species found in both marine and fresh-water fishes, but trout appear to be exceptionally free from them.

Chloromyxum truttæ is found in the gall bladder of brook trout and occurs in both wild and hatchery fish. Although it is sometimes very abundant in the bile, there is no evidence that it appreciably injures the host.

The vegetative stages of the parasite, known as trophozoites, are small transparent organisms, rounded to somewhat irregular in shape (fig. 16). They move slowly about by means of a single lobe-shaped projection or pseudopodium. The pseudopodium is a temporary locomotor organ, which may be formed or retracted at will. When actively moving about the trophozoites are usually distinctly pear-shaped. Trophozoites in various stages of development are ordinarily found together, the largest reaching a diameter of 50 to 60 microns. The protoplasm of the trophozoites contains a number of large, clear vacuoles, between which are crowded numerous small, spherical granules. In the large trophozoites there can usually be seen several rounded more opaque structures, the sporoblasts, which eventually develop into the reproductive bodies or spores.

The spores (fig. 17) are spherical, about 9 to 10 microns in diameter, and are surrounded by a thin, transparent shell, which is marked by a series of concentric ridges. At one side of the spore are four pear-shaped polar capsules, two of which are slightly smaller than the others. Within each polar capsule is a fine coiled thread, which may be extruded through a pore at the apex of the capsule under certain conditions. On the opposite side of the spore, below the capsules, is a nucleated mass of protoplasm known as the sporoplasm. When the spore germinates the sporoplasm emerges and forms a new trophozoite.

After the spores mature the trophozoite in which they were developed disintegrates and the spores pass into the intestine with the bile, eventually leaving the fish in the excrement. The spores are not uncommon in the intestines of infected fish and may occasionally be seen when search is being made for Octomitus or other intestinal parasites. The spores can live for some time in water but are unable to develop unless taken into the stomach of another fish. Once in the stomach of a trout the shell of the spore splits open, the sporoplasm emerges and makes its way to the gall bladder, thus completing the cycle.

BACTERIAL DISEASES

FURUNCULOSIS

Furunculosis derives its name from the development of "boils" or "furuncles," which is the most characteristic symptom of the disease. These "boils," however, are by no means always present, and it is then necessary to rely on other criteria to diagnose the disease. Furthermore, not all boils or ulcers are the result of furunculosis, as there is evidence that such lesions may be formed by several different organisms.

The disease affects chiefly the various species of salmonid fishes but may also occur in a large number of fresh-water and marine fishes, although it apparently occurs in epidemic form only among trout and salmon. Among the trouts, the brown and brook trout are particularly susceptible, while the rainbow trout are often considered to be immune. This is not strictly true, however, since rainbow trout may contract the disease if continually exposed to sources of infection, but under ordinary conditions there is little danger of this species becoming infected.

At first furunculosis was thought to be confined to hatcheries and fish farms, but a number of epidemics have been reported in wild fish during recent years, especially among salmon in European streams. In this country serious mortality from the disease has apparently been confined to brown and brook trout in hatcheries and rearing ponds.

In Europe furunculosis has rarely affected fingerling trout, having been confined almost entirely to yearlings and brood fish; but in America it annually takes a heavy toll among the young trout at many hatcheries.

SYMPTOMS

The symptoms of the disease are usually, though not always, well marked. As mentioned above, the most characteristic symptom is the presence of open sores on the body. These usually develop in the dorsal muscles, although they may occur on other parts of the body. Sometimes there is a marked tendency for the lesions to develop at or near the base of the dorsal or pelvic fins, and consequently furunculosis has sometimes been confused with the disease known as "fin rot," which is caused by an entirely different organism.

The lesions originate from small foci, which appear to the naked eye as minute red spots in the subcutaneous tissues or among the muscle fibers. These foci contain large numbers of the causative bacteria, which increase rapidly, producing disintegration of the blood vessels and other tissues in the immediate vicinity. As a result a swelling is formed, filled with a deep red, puslike material composed of bacteria, blood, and disintegrated muscle fibers. The lesions increase in size and may eventually break through the skin, forming an open sore. In many cases, however, death may occur before the lesions break through to the exterior. This is especially true of fingerling trout, where usually the only evidence of the lesion that can be seen from the exterior is an irregular, dark blotch just beneath the skin on one side of the body. This blotch ordinarily is situated between the dorsal and pelvic fins and is probably the most characteristic symptom of the disease in young trout.

In many cases the intestine is inflamed, especially in the pyloric region, and there is often a marked congestion of the blood vessels in the abdominal cavity. The spleen is usually considerably enlarged and has a bright cherry-red color, in striking contrast to the duller red of the organ in normal fish. The kidney is also affected and may become a semifluid necrotic mass.

According to Plehn, the disease may occur rarely in a quite different form, in which the causative organism is found only in the cavity of the intestine, at least until a comparatively late stage of the disease. In such cases there are no external symptoms, and recent investigations indicate that in some instances the bacteria may live in the intestine for some time without any apparent injurious effects on the fish.

ETIOLOGY

As indicated above, the causative organism is a bacterium that occurs in the tissues in various parts of the body and especially in the blood, causing a septicæmia or blood poisoning. In other words, the disease is essentially a generalized blood infection.

The bacterium was first described by Emmerich and Weibel in 1894 as the cause of an epidemic among trout in Germany. These authors called the organism *Bacterium salmoniciaa*. Later, Marsh, who was evidently unaware of Emmerich and Weibel's work, described an organism that he had isolated from the blood of diseased trout from Northville, Mich., and which he named *Bacterium truttæ*. There can be little doubt that the bacteria described by Emmerich and Weibel and by Marsh are identical, and accordingly the specific name *salmonicida* takes precedence over the later name of *truttæ*.

The bacterium is a short rod about 2 to 3 microns long, with rounded ends, but may show considerable variation in form, especially when grown in culture media. The most important characteristic of the organism, which makes it easy to distinguish from other bacteria when growing on culture media, is the formation of a pigment that stains the media a transparent brown.

The bacteria can usually be found in the blood of infected fish, where they are present in large numbers, occurring both singly and in large clumps. They grow best at a comparatively low temperature the optimum temperature probably being about 10° to 15° C. (50° to 60° F.). They are unable to live for any length of time at 37° C. and for that reason can not develop in a warm-blooded animal.

The manner in which the disease is transmitted has not been determined definitely, but it seems most probable that the bacteria gain entrance into the body through the walls of the digestive tract or through small wounds on the body or gills. The disease may be readily transmitted experimentally by introducing the bacteria directly into the blood or tissues. After having gained entrance to the blood stream they multiply rapidly and are carried to all parts of the body. Some of the bacteria may become localized in the muscles, where they produce the small red foci previously mentioned. These may eventually form large ulcers filled with a red puslike material containing immense numbers of bacteria. The failure of such ulcers to develop in small fish is probably due to the fish dying before the bacteria have been able to attack the muscles to any great extent. The dark blotches on the side of the body, so characteristic of the disease in fingerling trout, are caused by the infiltration of blood among the muscle fibers accompanied by some disintegration of the tissues, but death supervenes before the breaking up of the muscle fibers has become an important feature of the lesion.

Among the visceral organs, the liver, spleen, and kidneys appear to be especially liable to infection. Large masses of the bacteria can usually be found in these organs, and the tissues of the spleen and kidney may be broken down entirely.

CONTROL MEASURES

In considering methods of controlling this disease, it is well to bear in mind that furunculosis is essentially a blood disease, the bacteria developing in tissues and cavities of the body, where they can not be reached by the external application of chemicals. Consequently, it is idle to attempt to cure the fish by the use of salt baths or disinfecting solutions. Probably a certain percentage of infected fish recover from the disease, but recovery rarely occurs in fish in which the disease is so far advanced as to produce lesions.

This being the case, control measures must be designed primarily to prevent the spread of the infection to healthy fish. This is by no means a simple matter, since it has been shown recently that apparently healthy fish may act as carriers, which greatly increases the difficulty of control. In some instances the disease has run its course and apparently died out, only to suddenly break out afresh at a later time. In such cases the bacteria may have been carried over in the intestines of apparently healthy fish or possibly in the mud and débris on the bottom of the pond, and later, should the fish become weakened in any way, the bacteria are again able to get the upper hand.

The only logical method of control is to destroy all infected fish at once. These should be burned, if possible, but if this is not practicable they should at least be covered with lime and buried in pits at a sufficient distance from the ponds to prevent contamination. Dead fish should never be allowed to lie in the ponds, as putrefaction does not appear to injure the bacteria, which, when the fish decompose, are set free in enormous numbers.

All ponds in which there have been diseased fish should be isolated and, after having been carefully cleaned, should be given a thorough treatment with some efficient disinfecting solution, such as a freshly prepared solution of water-slaked lime. According to German investigators, a 1 to 100,000 solution of potassium permanganate will kill the bacteria of furunculosis and, if preferred, may be used in place of lime. In using permanganate the pond should be filled and enough of the chemical added to make a 1 to 100,000 solution. Needless to say, great care should be exercised to insure that the disinfecting solution penetrates all cracks and crevises where the bacteria may be concealed. If practicable, after having been disinfected the pond should be exposed to the sun for several days and allowed to dry out as much as possible. Of course, all implements that have come in contact with infected material should be sterilized thoroughly at the same time.

It has been claimed by some investigators that pure water is deleterious to the bacteria and that they quickly die out in water of this type, while they may live for weeks in water containing an appreciable amount of organic matter. Consequently, it has been held that pollution is a predisposing factor, but Williamson (1928) was unable to find any connection between pollution and the disease. There is some evidence, however, that warm weather and low water favor its development. Possibly the true explanation lies in the fact that pollution, high temperatures, and low water tend to lower the vitality of trout and salmon and thus make them more susceptible to infection.

Of course, every precaution should be taken to prevent the spread of the disease from one hatchery to another through shipments of infected fish. In fact, no such shipments should be allowed from hatcheries in which the disease is known to be present. Fortunately, there appears to be less danger of the disease being spread by means of eggs. There is, however, danger that the bacteria may be carried on the packing material or egg cases, and these should be destroyed or thoroughly disinfected if there is any reason to believe that they may have been contaminated.

References: Belding, 1927; Marsh, 1903; Mettam, 1915; Plehn, 1924; Williamson, 1928.

GILL DISEASE

Gill trouble may be due to several causes, but there is only one disease that is so characteristically a gill infection as to justify the term "gill disease." This disease has only recently been recognized as a distinct infection, but there is every reason to believe that it is widely distributed in this country. Probably many obscure losses among trout, which have been attributed to the water supply and similar agencies, have in reality been due to this disease.

Recent investigations have shown that the gill disease occurs in trout hatcheries in virtually all sections of the country, and it has also been found in chinook and sockeye salmon fingerlings at a hatchery on the Pacific coast. All species of trout may be affected and probably also all species of salmon, since the disease has been observed in steelhead and landlocked salmon fingerlings as well as in the chinooks and sockeyes mentioned above.

SYMPTOMS

Unfortunately, the disease is not characterized by any well-defined symptoms other than the appearance of the gills. In the early stages the fish are often somewhat weakened, but in many cases they appear to be perfectly normal until a short time before death. In the case of large fingerlings and older fish the gills are usually congested in early stages of the disease. Later the gill filaments become fused together more or less completely, while the tips become enlarged and distinctly lighter in color (figs. 19 and 20). Eventually the gills may become badly fungused, the fungus often spreading from the gills to the top and sides of the head. This fungus is purely a secondary infection and, in the case of large fingerlings and yearlings, is almost invariably present before the fish die. Infected fry and small fingerlings, however, rarely show any trace of fungus, probably due to the fact that the disease is so quickly fatal to small fish that fungus has no opportunity to develop.

Probably the most constant symptom that can be easily recognized is the greatly increased secretion of mucus by the gills. This is usually a prominent feature of the disease in fish of all ages and is particularly noticeable, as débris of various kinds becomes entangled in the mucus and may so clog the gills as to interfere with respiration. It is well to bear in mind, however, that this excessive secretion of mucus by the gills is not distinctive, since it may be due to other causes as well as gill disease.

ETIOLOGY AND PATHOLOGY

The disease is due to infection with bacteria, which forms a luxuriant growth over the surface of the gills. These bacteria occur in the form of long, threadlike filaments, which usually lie side by side to form a more or less continuous layer over the gills. These filaments, which are in reality composed of long, rod-shaped bacteria closely joined end to end, are colorless, transparent, and so difficult to distinguish that it requires very careful focusing under a high magnification to make them out as they lie closely applied to the surface of the gills. The bacteria are most abundant on the outer third of the gill filaments, where, evidently as a result of the irritation set up by their presence, there is a rapid proliferation of the epithelial cells. This results in the free ends of the filaments becoming enlarged so that they are often more or less distinctly club-shaped. One of the most striking features of the disease is a more or less complete fusion of adjoining filaments. This fusion is more noticeable near the tips of the filaments, but in extreme cases all the filaments of each gill may become converted into a continuous mass. Sometimes the gills become necrotic, but as this condition is almost invariably accompanied by fungus it is probable that this organism is chiefly responsible for the necrotic condition. The fish usually succumb in a very short time after the fungus develops.

The increased secretion of mucus, accompanied by enlargement of the gill filaments, must seriously interfere with the circulation of water over the gills. To make matters worse, the mucus usually becomes filled with sand grains and débris, which must still further impede the flow of water. The result is serious interference with normal respiration, which probably largely accounts for the high mortality often caused by this disease among fry and small fingerlings.

Ordinarily, the bacteria are found only on the surface of the gills, but in the case of fry they may also occur on the body and fins. This may account for the great destructiveness of the disease among fish of this age. In a number of instances the disease has caused virtually a total loss among fry within a few days of its appearance.

CONTROL MEASURES

Inasmuch as the disease is caused by bacteria, which occur only on the surface of the gills and body, it is evident that it should be controlled more easily than one that is due to internal parasites. This assumption is borne out by practical experience, as it has been found that the disease yields readily to treatment with copper sulphate. On the first appearance of the disease the fish should be dipped in a 1 to 2,000 solution of copper sulphate for one minute and then quickly transferred to running water. If the treatment is carried out properly, there will be little loss unless the fish have been weakened previously by the disease. In such cases it is impossible to prevent considerable loss, as the gills have been injured so badly that many of the fish die even though the bacteria are destroyed entirely. When the disease has become established two treatments on successive days will probably be required to destroy all the bacteria; but if the fish are treated on its first appearance, one dipping is sufficient, and the loss among the treated fish is usually negligible.

It has been found that fry and fingerlings may contract the disease from older fish that appear to be perfectly healthy. Evidently the bacteria may live in small numbers on such fish for an indefinite time without producing any noticeable effects. These fish act as carriers, and it is probable that in this way the disease is carried over in a hatchery from one season to the next. It is evident that the presence of carriers will make it very difficult, if not impracticable, to completely eradicate the disease from a hatchery.

References: Davis, 1926 and 1927.

FIN ROT

This disease, which is also known as "tail rot," has recently occurred at a number of widely separated hatcheries, where it has caused considerable mortality. It has sometimes been confused with the fin disease caused by Gyrodactylus, which is entirely different, although the early symptoms may be quite similar.

SYMPTOMS

Fin rot is characterized by the disintegration of the fins, which frequently are destroyed entirely. Nevertheless, the disease is sometimes difficult to diagnose, because there may be considerable variation in the symptoms, probably due largely to differences in the age of the fish and in the virulence of the causative organism.

In small fingerlings the pectoral fins usually are affected first, the dorsal fins being attacked next, and the infection may spread eventually to the other fins, although they are rarely as badly affected as the pectorals and dorsals. In older fish there does not appear to be the same sequence in the order of infection, and in many instances the dorsal or caudal fins are apparently affected before the pectorals.

Ordinarily the first noticeable indication of the disease is a more or less distinct white line along the outer margin of the fin. This white streak gradually moves toward the base of the fin, while at the same time the outer margin becomes badly frayed owing to the disintegration of the tissue between the fin rays (fig. 4). This process continues until eventually the entire fin may be destroyed. In late stages of the disease sores filled with glistening white pus may develop at the base of the fins, and occasionally such lesions are found on the body at some distance from the fins. Due to the discharge of pus into the surrounding water these lesions may appear as small, usually circular depressions, which extend for some distance into the underlying muscles. The sides of such lesions are so sharply defined as to give the impression of a small piece of tissue having been removed by some sharp instrument.

At this stage the disease has been confused with furunculosis but can readily be distinguished from the latter by the character of the lesions. The characteristic sores of furunculosis always contain a red puslike material, which is very different from the white pus found in the lesions caused by fin rot. Furthermore, the development of the sores is entirely different in the two diseases. In fin rot the infection is from the outside, so that the more superficial tissues are attacked first. Consequently, the tissues are gradually eroded from the surface, forming a lesion, which looks as though it might have been eaten out by some small animal. On the contrary, in furunculosis the sores develop from small foci, which are usually deeply embedded in the muscles and gradually extend toward the surface as the bacteria invade the surrounding tissues.

The extent to which the sores develop at or near the base of the fins is largely dependent on the size and age of the fish. In young fingerlings death usually occurs before the infection extends beyond the fins, so that the occurrence of lesions on the body is rare. Larger fish, being more resistant, may live for a time after some of the fins have been entirely destroyed, and therefore there is more opportunity for lesions to develop in the adjacent tissues.

Sometimes only a portion of the fin is destroyed. This is especially true of the dorsal and caudal fins. In the caudal only a few rays may be affected, and these disintegrate, forming a deep notch in the fin, which otherwise appears to be normal. In the dorsal fin only the outer half or two-thirds may be destroyed, the basal portion remaining unaffected.

ETIOLOGY AND PATHOLOGY

The causative organism is a rod-shaped bacterium, which can usually be found in large numbers in the infected fins. The writer has found this organism in all cases of fin rot from several different localities, and apparently it is the only organism that is uniformly present in the diseased tissues.

As previously indicated, the infection usually starts on the outer margin of the fin. As a result of the irritation caused by the growth of the bacteria there is a rapid proliferation of the epithelial cells, so that the epithelium becomes greatly thickened. This thickened epithelium forms a white streak across the fin, which is so characteristic of the early stages of the disease. Later the epithelium is destroyed, exposing the fin rays, which are also attacked by the bacteria and soon become frayed and broken. On the inner side of the infected area the bacteria are continually invading uninfected tissues, which in turn pass through the same sequence of events as those infected earlier.

The bacteria develop not only on the outer surface of the fins but also invade the tissues, attacking chiefly the connective tissues. In their growth through the tissues the bacteria follow the lymph channels and frequently can be seen grouped around the fin rays in great masses. As the cartilages at the base of the fins are less resistant to bacterial action than the denser peripheral portions, they are sometimes destroyed first, and the fins may drop off instead of gradually disintegrating. Arriving at the base of the fin through the lymph channels, the bacteria proceed to invade the surrounding tissues, causing the formation of the sores previously referred to.

CONTROL

In view of the method of infection outlined above, control measures obviously must be directed toward destroying the bacteria before they penetrate the tissues. This can be accomplished by dipping the fish for one to two minutes in a 1 to 2,000 solution of copper sulphate. This treatment has been found to be effective in early stages of the disease, but after the bacteria have gained entrance to the tissues they are out of reach of chemical baths. Usually several treatments at intervals of 24 hours are required before the spread of the disease can be checked effectually. As it is impossible to cure fish in advanced stages of the disease, all such fish should be destroyed before beginning the copper sulphate treatment. If not removed, they form a continual source of infection, as great numbers of bacteria pass into the water from lesions on the fins and body. It is also essential that the troughs or ponds and all utensils used around the diseased fish be thoroughly disinfected.

The disease varies greatly in severity; in many instances only a small percentage of the fish die, while in other cases the mortality may be very high. In the milder form of the disease a large proportion of the infected fish may recover; the lesions heal before the fins are entirely destroyed, and the fins regenerate more or less completely.

Little information has been obtained regarding the factors that tend to bring on an outbreak of the disease. As in the case of so many other trout diseases, overcrowding is undoubtedly an important contributing factor. There is also evidence that Gyrodactylus may be involved in some instances. It is easy to understand how injury to the fins by this parasite might make them more susceptible to infection.

MISCELLANEOUS DISEASES, INCLUDING THOSE OF UNCERTAIN ORIGIN

FUNGUS DISEASE

Trout, like most fresh-water fish, occasionally are attacked by a fungus disease caused by the development of water molds or Saprolegniaceæ. The fungus that occurs on trout is commonly referred to as *Saprolegnia ferax*, but it is probable that several distinct species have been confused under this name.

Although the disease often causes quite heavy losses, there is every reason to believe that the fungus is not the primary cause of the trouble. Any physical injury or infection by external parasites may result in Saprolegnia obtaining a foothold on the fish, which then spreads from the original site of infection. The fungus may develop on any part of the fish and usually occurs in small definite patches but in late stages may cover an extensive area. Ordinarily it appears as a tuft of white threads, which radiate out from the body of the fish for a distance of about 1/8 inch or more. When the water is somewhat roily sediment and débris may become entangled among the fungal filaments so that the "fungused" areas appear a dirty gray or brown. The fungus is attached to the fish by means of small, rootlike filaments, which penetrate the skin and in late stages of the disease may even invade the underlying muscles. As the filaments extend through the skin, they cause the death of the surrounding tissues so that large necrotic areas are formed, which may eventually cause the death of the fish.

Saprolegnia may also attack the eggs, and at most hatcheries the heaviest losses from fungus occur at this stage. There is no evidence that Saprolegnia can begin to develop on a normal, healthy egg unless there is some foreign organic matter adhering to the surface. However, it develops very quickly on any dead eggs that may be present, and from these eggs the mycelial filaments spread rapidly to adjoining healthy eggs, which are soon killed. Consequently, within a comparatively short time a large number of eggs may become bound together in a mass by entangling filaments, which continually spread farther and farther from the original site of infection.

Saprolegnia reproduces by means of minute biciliate zoöspores, which are produced in enormous numbers in enlarged club-shaped ends of the filaments known as zoösporangia, and it is these zoöspores that enable the fungus to spread from fish to fish. In addition to a sexual reproduction by means of zoösporangia and their zoöspores, Saprolegnia reproduces sexually through the formation of egglike oöspores, which, after being fertilized, develop into mycelia similar to that formed by the zoöspores. The sexual type of reproduction occurs only rarely and is of little importance from the practical standpoint.

There is no doubt that this fungus was originally a saprophyte, developing only on dead animal matter, and that the parasite habit is a secondary acquirement. As a matter of fact, it may grow either as a saprophyte or as a parasite and often develops on dead fish or other animal matter that may be available.

CONTROL

Everything considered, probably the best treatment for fish affected with "fungus" is a strong solution of salt (sodium chloride). The fish should be dipped in a 3 per cent solution until they begin to show signs of distress. In early stages of the disease one treatment is often sufficient, but if the fungus has become well established it will probably be necessary tó dip the fish on several successive days. Dipping the fish for one minute in a 1 to 2,000 solution of copper sulphate is also effective. German fish-culturists recommend a solution of 1 to 100,000 of potassium permanganate, in which the fish are allowed to remain for 30 minutes or longer. This treatment would hardly be practicable where many fish are affected.

In dealing with "fungus," however, by far the most effective method is to prevent the development of the disease, and in most cases this is a comparatively simple matter. As previously mentioned, there is reason to belive that healthy, uninjured fish are not affected by Saprolegnia; but infection is very likely to follow any mechanical injury, even though very slight. Once the protective mucous covering of the fish is broken an opportunity is afforded for the zoöspores to germinate and penetrate the epithelium at the point of injury. From this focal point the mycelium then invades the surrounding uninjured tissues.

Infection as a result of physical injuries is especially liable to occur during or shortly after the spawning season. Not only is it almost impossible to avoid slight injuries to the fish as a result of handling incident to stripping, but, the vitality of the fish is usually lower at this time than at other seasons, so that they are especially susceptible to infection. Fortunately, the danger of spawned fish developing a fungus infection can be decreased to a marked extent by dipping them in a 3 per cent salt solution after they have been stripped.

In some cases fish that have not been handled may become infected with fungus as a result of their own spawning activities, which often produce abrasions on the fins and body. Of course, such fish should be treated at once with a strong salt solution.

Infection with external parasites such as Gyrodactylus often results in the appearance of patches of fungus on the fins and body. In fact, if the fish have not been handled recently, the widespread appearance of fungus is almost invariably an indication that the fish are infested with some animal parasite or have contracted a bacterial disease. Obviously, in such cases the treatment should be directed against the primary parasite rather than the fungus, which is a purely secondary infection.

Under ordinary circumstances Saprolegnia can be prevented from causing any considerable injury to incubating eggs by carefully removing all dead eggs at frequent intervals. If this is done, there will be little opportunity for the fungus to become established. Care should also be taken to prevent the eggs becoming covered with sediment or débris. This not only tends to smother the eggs but also affords an opportunity for the development of bacteria and protozoa, which may so injure the eggs as to make them susceptible to infection by Saprolegnia.

One of the most effective weapons in combating fungus is to keep the ponds and troughs in a sanitary condition. Any surplus food or dead fish that are allowed to remain in the ponds for any length of time become covered with a luxuriant growth of Saprolegnia, which, of course, results in the formation of enormous numbers of zoöspores. These are continually being set free in the water, so that the slightest wound on any fish present is very liable to become infected.

The writer recently saw a very striking example of the danger of allowing Saprolegnia to grow in a hatchery. An investigation of a widespread infection by fungus among fingerling trout disclosed the fact that the fish were infested with Gyrodactylus. Although these parasites were present on every fish, they did not appear to be abundant enough to account for such a large percentage having developed fungus. On further investigation it was found that decaying food had been allowed to accumulate in the flume supplying the troughs and ponds containing the diseased fish. This food was covered with a very luxuriant growth of Saprolegnia, which was, of course, producing zoöspores in countless numbers. These spores were being carried directly to the fingerlings infested with Gyrodactylus and were evidently responsible for the exceptional growth of fungus that appeared on these fish.

Reference: Clinton, 1894.

POPEYE

"Popeye" is a popular term applied to fish that show a marked protrusion of the eyeballs. This condition is common among fingerling trout at some hatcheries and in many instances has resulted in heavy losses.

There are undoubtedly several forms of "popeye" disease, due to quite different causes. One form, caused by a severe infestation with the larvæ of a trematode worm, has already been referred to in the section on parasitic worms. Another type of "popeye," often called "gas bubble" disease, described by Marsh and Gorham (1905), is the result of the water supply being supersaturated with air. Most spring waters are more or less deficient in dissolved air, but occasionally the water may be supersaturated. In such cases there is a tendency for nitrogen gas to collect in various parts of the body, including the loose connective tissues surrounding the eyeball, causing it to protrude from the orbit. This form of "popeye" can be prevented easily by installing an efficient aerating or, in this case, deaerating device, which will allow any excess gas to escape from the water.

Still another form of "popeye" results from an accumulation of serous fluid in the abdominal cavity and other parts of the body. In this case the abdomen is greatly distended and when opened is found to be filled with a watery fluid. This is probably the most common form of "popeye" in trout and in all cases observed by the writer has been found to be associated with a diseased condition of the kidneys. The kidneys of the affected fish are usually darker in color than normal, due to the accumulation of pigment, and the tubules contain casts and crystals, probably of some calcium salt. In places the epithelium lining of the kidney tubules may be entirely disintegrated. The cause of this disease is unknown, no evidence having been found that it is due to a specific infection of any kind. Trout showing this type of "popeye" have in several instances shown a marked improvement following the addition of 1½ to 2 per cent of cod-liver oil to the diet. This suggests that the disease may possibly

54489—29——4

be connected in some way with calcium metabolism, especially since it appears to occur only at hatcheries supplied with water having a high calcium content.

Recently the writer observed still another form of "popeye" in fingerling trout characterized, as in the previous case, by the accumulation of serous fluid in the abdominal cavity and around the eyeball. Here, however, the resemblance ends, since the kidney tubules do not contain the characteristic casts and crystals observed in previous cases but, on the contrary, show a heavy infection with a myxosporidian parasite. It has not yet been determined whether or not this parasite is the cause of the popeyed condition.

Several writers have held that certain forms of "popeye" are due to bacterial infections of the eye, but there is still considerable doubt if this is the case. In a recent study of "popeye" by Williamson (1927) the investigator isolated 22 strains of bacteria from the diseased eyes of fishes, but concluded that none of them could be proved to be responsible for the "gas bubble" disease.

References: Marsh and Gorham, 1905; Williamson, 1927.

THYROID TUMOR OR GOITER

This disease, which is characterized by enlargement of the thyroid gland, was at one time believed by some investigators to be of a cancerous nature. It is now universally conceded, however, to be analogous to goiter in man and to have no relation to cancer. The belief in the cancerous nature of thyroid enlargement in trout was largely due to the peculiar structure of the gland in fishes. Unlike the thyroid of higher animals, the gland in fishes is not surrounded by a definite capsule. On the contrary, the cells form a branching structure, which extends into the surrounding tissues. When the gland becomes enlarged it has a striking superficial resemblance to a maligant growth, since it appears to invade the surrounding tissues in a similar manner.

The thyroid is a small, ductless gland that produces an internal secretion essential to the health of the animal. It is located beneath the floor of the mouth between the first and third gill arches. Owing to its small size and the separation of its units, which are distributed among other tissues, it is not recognizable to the naked eye.

The first external indication of thyroid enlargement is a red streak or spot on the floor of the mouth near the second pair of gill arches. This red area is due to an increased blood supply to the enlarging thyroid and may appear in fish only 2 to 3 months old. This is followed by an external swelling, which may appear on the ventral side of the head just beneath the gills as a cone-shaped, reddish tumor. Sometimes the tumor first appears on the floor of the mouth and secondary growths frequently occur on the gills and at the anterior end of the lower jaw. The tumor does not become visible externally before the fish are at least 6 months old, and only rarely do they become noticeable before the fish are a year old. The greatest number of goiters are said to appear during the second and third years of life, probably due to the fact that the thyroid is most active in rapidly growing fish. In older fish the activity of the thyroid decreases, and the tumor may decrease in size and disappear, the fish making a spontaneous recovery. Large tumors often become abraded, which results in infection by fungus or bacteria.

The primary cause of thyroid tumor is now generally conceded to be a deficiency of iodine, which is essential to the proper functioning of the thyroid gland. There is also evidence that overcrowding, overfeeding, a limited water supply, and insanitary conditions in the ponds are important contributing factors.

CONTROL

Since the causes of the disease are so well understood, its control is a comparatively simple matter. Wild trout virtually never show any evidence of goiter, and hatchery fish in early stages of the disease show an immediate improvement when liberated in natural waters.

Inasmuch as a deficiency of iodine is the principal causative factor, it is essential that this condition be corrected at once. This can be done by adding small quantities of a solution of iodine to the water, but the addition of iodine directly to the food is much simpler and apparently gives equally good results. The form in which the iodine is administered appears to make little difference in the results. At the bureau's hatcheries very good results have been obtained with the so-called "Lugol's solution," which consists of 1 per cent iodine dissolved in a 1 per cent solution of potassium iodide. A tablespoonful of this solution thoroughly mixed with about 50 pounds of ground food is sufficient to keep the fish from showing any trace of thyroid tumor.

When such products as shrimp meal, clam meal, haddock meal, or cod-liver meal, which are rich in iodine, are fed to the fish, it is, of course, unnecessary to add iodine to the ration. Even a comparatively small percentage of these iodine-rich products will serve to protect the fish from goiter.

References: Marine and Lenhart, 1910 and 1911; Marine, 1914; Marsh, 1911; Gaylord and Marsh, 1914.

WHITE-SPOT DISEASE

The white-spot disease occurs in both eggs and fry and is characterized by the appearance of an opaque or white area in some part of the embryo, usually the yolk. The opaque area is very noticeable in the semitransparent yolk, so that the disease is easily recognizable even in its early stages. White-spot may occur at any stage of development up to the complete absorption of the yolk sac but is more likely to appear during the early stages.

There is still considerable uncertainty regarding the cause of the disease, and it seems probable that it is not always due to the same agency. The characteristic white-spot in the yolk is due to coagulation of the transparent yolk, causing it to become opaque. In many instances the coagulated yolk contains one or more kinds of bacteria, but this is by no means always the case. Frequently numbers of the so-called periblast cells, which are instrumental in the absorption of the yolk, are present in the white spots.

The evidence points strongly toward the conclusion that white-spot is primarily caused by some injury to the eggs. Such an injury might produce coagulation of the yolk followed by increased activity of the periblast cells. If the egg membrane, or in the case of the fry the layer of cells surrounding the yolk, is ruptured or perforated, any bacteria present may gain entrance and develop in the yolk, which, of course, is simply nonliving organic material.

The fact that several kinds of bacteria may occur in the white spots and that no one kind appears to predominate is strong evidence that the disease is not due to a specific infection. Furthermore, there is no indication that the disease is contagious, as is shown by the random distribution of diseased eggs among those that are perfectly normal.

It is well known among trout culturists that white-spot is most likely to occur in eggs that have been shipped some distance or that have been handled roughly. This, of course, is in complete accord with the theory that the disease is usually the result of physical injuries. There is also evidence that in some cases the disease may have been the result of the eggs having been chilled or frozen.

Reference: Leach, 1924.

BLUE-SAC DISEASE

The blue-sac disease affects the fry before the yolk sac is absorbed and usually appears within one or two weeks after hatching. The first symptom is an enlargement of the yolk sac, which soon becomes so heavy that the fish are unable to rise to the surface. The sac usually bursts after a few days, which results in the death of the fry.

The enlargement of the yolk sac is due to the accumulation of a serous fluid between the yolk and the outer wall of the sac. The fluid often has a bluish tinge, which has given rise to the name commonly applied to this disease.

The cause of the disease is not known definitely, but has been variously ascribed by different writers to rough handling of the eggs, resulting in shocks or jars, to too much pressure during stripping, and to infection by bacteria. In support of the latter view it has been found by a German investigator, L. von Betegh, that the serous fluid may contain a pure culture of a diplobacillus. He also calls attention to the fact that the disease may break out suddenly in a lot of young fry, which indicates that it is infectious. On the other hand, in many cases it has not been possible to demonstrate the presence of bacteria in the serous fluid, so that the bacterial origin of the disease is by no means proved.

As in the case of the white-spot disease, it seems probable that blue sac is usually associated with the improper care and handling of the eggs and that it rarely attacks fry hatched from healthy, uninjured eggs.

References: von Betegh, 1912; Leach, 1924.

SOFT-EGG DISEASE

The soft-egg disease is a peculiar condition of the eggs, which has caused very heavy losses at a number of commercial hatcheries in New England. The disease, which does not appear until some time after the eggs are spawned, is characterized by the eggs becoming soft and flaccid. The cause of this condition is the formation of minute openings in the egg membrane, which allow the water to pass freely in either direction, thus destroying the turgidity characteristic of normal eggs. If these perforations are formed before the yolk sac has developed, more or less of the yolk may escape into the water, where it immediately hardens.

The openings in the egg membrane are produced by some external agency, which causes disintegration or digestion of the membrane in small localized areas. There is no doubt that the perforations are produced by some microscopic organism, but the identity of this organism has not been definitely determined. Three types of organisms usually are found in the infected areas—a fungus (Saprolegnia), bacteria of several species, and an ameba. There is little doubt that the primary cause of the disintegration of the egg membrane is either bacteria or the ameba, because the fungal filaments do not appear to be present until after the perforations have been formed. The filaments then grow through the holes and spread out on the inside of the egg membrane. The evidence at hand seems to indicate that the ameba is the primary agent rather than the bacteria, but this evidence is by no means conclusive.

Fortunately, exact knowledge of the source or nature of the causative organism is not necessary for working out efficient methods of control. Since the cause of the trouble is undoubtedly some organism that gets on the eggs after they are removed from the fish, it is evident that rigid sterilization and antiseptic methods are the prime requisites. All pans, receptacles, etc., including trays, should be sterilized thoroughly (preferably by boiling) at frequent intervals, and all troughs should be painted each season. Every precaution should be taken to avoid, as far as possible, introduction of infection from outside ponds, and in spawning and washing the eggs clean spring water should always be used. At a number of hatcheries very good results have been obtained by treating the eggs with a strong salt solution for a short time. At hatcheries where these methods of control have been adopted the loss from soft eggs has been reduced to a negligible quantity.

BIBLIOGRAPHY

BELDING, DAVID L.
1927. Fish disease epidemics. Transactions, American Fisheries Society, vol. 57, 1927, pp. 217-221. Hartford, Conn.

CLINTON, G. P.
1894. Observations and experiments on Saprolegnia infesting fish. Bulletin, U. S. Fish Commission, Vol. XIII, 1893 (1894), pp. 163-172. Washington.

DAVID, HANS.
1928. Zur Bekämpfung der Furunkulose der Fische. Oesterreichische Fischerei-Zeitung, Nr. 13, XXV Jahrgang, July, 1928, pp. 97-99. [English translation in The Fishing Gazette, Vol. XCVIII, pp. 127-128. London.]

DAVIS, H. S.
1924. The intestinal Protozoa of trout. Transactions, American Fisheries Society, vol. 54, 1924, pp. 57-63, 1 fig. Hartford, Conn.
1925. *Schizamœba salmonis*, a new ameba parasitic in salmonid fishes. Bulletin, U. S. Bureau of Fisheries, Vol. XLII, 1926 (1927), pp. 1-8, 40 figs. Bureau of Fisheries Document No. 987. Washington.
1925a. *Octomitus salmonis*, a parasitic flagellate of trout. *Ibid.*, pp. 9-26, 57 figs. Bureau of Fisheries Document No. 988. Washington.

DAVIS, H. S.—Continued.

1926. A new gill disease of trout. Transactions, American Fisheries Society, vol. 56, 1926, pp. 156–159. Hartford, Conn.

1927. Further observations on the gill disease of trout. *Ibid.*, vol. 57, 1927, pp. 210–212. Hartford, Conn.

DAVIS, H. S., and M. C. JAMES.

1924. Some experiments on the addition of vitamins to trout food. Transactions, American Fisheries Society, vol. 54, 1924, pp. 77–85, 3 figs. Hartford, Conn.

EMBODY, GEO. C.

1924. Notes on the control of Gyrodactylus on trout. Transactions, Amercan Fisheries Society, vol. 54, 1924, pp. 48–50. Hartford, Conn.

1927. Stocking policy for the Genesee River System. *In* A biological survey of the Genesee River System, supplemental to Sixteenth Annual Report, 1926, New York Conservation Department, pp. 12–28, figs. 3–4. Albany.

EMBODY, GEORGE C., and CHARLES O. HAYFORD.

1925. The advantage of rearing brook-trout fingerlings from selected breeders. Transactions, American Fisheries Society, Vol. 55, 1925, pp. 135–138. Hartford, Conn.

FASTEN, NATHAN.

1912. The brook-trout disease at Wild Rose and other hatcheries. Biennial Report, Commissioners of Fisheries of Wisconsin, 1911 and 1912 (1912), pp. 12–22, 5 figs. Madison.

1918. Trout and fish lice. Publications, Puget Sound Biological Station, vol. 2, 1918–1920, pp. 73–76, pl. 18. Seattle.

1921. Studies on parasitic copepods of the genus Salmincola. American Naturalist, Vol. LV (1921), No. 640, pp. 449–456. New York.

1922. The tapeworm infection in Washington trout and its related biological problems. *Ibid.*, Vol. LVI (1922), No. 646, pp. 439–447, 7 figs. New York.

GAYLORD, HARVEY R., and MILLARD C. MARSH.

1914. Carcinoma of the thyroid in the salmonoid fishes. Bulletin, U. S. Bureau of Fisheries, Vol. XXXII, 1912 (1914), pp. 363–534, Pls. LVI–CX, 53 text figs. Bureau of Fisheries Document No. 790. Washington.

LAIRD, JAMES A.

1927. The use of Zonite in treating gillworm. Transactions, American Fisheries Society, vol. 57, 1927, pp. 177–179. Hartford, Conn.

LEACH, GLEN C.

1924. Artificial propagation of brook trout and rainbow trout, with notes on three other species. Appendix VI, Report, U. S. Commissioner of Fisheries for 1923 (1924). Bureau of Fisheries Document No. 955, 74 pp., 22 figs. Washington.

LINTON, EDWIN.

1891. A contribution to the life history of *Dibothrium cordiceps* Leidy, a parasite infesting the trout of Yellowstone Lake. Bulletin, U. S. Fish Commission, Vol. IX, 1899 (1891), pp. 337–358, Pls. CXVII–CXIX. Washington.

MARINE, DAVID.

1914. Further observations and experiments on goiter (so-called thyroid carcinoma) in brook trout (*Salvelinus fontinalis*). III. Its prevention and cure. Journal of Experimental Medicine, vol. 19 (1914), pp. 70–88, 1 text fig., pls. 13–17. New York.

MARINE, DAVID, and C. H. LENHART.

1910. Observations and experiments on the so-called thyroid carcinoma of brook trout (*Salvelinus fontinalis*) and its relation to ordinary goiter. Journal of Experimental Medicine, vol. 12 (1910), pp. 311–337, 3 text figs., Pls. XXV–XXVI. Lancaster, Pa. [Also published as Pennsylvania Department of Fisheries Bulletin No. 7.]

1911. Further observations and experiments on the so-called thyroid carcinoma of the brook trout (*Salvelinus fontinalis*) and its relation to endemic goiter. *Ibid.*, vol. 13 (1911), pp. 455–475, 1 text fig., Pls. LX–LXI. Lancaster, Pa.

MARSH, M. C.
1903. A more complete description of *Bacterium truttæ*. Bulletin, U. S. Fish Commission, Vol. XXII, 1902 (1904), pp. 411–415, II Pls. Washington.
1911. Thyroid tumor in salmonoids. Transactions, American Fisheries Society, vol. 40, 1911, pp. 377–391, 1 pl. Washington.
MARSH, M. C., and F. P. GORHAM.
1905. The gas disease in fishes. Report, U. S. Commissioner of Fisheries for 1904 (1905), pp. 343–376, III Pls. Washington.
McCAY, C. M., and W. E. DILLEY.
1927. Factor H in the nutrition of trout. Transactions, American Fisheries Society, vol. 57, 1927, pp. 250–260, 3 graphs. Hartford, Conn.
METTAM, A. E.
1915. Report on the outbreak of furunculosis in the River Liffey in 1913. Scientific Investigations, Department of Agriculture and Technical Instruction for Ireland, 1914, II (1915), 19 pp., III Pls. Dublin.
MOORE, EMMELINE.
1923. Diseases of fish in State hatcheries. Twelfth Annual Report, New York Conservation Commission, 1922 (1923), pp. 66–79, 2 pls., 5 figs. Albany.
1923a. A report of progress on the study of trout diseases. Transactions, American Fisheries Society, vol. 53, 1923, pp. 74–81, 2 figs. Hartford, Conn.
1924. Diseases of fish. Fourteenth Annual Report, New York Conservation Commission, 1924 (1925), pp. 83–97, 12 figs. Albany.
1924a. The transmission of *Octomitus salmonis* in the egg of trout. Transactions, American Fisheries Society, vol. 54, 1924, pp. 54–56. Hartford, Conn.
PLEHN, M.
1924. Praktikum der Fischkrankheiten. 179 pp., XXI col. pls., 173 text figs., 1924. E. Schweizerbart'sche Verlagsbuchhandlung, Stuttgart. [NOTE.—This is the most complete work published on the diseases of fish.]
PRYTHERCH, HERBERT F.
1924. The ichthyophthirius disease of fishes and methods of control. Appendix IX, Report, U. S. Commissioner of Fisheries for 1923 (1924). Bureau of Fisheries Document No. 959, 6 pp., 10 figs. Washington.
VON BETEGH, L.
1912. Hydrocoele embryonalis. Centralblatt für Bakteriologie, Parasitenkunde und Infektionskrankheiten, erste Abteilung, 66 bd., Originale, pp. 284–286, 1 taf. Jena. [English translation by Anne L. Massey in Scientific Investigations, 1913, No. III, Department of Agriculture and Technical Instruction for Ireland, Fisheries Branch, 4 pp., I Pl. London.]
WARD, HENRY B., and JUSTUS F. MUELLER.
1926. A new pop-eye disease of trout fry. Archiv für Schiffs- und Tropen-Hygiene, Pathologie und Therapie Exotischer Krankheiten, XXX Band (1926), pp. 602–609, 4 figs. Leipzig.
WILLIAMSON, ISOBEL J. F.
1928. Furunculosis of the Salmonidæ. Fishery Board for Scotland, Salmon Fisheries, 1928, No. V, 17 pp., 2 pls. Edinburgh.
WILLIAMSON, JANE.
1927. Bacteriological investigation of the cause of bulging eye in certain marine food fishes. 46 pp., 12 figs., 1927. Aberdeen Press and Journal Office.

O

WHITEFISH, GRAYLING, TROUT, AND SALMON OF THE INTERMOUNTAIN REGION[1]

By S. B. LOCKE,

Forest Examiner, Forest Service, U. S. Department of Agriculture[2]

INTRODUCTION

[By R. H. RUTLEDGE, District Forester, Intermountain District]

The maintenance of conditions favorable to fish life in our mountain streams is largely dependent upon the preservation of the forests. In fact, the fish life within the national forests may well be considered one of their resources, which may be favorably influenced in proportion to our ability properly to administer the forests. In this region the sources of the principal fish streams lie within the national forests. The maintenance of a timber cover tends to insure a constant flow of cold water and other conditions essential to the growth and development of game fish. The practice of forestry both inside and outside the national forests is of vital interest to the fisherman who desires to see his sport perpetuated. Under the practice of forestry the mature trees are harvested, but the young growth is protected and the forest cover maintained. This means that favorable stream conditions will be preserved. All rearing of trout in hatcheries or protecting them by closed seasons is wasted unless suitable conditions for survival exist in the lakes and streams. Several specific examples are on record of how trout have been killed directly as a result of forest fires. Besides these are the cases in which the burning of the forest cover has resulted in the streams filling with mud and silt, the water ceasing to flow during dry periods, or becoming too warm for fish life.

The greatest problem in the protection of the national forests is the prevention of forest fires. A much too large proportion of such fires is caused by the carlessness of persons seeking recreation there. This pamphlet has been prepared for your use and information in connection with your sport. We hope it will add to your interest and pleasure in fishing. In return, greater appreciation of the necessity of the preservation of forests to the maintenance of fishing is desired, and full cooperation in the prevention of forest fires is expected.

---

[1] Appendix V to the Report of the U. S. Commissioner of Fisheries for 1929. B. F. Doc. 1062. Submitted for publication Feb. 4, 1929.

[2] Key reviewed and much valuable assistance given by Dr. W. C. Kendall, ichthyologist, U. S. Bureau of Fisheries. Illustrations from publications of the U. S. Bureau of Fisheries and the California Fish and Game Commission in part.

RELATION TO GEOGRAPHIC DIVISIONS

The intermountain region as here discussed coincides roughly with United States Forest Service District No. 4, including Nevada, the Snake River drainage in Idaho south of the Salmon River and in Wyoming, the Great Basin in Utah, and the Colorado River drain-

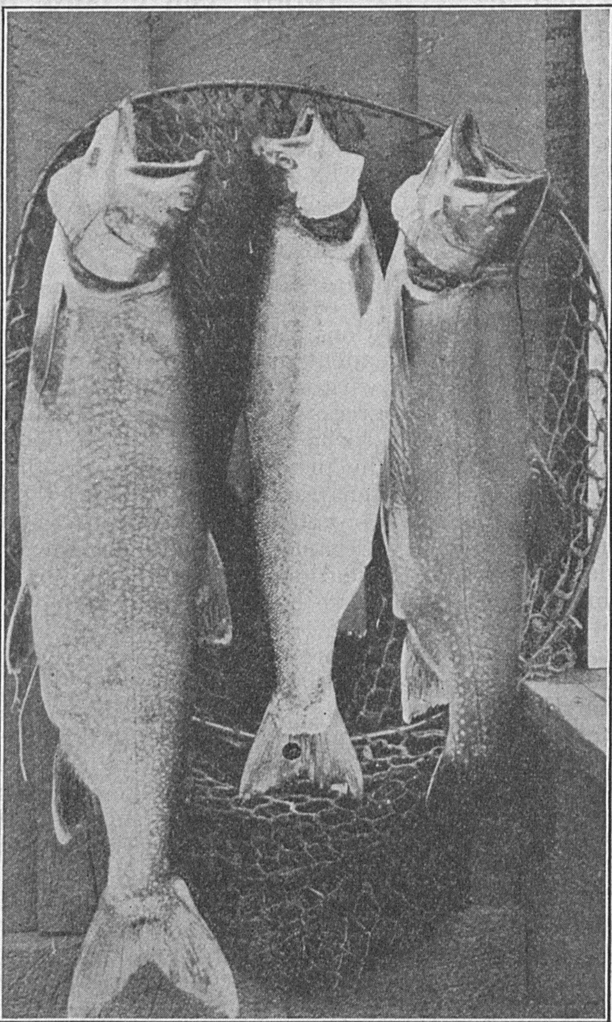


FIGURE 1.—Mackinaw, rainbow, and eastern brook trout

age in Utah and Wyoming. Within each of the geographic divisions are one or more species of the fish discussed in this paper, with considerable local variation in the native trout. The connection and discharge from the ancient Lake Bonneville into the Snake River gives very similar fish species in the Great Basin and upper Snake River. Apparently Shoshone Falls has long been a barrier to fish, since there are in general different species in the Snake River Basin above and below these. Until planted by white men, the Lost River Basin held only whitefish. Fish culture has introduced several new species and mixed those native to several of these divisions. The introduced species also have been mixed, the brown trout with the Loch Leven and the steelhead with the rainbow.

IDENTIFICATION OF FISH SPECIES

Only a small amount of knowledge is necessary to enable one to undertake the identification of the various trout species. The ability to distinguish these gives the fishermen greater interest in his sport and the opportunity to observe and interpret more clearly facts regarding their life history.

The native trout, as represented here in the cutthroat or black-spotted group, are apparently inclined to vary in minor characteristics in response to differences in their habitat or restrictions to interbreeding imposed by isolation. This results in local variations not always constant and not sufficiently distinct to make separate species. On the other hand, the whitefish or mountain herring is very stable and, except in Bear Lake, there is only one species over the entire area. To constitute separate species does not require very marked differences if these are constant and no intermediate forms occur. Very distinct and noticeable differences, if they are not uniform and intergrading forms occur, are not sufficient to make separate species. There are some puzzling cases, more particularly with the three groups of western trout—rainbow, steelhead, and cutthroat—in which there is difficulty in separating closely related species, but these seldom occur in the same locality. Under normal conditions it is unusual to find natural hybrid trout unless among very closely related species and then probably resulting from fish culture. According to W. M. Keil, Idaho fish commissioner, intermediate types between rainbow and cutthroat trout are not uncommon there, being found often in the Henry Lake section. In most waters heavily fished and planted from hatcheries the introduced species better adapted to fish culture have largely replaced native trout. In a very few cases there is confusion in the general classification of trout species. The key is far from infallible, but with the exceptions noted identification is not difficult, and it is hoped the information will be of value.

A few terms used in descriptions must be understood, but these are rather simple and are not difficult of application. The proportions of different parts of a fish after maturity do not change greatly in the various sizes of the same species, so length or size of such parts is expressed in proportion to other parts. The arrangement of scales and the fin structure are also constant within certain narrow limits. The scale count used most often is the number of diagonal rows immediately above the lateral line (marking the middle of the side), from the head to the last vertebra in front of the tail, not counting the last very small scales on the base of the tail. The length of the body is taken from the nose to the last vertebra, the same point to which the scales are counted. The bones

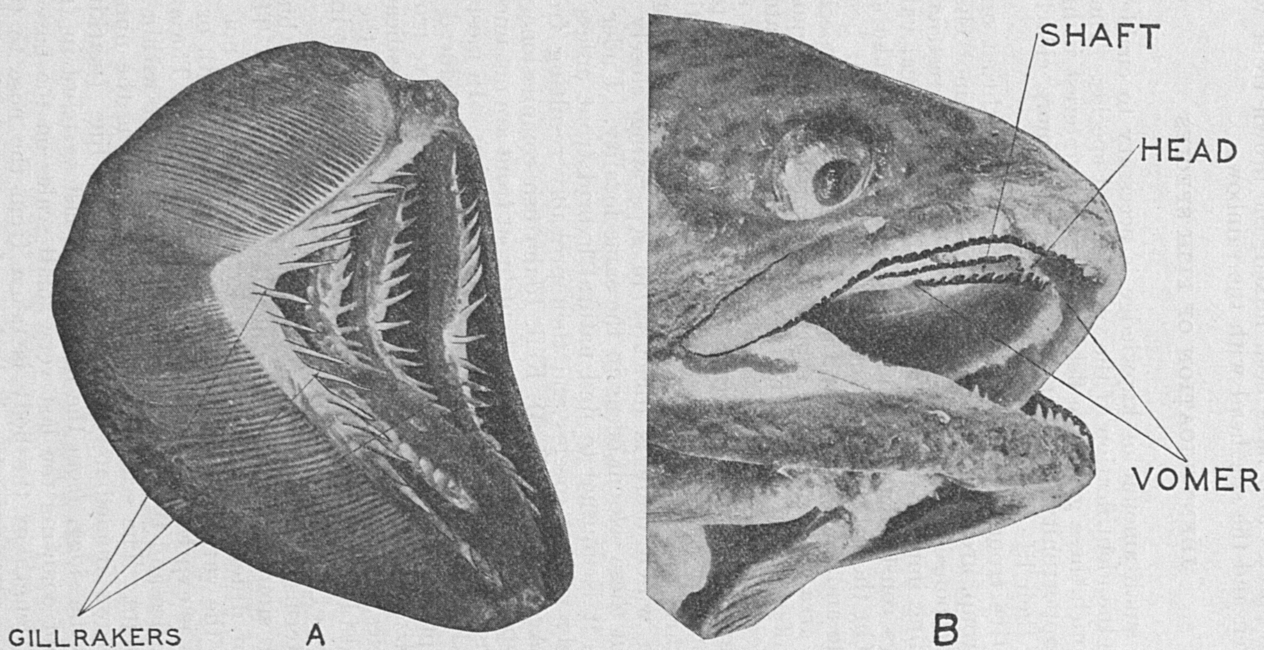


FIGURE 2.—A, Gill arch of silver salmon; B, head of rainbow trout

that support the fins are known as "rays." The maxillary is the flattened plate on the side of the upper jaw. The vomer is the bone in the front central part of the roof of the mouth. It is concealed by membrane and, although of high value in fish classification, will require rather careful observation for the fisherman to use it. The vomer has the front part or "head," from which the "shaft" extends backward. The gill rakers are located on the front or anterior part of the gill arch opposite the "breathing" part of the gills; when few, they are shaped like fingers or hooks, and when numerous they resemble a fine-toothed comb.

Color of the flesh is a very uncertain factor that depends largely on the nature of the food and the condition of the fish as well as the age. Colors and spotting in general are somewhat unreliable, being modified by the nature of the water and the color of the bottom as well as by the maturity and condition of the fish. Large trout with reddish or yellowish flesh are often known as salmon trout, but they are not distinct from some of the local trout of smaller size and light-colored flesh. Male trout and salmon are generally more

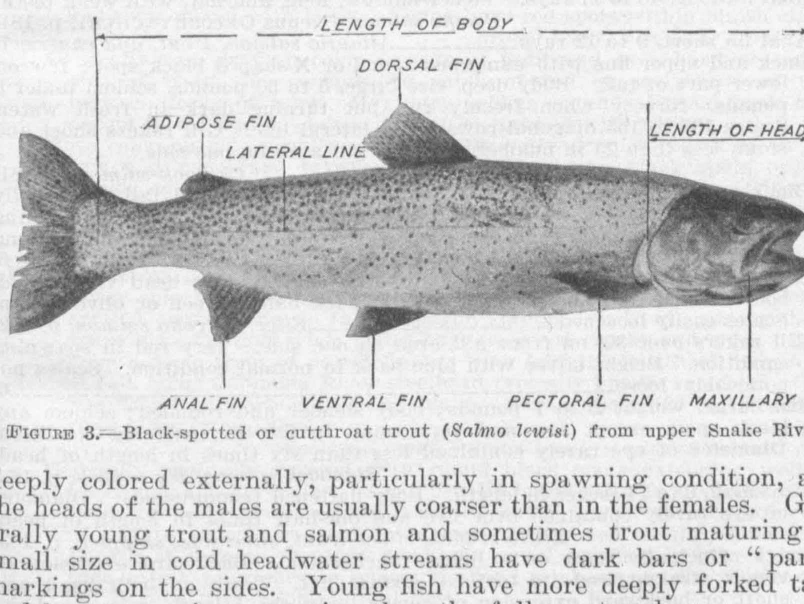


FIGURE 3.—Black-spotted or cutthroat trout (*Salmo lewisi*) from upper Snake River

deeply colored externally, particularly in spawning condition, and the heads of the males are usually coarser than in the females. Generally young trout and salmon and sometimes trout maturing at small size in cold headwater streams have dark bars or "parr" markings on the sides. Young fish have more deeply forked tails and larger eyes in proportion than the fully matured ones.

USE OF KEY

Any fish caught in this region, having the soft adipose fin present, can be placed in this key, except the catfish, which has also stiff, sharp spines on several fins and no scales. A person using the key will compare the specimen at hand with the two descriptions under the first numbered heading, determining with which description the specimen agrees. At the end of the description agreeing with the specimen a reference is made to a page number or another numbered heading. If this reference is to a numbered heading, the same process is repeated with this as with the first one and continued until the fish is named and a reference found to a page number for additional information. Under numbered paragraphs 3 and 7 a page reference is made to a description of a genus, the species being described in other numbered paragraphs. The key contains the more complete and technical description, while more general identification terms are given under the discussion for each species.

KEY

1. Dorsal fin large and saillike, having not less than 20 rays and with orange or rose spots. Scales large, 85 to 100 diagonal rows along lateral line. Few black spots on upper part of body in front of dorsal fin.
   Grayling (Family THYMALLIDÆ), p. 180.

   Dorsal fin with 12 rays or less___Whitefish and salmon and trout families, 2.
2. Small mouth, not extending to point below middle of eye; teeth weak or lacking; scales large, 70 to 90 diagonal rows along lateral line. No black spots except sometimes a few relatively large ones in young.
   Whitefish (Family COREGONIDÆ), p. 180.

   Mouth cleft beyond point below center of eye. Teeth strong.
   Salmon and trout (Family SALMONIDÆ), 3.
3. Anal fin long, 13 to 17 rays. Vomer narrow, long, and flat, with weak teeth.
   Pacific salmon (Genus ONCORHYNCHUS), p. 181.

   Anal fin short, 9 to 12 rays___________*Atlantic salmon, trout, and charrs*, 7.
4. Back and upper fins with numerous round or X-shaped black spots, few on lower part of tail. Body deep, size large, 5 to 50 pounds, seldom under 8 pounds. Silvery when freshly run but turning dark in fresh water. Scales 135 to 155 diagonal rows along lateral line. Gill rakers short and stout, less than 25 in number, on front gill arch on one side.
   Chinook salmon, p. 181.

   Black spots lacking or few and small on upper back and tail. Generally under 8 pounds in weight. Gill rakers slender, length nearly equaling or equaling diameter of eye. Scales 125 to 135 diagonal rows along lateral line____5.
5. Gill rakers less than 25, on front gill arch on one side; head very round, body slender and flattened, eye small; back bluish green or olive brown. Scales easily loosened___________________*Silver or coho salmon*, p. 182.

   Gill rakers over 30, on front gill arch on one side. Very red in spawning condition. Bright silver with blue back in normal condition. Scales not noticeably loose____6.
6. Size large, weight 2 to 7 pounds; body slender and rounded; seldom any black spots except few and very small in fish in spawning condition. Diameter of eye rarely contained less than six times in length of head.
   Blueback salmon, big redfish, p. 182.

   Size small, 6 to 14 inches in length. Body flattened (compressed). Diameter of eye rarely contained over five and one-half times in length of head.
   Little redfish, silver trout, silverside, skipjack, p. 183.
7. Spots principally dark on a lighter background. Backward extension of vomer straight and its toothed surface flat. Teeth on both head and shaft or backward extension of vomer. (In old Atlantic salmon seldom teeth on shaft of vomer and only one or two on head.) Scales 110 to 180 or more diagonal rows along lateral line.
   Atlantic salmon and true trout (Genus SALMO) (p. 183 for description of genus), 8.

   Red, gray, or yellow markings or spots paler than ground color of skin. Vomer boat shaped, without teeth on its backward extension or shaft. Scales usually 200 or more________________________________*Charrs*, 13.
8. No rosy wash on sides nor dash of red on throat. Black markings on head, back, dorsal fin, and upper side, but generally none on tail except sometimes as obscure markings. Often red spots on sides. Scales 112 to 130 diagonal rows along lateral line_____________________________________9.

Rose or flesh color on side of head and as band or wash on side, or a conspicuous patch of red on membrane of throat between forks of jaws. Black markings on tail. No red spots on side. Scales 120–180 or more diagonal rows along lateral line...11.

9. Outer or first rays of ventral and anal fins not definitely white. No red spots on sides except in young, and then lacking a blue circle. X-shaped or irregular black spots on body, generally several large spots on side of head. Sides silvery. Breeding fish, particularly males, variously colored, often with yellowish markings on the tails. Scales 112 to 118 along lateral line.
Landlocked or fresh-water salmon from Maine; Ouananiche, p. 184.

Outer or first rays of ventral and anal fins definitely white; often red spots on sides. Scales 118 to 130 along lateral line...................10.

10. Body slender, greatest depth $4\frac{1}{4}$ to $4\frac{1}{2}$ in length of body less tail. Adipose fin small, width one-half length. Depth of narrowest part of body in front of tail three-eighths of depth of body and equal combined length of snout and eye. Eye usually $5\frac{1}{2}$ to 6 in length of head. Head two-ninths to one-fifth of length of body less tail. Spots often with light border or ring..........................*Loch Leven trout, Scotch lake trout*, p. 185.

Body short and deep, greatest depth 4 in length of body less tail. Adipose fin long and expanded at end. Depth of narrowest part of body in front of tail two-fifths of greatest depth or of length of head. Eye usually 5 in length of head. Head one-fourth of length of body less tail. Generally red spots mixed with black. Young have red spots within bluish circle.
Brown trout, Von Behr trout, p. 185.

11. Generally rose or flesh color on side of head and as a band or wash on side of body. No conspicuous patch of red on membrane of throat between forks of jaws. Maxillary seldom extends beyond back of eye except in old males. Lower fins often touched with white............12.

Rose color on side usually lacking. Generally definite red dash on lower jaw and membrane between jaws. Seldom any black spots or white border on lower fins. Often an interrupted red (not rose) stripe along side, particularly in small fish. Scales ordinarily 150 to 180 or more along lateral line. Maxillary extending well beyond eye.
Cutthroat trout, black-spotted trout, p. 187.

12. Black spots generally small and irregular in shape and not extending to lower side or lower fins. Sometimes scantily and sometimes profusely spotted, particularly on tail. Sea-run specimens silvery, turning dark in spawning condition, when males have deep red cheeks and sides. Length from nose to front of dorsal fin less than half the length of body to base of tail. The Columbia River steelhead typically has 60 vertebræ. Ocean-run fish slender when reaching Idaho. Scales about 120 to 135 diagonal rows along lateral line.
Steelhead trout, salmon trout, steelhead salmon, p. 186.

Generally profusely covered with round black spots extending well over lower side and lower fins. Spots usually larger than in steelhead. Sometimes rose-colored or reddish mark on under jaw or throat, particularly of mature males, but no definite dash of deep red on throat membrane. Length of nose to front of dorsal fin equal one-half length of body to base of tail. Vertebræ in typical McCloud rainbows are 63. Scales 140 to 155 diagonal rows along lateral line.
Rainbow trout, McCloud River rainbow, p. 186.

13. Tail strongly forked. Gray or yellow spots, not definitely red. Upper body with dusky or yellowish markings, underfins often touched with yellow crest. Scales 180 to 205 diagonal rows along lateral line.
Mackinaw or Great Lakes trout, p. 188.

Tail square or slightly forked. Either underfins with white on edges only and usually red spots on side or underfins with considerable white and red spots lacking. Underfins, when edged with white, usually contain also black and red. Vomer without raised crest and with teeth only on head and not on flattened backward extension or shaft. Scales 215 to 250 diagonal rows along lateral line, too small to be counted easily.
Genus SALVELINUS, 14.

14. Marbled or worm-shaped markings on head, back, back fins, and tail. Red spots on side with purplish or bluish ring. Body deep and not rounded.
Eastern brook trout, p. 188.

No marbled or worm-shaped markings on head, back, back fins, or tail. Red spots, when present, without purplish or bluish ring..............15.

15. Yellow or reddish spots (not marbling) on side, back, and head. Generally bright red spots on side, without purplish or bluish ring. Head large, flattened on top, its length contained less than 4 in length of body. Body round. Underfins often edged with white.
Dolly Varden, bull trout, charr in northern Idaho, p. 189.

Back without spotting. No red spots. Few of the yellow spots on side extend above lateral line. Head small, length contained four and one-half to five times in length of body. Golden sheen on scales. Belly of male orange and underfins with considerable white in breeding season.
Sunapee golden trout, white trout or *saibling*, p. 190.

DESCRIPTION OF SPECIES

MONTANA GRAYLING (*Thymallus montanus*)

Found originally only in the waters of the Missouri River above the Great Falls, the range of this fish has been somewhat enlarged by fish-cultural operations. It is identified by its small mouth, large scales, black spots on front part of body, and large sail-like dorsal fin with orange or rose marking. Grayling fishing is available in the Madison River, Big Hole Basin, and in

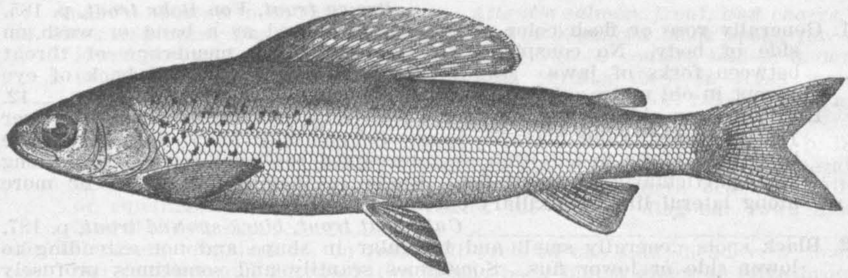


FIGURE 4.—Montana grayling, *Thymallus montanus*

Yellowstone National Park. This attractive fish ordinarily does not exceed 12 inches in length and a pound in weight but may reach 4 pounds. The fish ascends long distances to the headwaters to spawn in May. It is an active, gamey fish, taking a fly readily, and the flesh is superior to that of the trout. The large back fin is very brilliantly colored and is a ready means of identification. It has been planted in the headwaters of the Salmon River and in Utah.

ROCKY MOUNTAIN WHITEFISH (*Coregonus williamsoni*)

The Rocky Mountain whitefish is distributed widely throughout this region, the same species occurring in the Great Basin, Lahonta Basin in Nevada, and the Green River and Snake River watersheds. It is also called mountain herring and sometimes miscalled grayling. It is identified by the small mouth, large scales, lack of black spots, and back fin not long. It occurs in clear, cold lakes and streams and spawns in early winter. It ordinarily reaches a growth of about a foot in length, although it may reach about 4 pounds in weight. In several lakes in Idaho great numbers of them averaging around 8 inches long run into inlets to spawn in early winter. They take a fly or bait readily and are quite game fighters but not as much so as the trout. The flesh is white and very sweet. Owing to their small mouth, a small hook (No. 10 or 12) is best for their capture.

In Bear Lake are three other species found only in that water. The Bonneville whitefish (*Coregonus spilonotus*) reaches 2½ pounds in weight, has heavy and deep body with large head, 74 to 80 rows of scales along the lateral line, and the depth is contained 3.6 in the length of the body. Young up to 10 inches in length have large dusky black spots on the back. The Bear Lake whitefish (*Coregonus abbissicola*) reaches 8 to 12 inches in length, has a slender head and body, 69 to 78 rows of scales along the lateral line, no black spots, and the depth is contained about 4½ in length of body. The Rocky Mountain whitefish has 83 to 87 scales along the median line. The Bonneville cisco or peak nose (*Leucichthys gemmifer*) is a slender little fish reaching about 7½ inches in length, the depth is contained 5½ or more in length of body, and it has 71 to 77 rows of scales along the lateral line. This is an interesting little fish, as it is the only western representative of this genus of which several species occur in the Great Lakes and more eastern waters.

Pacific salmon (genus Oncorhynchus)

This group, containing five or more species, is of great commercial importance on the Pacific coast and in Alaska. The soft bones and the habit of almost universally dying after once spawning are peculiar to this genus. The steelhead trout has been known as a salmon, but it is a true trout and usually recovers from spawning, as do also the salmon of Atlantic waters. Pacific salmon may be distinguished from all other trout and salmon by the long anal or under rear fin, with never less than 13 rays, and the slenderness of the body in front of the tail. During the spawning season great changes in color and shape take place, there being a tendency then to turn red or very dark

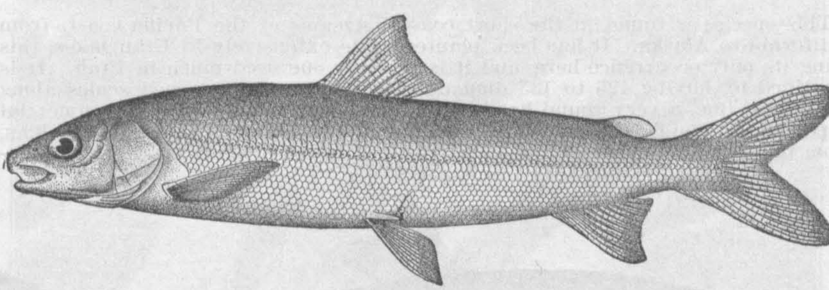


FIGURE 5.—Rocky Mountain whitefish, *Coregonus williamsoni*

and for the males to develop coarse teeth and hooked noses so that there is little resemblance to the fish in its normal condition. At the end of spawning period the fins are frayed, the body often is covered with sores, and the flesh is so soft that the entire fish quickly disintegrates soon after death. The fish from the ocean do not feed after once definitely starting the spawning migration, but live on fat stored in the body and flesh, so that the flesh loses color and flavor as the fish are longer in fresh water. They are found here principally in the tributaries to lower Snake River, but some species have been planted in lakes in other sections.

Chinook salmon (*Oncorhynchus tschawytscha*)

This is the largest and most important species of Pacific salmon. It is at present found in this region principally in the watershed of the Salmon River in Idaho. Plantings have been made in some Utah lakes. It is identifiable by its large size (seldom under 8 pounds), stout body, fine scales, and small black spots on its back and under fins. It ascends sometimes over 1,000 miles from the ocean to spawn in the headwaters in July, August, and September. The little salmon spend about a year in fresh water and then migrate to the ocean, from which they return in from four to seven years to spawn and die. This fish has been known to reach 100 pounds in weight, and specimens weighing 50 pounds have been taken in Idaho, but ordinarily it does not exceed 20 pounds in these waters. In the latter part of the spawning season the males turn very dark and develop hooked snouts, being known locally as "dog salmon." The true dog salmon (*Oncorhynchus keta*) spawns near the ocean and never reaches Idaho. Ordinarily it is captured by spearing but may be taken on a spoon or wabbler when gathered in pools prior to spawning and often will strike at a spoon or other bait when on the spawning riffles. The flesh is quite palatable when the fish first reaches the spawning waters but soon loses firmness and flavor.

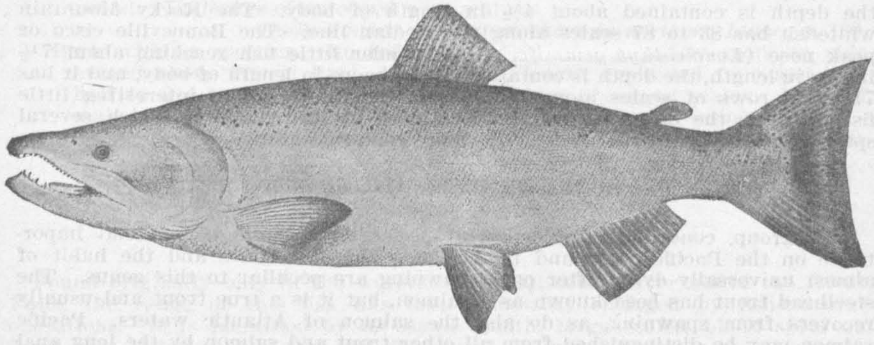


FIGURE 6.—Chinook salmon, breeding male, *Oncorhynchus tschawytscha*

SILVER OR COHO SALMON (*Oncorhynchus kisutch*)

This species is found in the short coastal streams of the Pacific coast, from California to Alaska. It has been planted quite extensively in Utah lakes, this being its only occurrence here, and it is the only one used much in Utah. It is identified by having 125 to 135 diagonal rows of loosely attached scales along the lateral line, a very round head, and a small eye. It is third in commercial importance. The flesh, although of excellent flavor, is light in color. It weighs, from the ocean, from 3 to 15 pounds. In fresh water it offers good fishing temporarily but seldom reproduces there and dies when fully mature. It is sometimes confused in name with the landlocked salmon from Maine.

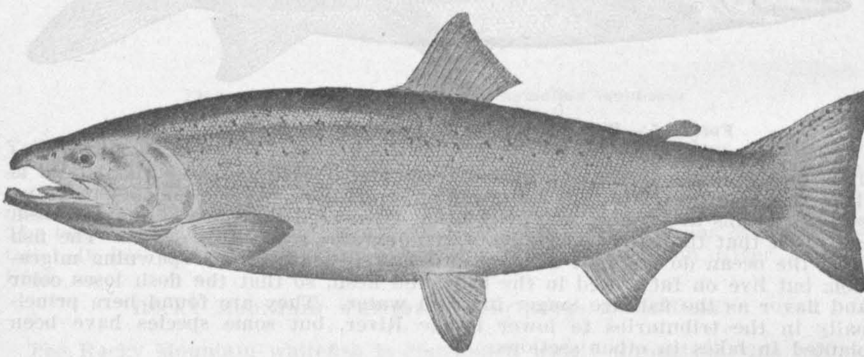


FIGURE 7.—Silver or coho salmon, breeding male, *Oncorhynchus kisutch*

BIG REDFISH OR BLUEBACK SALMON (SOCKEYE OR RED SALMON IN ALASKA) (*Oncorhynchus nerka*)

Formerly this salmon spawned in inlets to Payette Lake and Redfish Lakes, but it is unable to reach them now. Occasionally it is found below the Sunbeam Dam and may enter lower Payette waters. It may be identified by its slender body, general lack of black spots, large scales, and size (4 to 7 pounds). In the Columbia River it enters only streams with lakes at their sources and spawns in the lake inlets. Both males and females become bright red when in spawning condition, the males developing humped backs and greatly distorted jaws. Commercially it is the most valuable of the salmons and furnishes the choice "Alaska red" salmon.

LITTLE REDFISH; SILVER TROUT; SILVERSIDE (*Oncorhynchus kennerlyi*)

This fresh-water relative of the big redfish occurs in numerous waters in western North America and in this region is known from Payette Lake, Warm Lake, near Knox, and the Redfish Lakes in Idaho. It has been planted rather extensively as silver trout. It can be identified by its small size (6 to 14 inches), flattened body, few small black spots on the upper back and tail, large eye, and the fact that there are never less than 13 rays in the anal fin. It enters inlets whenever available for spawning, generally in August but sometimes later. In Alturas and Payette Lakes it averages about 11 inches long and weighs one-half pound, while in the other lakes it ranges from 6 to 8 inches long. In ordinary condition in the lakes it is very bright silvery with bluish back and delicate head; but when spawning it turns a dirty red to a bright red, with olive-green head, and the males develop hooked jaws. A school of the brilliant red spawning fish circling over the clear shallows of the lake inlets makes a very interesting spectacle. In Payette and Alturas Lakes this fish may be caught by trolling a fly or a small spoon and by still fishing with bait in

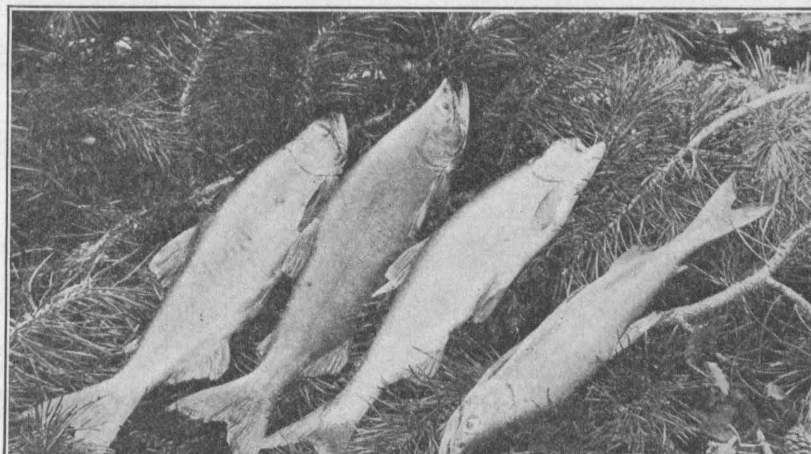


FIGURE 8.—Little redfish, silver trout, silverside, *Oncorhynchus nerka kennerlyi*

deep water. At Alturas Lake it feeds largely on the surface over deep water from sundown to dark and is best taken then but may be taken at any time by trolling deeper. Owing to the tenderness of its mouth, careful handling is required to land it. It is a game fighter. The flesh is of very fine quality except during the spawning season. Owing to the small size attained in other than the two waters mentioned above, and to the tender mouth, it is difficult to catch these fish there by angling.

ATLANTIC SALMON AND TRUE TROUT (GENUS SALMO)

This group includes the western trout with black spots and the introduced fresh-water Atlantic salmon and European trout. From the standpoint of the fish-culturist or fisherman in this region, these are the most important of all fishes. It can be identified by the small anal or back under fin, dark spots on lighter background, and seldom over 150 diagonal rows of scales along lateral line.

There are three general groups of these fish native to western America—the steelhead, rainbow, and cutthroat. Over the entire range these groups are not clear-cut, and intergrading forms occur, but in a given locality it is not hard to separate them. However, there are several different species of rainbow trout, two or more of which have been used in fish culture and often mixed. These have also been mixed with steelhead stock, so that a clear-cut identification of the planted steelhead and rainbow is extremely difficult. The female rainbow or steelhead have more delicate heads and less spotting than the males, particularly where the fish have made rapid growth and attained large size before spawning. These female fish with delicate heads, silvery color, and scanty spotting are often classed by fishermen as "steelheads" and the males or mature females as "rainbows." It is stated that in typical specimens the McCloud River rainbow has 63 and the Columbia River steelhead 60 vertebræ, but few fishermen will be tempted to make this count except, perhaps, after the fish have been through the fry pan. The silver trout (*Salmo gibbsii*), which occurs in lower Snake River waters such as Wood, Payette, and Salmon Rivers, has about 140 rows of scales along the lateral line, a rosy wash on the cheeks

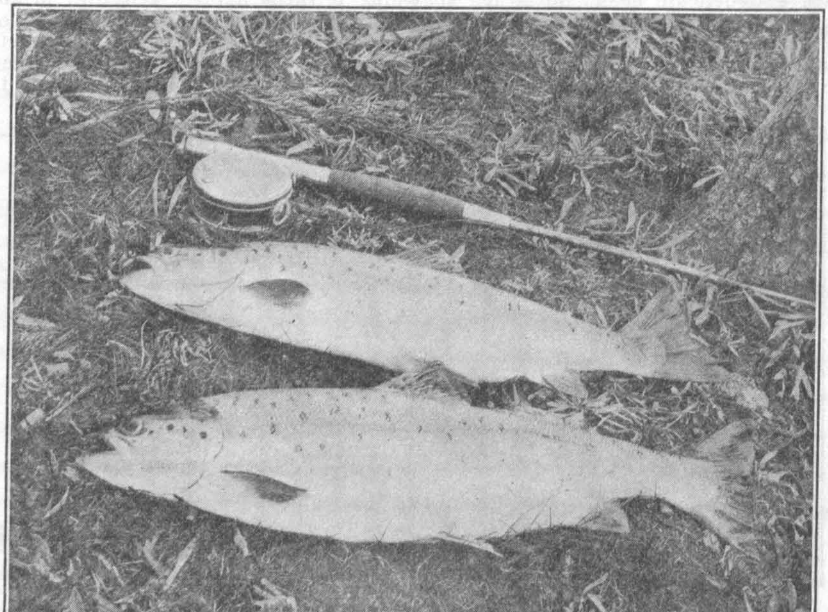


FIGURE 9.—Landlocked salmon, *Salmo sebago*

and sides, and sometimes a dash of red on the throat. In general appearance it resembles closely the rainbow or steelhead and very probably is a resident form derived from the Columbia River steelhead.

LANDLOCKED SALMON; OUANANICHE (*Salmo sebago*)

This fresh-water salmon occurred originally in four lake basins in Maine, and a closely related form was found in eastern Canada, but its range has been extended somewhat by cultivation. It is a lake fish but enters streams connected with lakes and spawns in such waters, generally in November. Ordinarily it does not die after spawning, as do the Pacific salmons. It is not found naturally in the absence of the fresh-water smelt, which constitutes its chief food, and it has never been established successfully where this food is lacking. Plantings of the Schoodic salmon from eastern Maine have been made in Payette Lake and several lakes in the Sawtooth Mountains and in the

TIMBERED SLOPES MEAN CLEAR STREAMS; CLEAR STREAMS MEAN GOOD TROUT WATER

latter locality have given encouraging results. They have also been planted with some success in Fish Lake, Utah. This fish may be identified by the lack of red or rose color, its large scales, X-shaped or irregular spots, broad and more or less forked tail, and the narrowness of the body in front of the tail. The weight varies in different waters—in some from 3 to 5 pounds and in others up to 10 or 15 pounds and to a maximum of 20 to 35 pounds. It has a well-deserved reputation for being a game fighter, many experienced fishermen placing it above all the trout, and its flesh is of very excellent quality. In cold streams or lakes it rises well to a fly, but in large lakes in midsummer it is more often taken by still fishing with a live bait or by trolling.

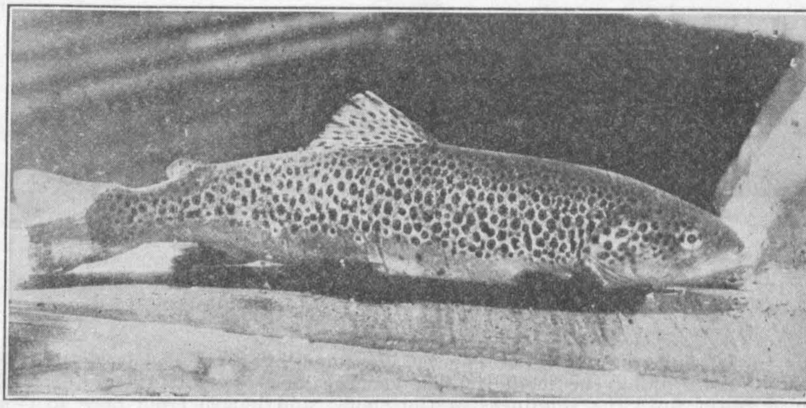


FIGURE 10.—Loch Leven trout, *Salmo trutta levenensis*

LOCH LEVEN OR SCOTCH LAKE TROUT (*Salmo levenensis*); BROWN OR VON BEHR TROUT (*Salmo fario*)

These two trouts have been introduced from Europe, where the brown trout is widely distributed. It can be distinguished from the other trouts by its large scales, heavy spotting, and generally both dark and red spots on the side. The Loch Leven trout is claimed to be peculiar to the Scotch lake of the same name. There has been considerable confusion in distinguishing between these two as planted in this country, and much mixing or hybridizing has resulted.

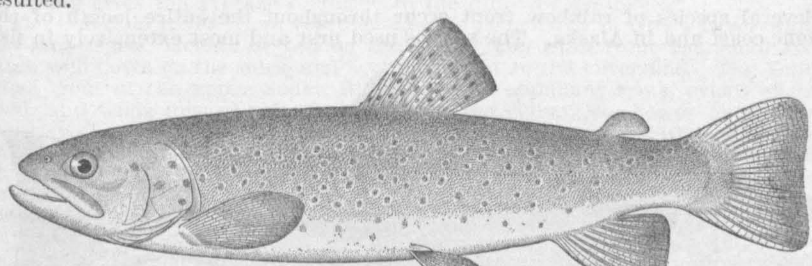


FIGURE 11.—Brown trout or von Behr trout, *Salmo fario*

The Loch Leven trout occurs in the headwaters of the south fork of the Snake River and in the Madison River. It can be identified by its slender shape and short adipose fin. The brown trout has been planted in the Madison River and in a number of streams in the Great Basin. It is identified by its short and deep body and long adipose fin. These two species spawn in early winter. A specimen weighing 25¼ pounds was taken in the Logan River, but ordinarily a 5 to 10 pound fish is considered very large. Particularly in the smaller streams they take a fly readily, but the larger fish in the lower streams are taken more often on bait or artificial lures. They are game fighters and of excellent quality for table use. They are considered to be detrimental to the other trout, and their introduction is not advised except in waters unfavorable for the other trout. Brown trout are spawn eaters, even making a meal of their own spawn.

STEELHEAD TROUT (*Salmo gairdnerii*)

This fish is generally migratory in habits, entering the ocean and returning to fresh water to spawn, although in certain Snake River waters resident types are to be found. It has been planted in Great Basin waters and mixed with rain-

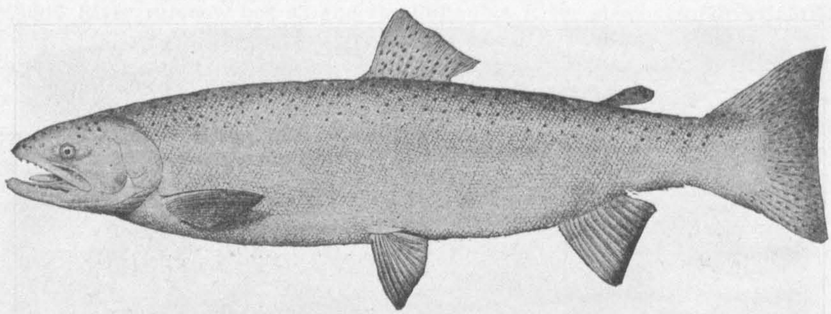


FIGURE 12.—Steelhead trout, *Salmo gairdnerii*

bows in fish-cultural work. It can be identified by its scales in 120 to 135 diagonal rows along the median line; general lack of spotting on its lower side or lower fins; the smallness of the spots; and length from nose to front of dorsal fin, which is generally less than half the length of the body to base of tail. It reaches Idaho waters from the sea from December to early spring, spawning in the headwaters from late winter to spring. The largest ever taken on a rod weighed 22 pounds, although they seldom exceed 15 pounds in this region. In the Salmon River they are known as salmon trout, generally being slender and having red colors there. The planted fish in inland waters are taken largely by fly fishing, but those from the sea are generally taken with bait or a small spinner. They are probably more game than any other native trout, and, except when out of condition from spawning, the flesh is very good.

RAINBOW TROUT

Several species of rainbow trout occur throughout the entire length of the Pacific coast and in Alaska. The species used first and most extensively in fish

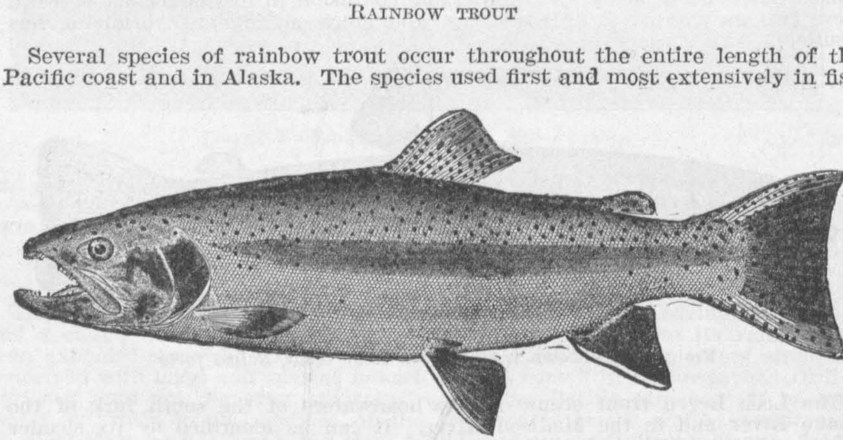


FIGURE 13.—Rainbow trout, *Salmo shasta*

culture was the McCloud River rainbow, which has relatively fine scales. Mixtures of these and rainbows having larger scales from the Klamath Basin and also with steelhead are common. It may be identified by larger and more profuse spotting than in the steelhead, 140 to 155 diagonal rows of scales along the median line, and the fact that the length from the nose to front of dorsal fin generally equals one-half the length of the body to base of tail. The rainbow trout, in general, has become very popular and in this region is more productive, makes more rapid growth, and is easier to handle in fish culture than any others. It spawns from midwinter in warm, spring-fed waters to July in cold waters at high elevations. It maximum size here is from 10 to 15 pounds, chiefly in lakes, but the average in streams is not over a pound. The record fish taken with a rod weighed 26 pounds, but the identification was not positive.

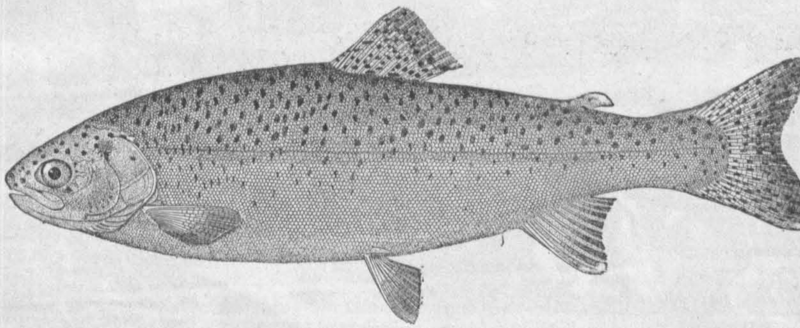


FIGURE 14.—Rainbow trout, heavily spotted type, *Salmo irideus*

It is a game fighter, taking a fly well and leaping vigorously from the water when hooked. Except from sluggish water or where there is considerable decaying vegetation its flesh is of excellent quality.

CUTTHROAT OR BLACK-SPOTTED TROUT

This is the "native" trout, and originally each main drainage basin contained a separate species as did also the upper and lower Snake River waters. These have been mixed considerably by cultivation, but, except for the silver trout in lower Snake River, all of these are characterized by a definite red dash on the throat membrane. It can be identified by this red dash, its small scales, large head, and maxillary extending well beyond the eye. The spotting and coloring vary considerably among the different species and in different water, but the following gives the average condition in the different drainages:

The Colorado River trout, represented here principally in Green River waters, has large spots, lacking or few on the head. The Utah trout has small spots, often well down on the sides, and a purplish tint to the lower fins. The Yellowstone trout of the upper Snake River has less abundant spots, evenly distributed, and tends toward yellow coloring on the belly. The lower Snake River trout are heavily marked on the rear part of the body with rather small spots and tend toward red colors, the so-called "red-sides" of Salmon River being particularly brilliantly colored. The Nevada trout has relatively large, well-scattered spots, often oval shaped, and tends toward yellow, if any color, on the belly; in alkaline waters there is a tendency toward pale colors. In deep water in Bear Lake the Utah trout develop a peculiar coloring and are known locally as "blue-nose" trout. The cutthroat trout spawn from early spring to early summer. In small streams and lakes they are an excellent fly fish but in larger waters are taken more often by trolling or bait fishing. Ordinarily they weigh from 1 to 5 pounds but may reach a weight of 15 pounds or more. One taken from Pyramid Lake, Nev., weighed 41 pounds, and they are said to have reached 22 pounds in Bear Lake. They are "shier biters" than any other species, and there are certain times when it is difficult to get them to bite at all. Their flesh is of very superior quality, particularly from cold streams and lakes.

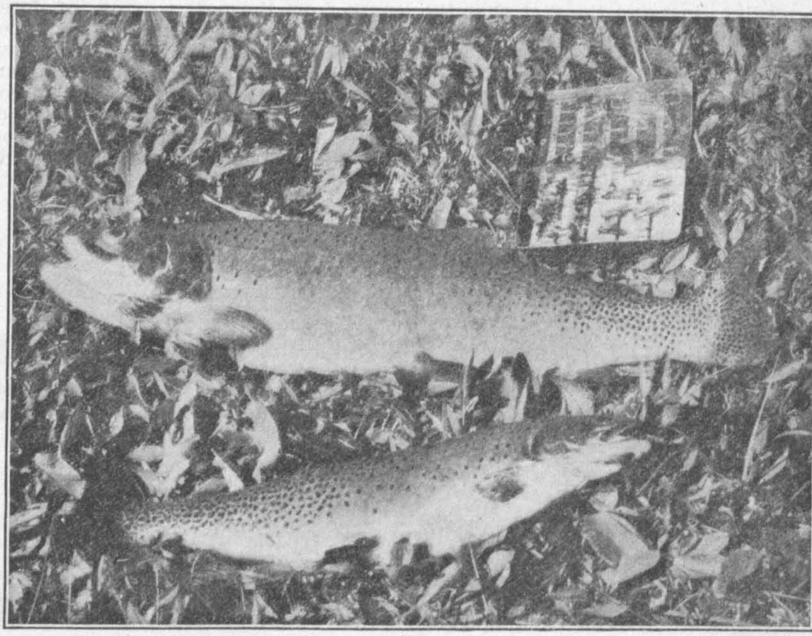


FIGURE 15.—Cutthroat or blackspotted trout, Salmon River type, *Salmo lewisi*

MACKINAW OR GREAT LAKES TROUT (*Cristivomer namaycush*)

This fish is distributed in the waters of northern North America from the Atlantic to the Pacific and has been planted in lakes in this region. It can be identified by its large size, small scales, forked tail, lack of red spots, large head, and strong teeth. It has been taken weighing 34 pounds in the Jackson Hole section and 28 pounds at Fish Lake, Utah, and in the Great Lakes has been known to weigh 100 pounds. Spawning takes place in the early winter. It is a coarse fish of predatory habit, and because it is generally taken in

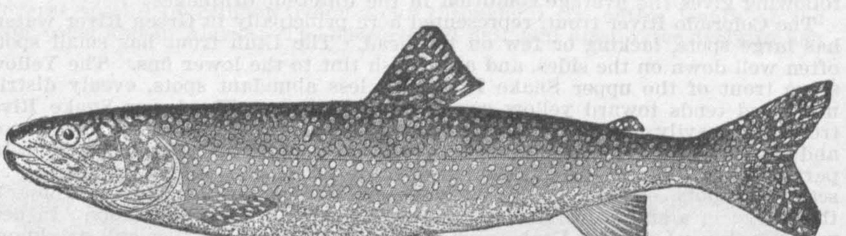


FIGURE 16.—Mackinaw trout, *Christivomer namaycush*

deep water on heavy tackle it does not offer as much sport in its capture as do the other trouts, its size being the chief attraction. The flesh is of very delicate flavor and is particularly rich in oil, which makes it superior for baking purposes.

EASTERN BROOK TROUT, SPECKLED TROUT (*Salvelinus fontinalis*)

This fish is of wide distribution in eastern North America, where it is the species most desired by anglers. It has been planted quite extensively in this section, being best known from Fish Lake in Utah and Lost River in Idaho. The upper Snake River waters also yield very large specimens. It can be identified by its deep body, mottlings on back and fins, red spots in a bluish circle, and square tail. It likes quiet waters and is at its best in high mountain

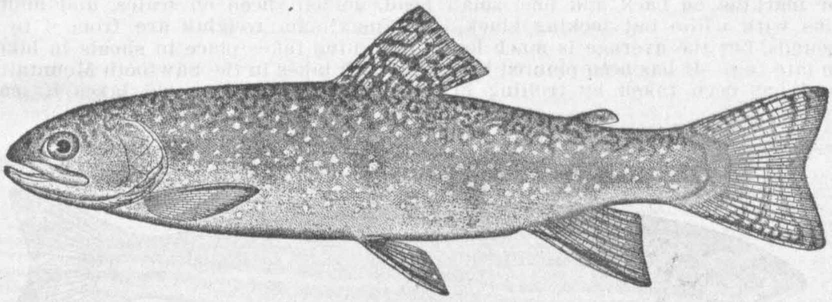


FIGURE 17.—Eastern brook trout, *Salvelinus fontinalis*

lakes. It spawns in streams in October and November. Specimens have been taken weighing from 8 to 14½ pounds, but 4-pound fish are uncommon. It takes a fly readily and is a vigorous if not showy fighter. In cold water its flesh is of excellent flavor, but, owing to the large amount of oil in the flesh, it does not remain firm as long as does that of trout having drier and less rich meat. Its beauty and free-feeding habits without "off periods" when it is difficult to take them by angling make it a valuable addition to the native fish species.

DOLLY VARDEN OR BULL TROUT (*Salvelinus spectabilis*)

This western representative of the group known as charrs occurs in Pacific waters from northern California to Alaska and can be identified by its large head, round body, red or yellow spots without a bluish circle, and forked tail. It is quite common in lower Snake River waters in lakes and streams. Large individuals ascend headwater creeks in early fall to spawn. It occasionally reaches 10 pounds or more in weight. It is a voracious and cannibalistic fish and is considered detrimental to other species, being particularly destructive to salmon eggs and fry. It is an irregular feeder, and it is often

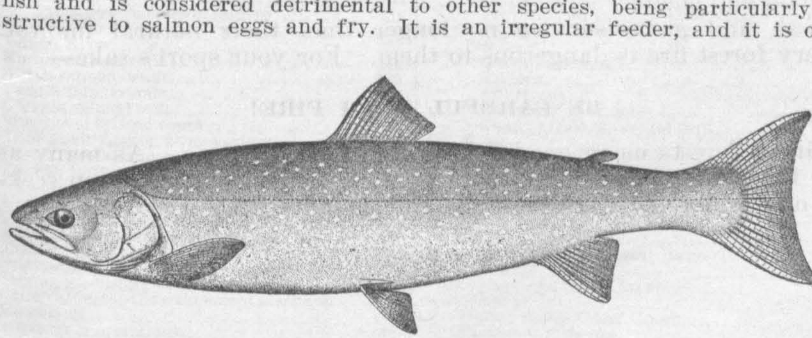


FIGURE 18.—Dolly Varden trout, *Salvelinus spectabilis*

difficult to get them to take bait. It is a fairly game fighter in swift water, being generally taken with salmon eggs or a bait. Its flesh is not as good as that of other trout. This is a rather coarse fish, not particularly attractive to the angler, and is the poorest of the charrs.

KILL YOUR CAMP FIRE—THEN BURY IT

SUNAPEE GOLDEN TROUT, WHITE TROUT, SAIBLING (*Salvelinus aureolus*)

Occuring only in a few waters in New Hampshire, Vermont, and one lake in Maine, this beautiful charr is not widely known. It is a lake fish and retires to deep water in summer. It can be identified by the lack of spotting or marking on back and fins, small head, golden sheen on scales, and under fins with white but lacking black. The maximum weights are from 6 to 8 pounds, but the average is much less. Spawning takes place in shoals in lakes in late fall. It has been planted in several high lakes in the Sawtooth Mountains and has been taken by trolling in Alice Lake. In these cold lakes it may

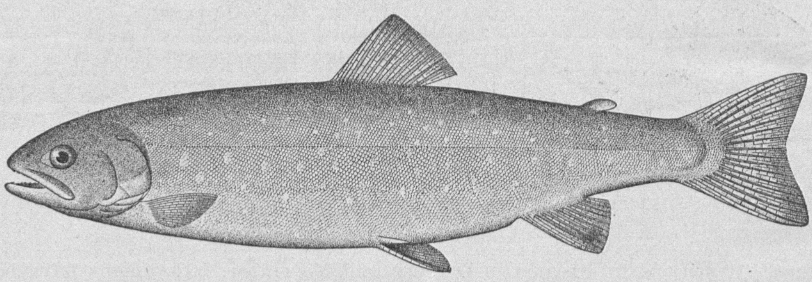


FIGURE 19.—Golden trout of Sunapee Lake, *Salvelinus aureolus*

probably be found away from deep water, but the usual method of taking it is with bait in from 40 to 100 feet of water. In such waters it may not grow to large size but probably will be brilliantly colored. Wherever found it is held in high esteem by anglers on account of its beauty of form and color, game qualities, and excellency for the table.

AFTERWORD

Forest fires destroy game birds and their nests, kill fish and wild animals, but of more serious consequences is the destruction of the opportunity for fish and game to survive and multiply. This loss is replenished only after the slow process of adequate replacement of food and shelter.

Fish and game survive no longer than their natural habitat. Every forest fire is dangerous to them. For your sport's sake—

BE CAREFUL WITH FIRE!

Green forests mean good fishing and good hunting. As many as 100 forest fires in a single year have been caused by recreation seekers on the national forests of the Intermountain District.

DON'T CAUSE ONE!

ALASKA FISHERY AND FUR-SEAL INDUSTRIES IN 1928 [1]

By Ward T. Bower, *Administrative Officer*

CONTENTS

[1] Appendix VI to the Report of the U. S. Commissioner of Fisheries for 1929. B. F. Doc. 1064.

INTRODUCTION

The bureau's work in the conservation of the fisheries of Alaska and the protection and management of the Pribilof Islands fur-seal herd followed the same general plan in 1928 as in previous years.

As the salmon fishery is the outstanding industry of the Territory, the value of its products for the last 10 years averaging annually about $36,500,000 and comprising upward of 85 per cent of the total fisheries output, the problem of maintaining it at a high level of productivity calls for particular attention. Commissioner O'Malley was in Alaska for several weeks during the active salmon-fishing season to observe conditions and determine the effectiveness of the methods employed to perpetuate and develop this important fishery.

Various amendments of the existing fisheries regulations were issued during the season as the need therefor became evident, and a general revision of the regulations was made late in the fall to be effective in 1929. This revision included the redistricting of the southeastern Alaska area into 8 divisions, instead of 6, as formerly, and a number of changes in restrictive measures to prevent depletion of the runs through overfishing.

In the patrol of the fishing grounds more than 200 persons were employed for varying periods. Fourteen vessels belonging to the bureau and eight chartered vessels, as well as a number of launches, participated in the work. Included in the bureau's fleet were two new vessels, *Teal* and *Crane*, designed especially for service in Alaska and used there this season for the first time. Markers were erected at the mouths of salmon streams and at the boundaries of other closed areas, and log jams and other barriers that were preventing the ascent of salmon to the spawning grounds were removed.

Scientific studies of the salmon, herring, and clam fisheries were continued. Weirs were maintained for the counting of the spawning escapement in 14 important salmon streams, and observations of escapement conditions were made in all districts, some very thorough surveys being carried on in the Bristol Bay region. Reports of commercial operations were collected, the data thus obtained being used in the compilation of the fishery statistics published herewith.

At the Pribilof Islands 31,099 fur-seal skins were taken, an increase of 6,157 over the preceding year. Of a total of 23,003 skins taken on St. Paul Island, 14,584 were blubbered before salting. To provide for the future breeding reserve, 8,852 3-year-old male seals were marked. A computation of the herd indicated that it contained 871,513 animals, an increase of 62,643 over the number computed in the preceding year. Foxing operations were carried on in conjunction with sealing activities, and in the winter of 1928–29, 544 blue and 9 white pelts were obtained. Valuable service was rendered by the United States Coast Guard in maintaining a patrol of the waters frequented by the Pribilof Islands fur seals.

Several new structures, chiefly houses for natives, were erected to replace dilapidated buildings, and the construction of a new medical building on St. George Island was begun. Some extension of improved roads was made also. The annual shipment of supplies for the islands was transported by the U. S. S. *Vega*, through the courtesy and cooperation of the Navy Department, and the skins then ready for shipment were brought to Seattle on the vessel's return trip.

Two public auction sales were held by the department's selling agents at St. Louis, at each of which both fur-seal and fox skins were sold.

Acknowledgment is made of the assistance rendered by members of the bureau's staff in the compilation and preparation of this document.

VISIT OF THE COMMISSIONER OF FISHERIES AND OTHER OFFICIALS TO ALASKA

The Commissioner of Fisheries sailed from Seattle on the *Brant* on July 5, 1928, for Alaska, where he inspected the fisheries as far west as the Kodiak area. Prince William Sound also was visited, and several weeks were spent in southeastern Alaska.

In August the bureau's vessel *Brant* was at the service of Secretary of Agriculture, William M. Jardine, during an inspection tour of southeastern Alaska. Visits were made at Ketchikan, Wrangell, Petersburg, Juneau, Skagway, and Sitka. Commissioner O'Malley accompanied the Secretary on the trip to these places and returned with him to Seattle on the *Brant*, sailing from Juneau on August 24.

Various fishery matters on the Pacific coast were given attention by Commissioner O'Malley before his return to Washington, where he arrived on September 22.

REGULATIONS FOR PROTECTION OF WALRUSES AND SEA LIONS

A revised edition (fourth) of departmental Circular No. 286, containing the laws and regulations for the protection of the walruses and sea lions of Alaska, was issued by the Acting Secretary of Commerce under date of May 1, 1928. The regulations governing the killing of walruses and sea lions are as follows:

WALRUSES

The killing of walruses in the Territory of Alaska or in any of the waters of Alaska over which the United States has jurisdiction is prohibited from May 1, 1928, to April 30, 1930, both dates inclusive. This prohibition shall not apply to the killing of walruses by natives for food or clothing, by miners or explorers when in need of food, or to the collection of specimens for scientific purposes under permits issued by the Secretary of Commerce.

SEA LIONS

The killing of sea lions in the Territory of Alaska or in any of the waters of Alaska over which the United States has jurisdiction is prohibited from May 1, 1928, to April 30, 1930, both dates inclusive. This prohibition shall not apply to the killing of sea lions by natives for food or clothing, by miners or explorers when in need of food, by anyone in the necessary protection of property or while such animals are actually engaged in the devastation of runs of salmon, or to the collection of specimens for scientific purposes under permits issued by the Secretary of Commerce.

The penalties and forfeitures imposed by law will be strictly enforced against all persons who commit acts in violation thereof or of the regulations promulgated in accordance therewith.

FISHERY INDUSTRIES

As in corresponding reports for previous years, the Territory of Alaska is here considered in the three coastal geographic sections generally recognized, as follows: (1) Southeast Alaska, embracing all that narrow strip of mainland and the numerous adjacent islands from Portland Canal northwestward to and including Yakutat Bay; (2) central Alaska, the region on the Pacific from Yakutat Bay westward, including Prince William Sound, Cook Inlet, and the southern coast of Alaska Peninsula, to Unimak Pass; and (3) western Alaska, the north shore of the Alaska Peninsula, including the Aleutian Islands westward from Unimak Pass, Bristol Bay, and the Kuskokwim and Yukon Rivers. These divisions are solely for statistical purposes and do not coincide with areas established in departmental regulations.

Detailed reports and statistical tables dealing with the various fishery industries are presented herewith, and there are also given the important features of certain subjects that were the objects of special investigation or inquiry.

EXECUTIVE ORDERS

Under date of October 25, 1928, an Executive order was issued whereby the vessels added to the bureau's Alaska service in recent years have been included among those specifically designated to assist in the patrol of certain waters to enforce the provisions of the northern Pacific halibut act. The text of the order is as follows:

It being expedient for the enforcement of the act for the protection of the northern Pacific halibut fishery, approved June 7, 1924, that a patrol be maintained in certain waters, and that public vessels be designated for that purpose and officers be designated to enforce said act: Therefore, it is hereby ordered—

1. That a patrol be maintained in the territorial waters of the United States and the high seas, including Bering Sea, extending westerly from the territorial waters of the United States and Canada, to be conducted by any naval or other public vessels on service in such waters and including specifically the following named vessels of the Bureau of Fisheries: *Widgeon, Murre, Auklet, Petrel, Eider, Kittiwake, Blue Wing, Merganser, Scoter, Brant, Teal, Crane,* and *Red Wing.*

2. That the masters of such vessels, and the agents, assistant agents, inspectors, and wardens of the Bureau of Fisheries are hereby designated as officials to exercise all powers of search and seizure conferred by said act upon persons so designated by the President.

Several islands of the Aleutian Islands Reservation, which was created by Executive order of March 3, 1913, and consisted of "all islands of the Aleutian chain, Alaska, including Unimak and Sanak Islands on the east, and extending to and including Attu Island on the west," were excluded from the reservation by Executive order of November 23, 1928, as follows:

It is hereby ordered that Executive order of March 3, 1913 (No. 1733), reserving all islands of the Aleutian chain, Alaska, for a preserve and breeding ground for native birds, for the propagation of reindeer and fur-bearing animals, and for the encouragement and development of fisheries, be, and it is hereby, revoked in so far as it affects the following-named islands as shown upon United States Geodetic and Coast Survey Chart No. 8802: Akun, Akutan, Sanak, Tigalda, Umnak, and Unalaska, including Sedanka.

And it is also hereby ordered, pursuant to Public Resolution No. 29 of February 14, 1920 (41 Stat. 434), as amended January 21 and December 28, 1922 (42 Stat. 358, 1067), that the public lands in the above-named islands shall, subject to valid rights and the provisions of existing withdrawals, be opened only to entry under the applicable homestead laws requiring residence by qualified ex-service men of the World War, under the terms and conditions of said resolution and the regulations issued thereunder, for a period of 91 days beginning with the sixty-third day from and after the date hereof, and thereafter to appropriation under any public land law applicable thereto by the general public.

Subsequent to the date hereof and prior to the date of restoration to general disposition as herein provided, no rights may be acquired to the excluded lands by settlement in advance of entry, or otherwise, except strictly in accordance herewith.

NEW FISHERY REGULATIONS

The regulations for the protection of the fisheries of Alaska, issued December 12, 1927, were amended by the following regulations issued by the Acting Secretary of Commerce under the dates indicated:

[*January 16, 1928*]

PRINCE WILLIAM SOUND AREA

Salmon fishery.—Regulation No. 10 (*b*) is amended to read as follows: Eastern coast of Chenega Island from a point 1 statute mile southward of its northern extremity to a point 1 statute mile eastward of Chenega village.

Regulation No. 10 (*d*) is revoked.

Regulation No. 10 (*g*) is amended to read as follows: Along the mainland eastward and northward from the outermost extremity of Point Pellew to 60 degrees 51 minutes north latitude.

Regulation No. 10 (*j*) is amended to read as follows: From the north side of the entrance to Sawmill Bay to a point on the coast 1 statute mile northeastward.

Regulation No. 10 (*k*) is amended to read as follows: Southwest coast of Bligh Island from 60 degrees 49 minutes 45 seconds north latitude to 146 degrees 44 minutes 20 seconds west longitude.

Regulation No. 10 (*l*) is amended to read as follows: Within ½ statute mile of the southwestern extremity of Bidarka Point, and from a point on the west side of Landlocked Bay at 60 degrees 49 minutes north latitude to a point on the north shore of Port Fidalgo at 146 degrees 32 minutes west longitude.

Regulation No. 10 (*r*) is amended to read as follows: From a point on the coast 1 statute mile northwestward of the light at Gravina Point to a point on the coast 2 statute miles northwestward of the light at Gravina Point, making an open space of 1 statute mile.

Regulation No. 10 (*t*) is amended to read as follows: From a point on the coast 2½ statute miles north of Bear Cape northward to the light at Johnstone Point, and from a point at 60 degrees 28 minutes 30 seconds north latitude, 146 degrees 32 minutes west longitude, to a point opposite Hawkins Island at 60 degrees 28 minutes north latitude.

Regulation No. 10 (*u*) is amended to read as follows: Within ½ statute mile eastward of a point on the south side of Port Etches at 146 degrees 40 minutes west longitude.

SOUTHEASTERN ALASKA AREA

Icy Strait—Cross Sound District

Salmon fishery.—Regulation No. 12 (*c*) is amended to read as follows: Inian Islands: (1) North of 58 degrees 15 minutes 42 seconds north latitude exclusive of the east end of the northeastern island, and (2) southwest coast of the northwestern island between 58 degrees 15 minutes 42 seconds north latitude and 58 degrees 15 minutes 18 seconds north latitude.

Prince of Wales Island District

Salmon fishery.—Regulation No. 7 (*c*) is amended to read as follows: Kosciusko Island: Western coast from the southern extremity of land at the west side of Halibut Harbor to 55 degrees 56 minutes 15 seconds north latitude, and from the south point at the entrance of Pole Anchorage to Ruins Point at 133 degrees 40 minutes west longitude, including the small islet at the north point of the entrance of Pole Anchorage.

Regulation No. 7 (*j*) is amended to read as follows: Heceta Island: Western and southern coasts from a point on the coast 1½ statute miles southeastwardly from Cape Lynch to a point at 55 degrees 44 minutes north latitude and approximately 133 degrees 29 minutes 20 seconds west longitude.

Regulation No. 7 (*aa*) is amended to read as follows: Dall Island: East coast from 54 degrees 59 minutes north latitude to 55 degrees 30 seconds north latitude.

Regulation No. 7 (*cc*) is amended to read as follows: Long Island, east of Dall Island: West coast between 54 degrees 46 minutes north latitude and 54 degrees 47 minutes north latitude.

Regulation No. 7 (*ee*) is amended to read as follows: (1) Coast of Prince of Wales Island from Point Webster southeastward to 54 degrees 54 minutes 45 seconds north latitude, exclusive of the waters of Kassa Inlet and its tributaries and branches, and (2) the west coast of the western of the two largest islands of the Ship Islands group and within 300 yards west of the southern extremity of the eastern large island of this group

Regulation No. 7 (*jj*) is amended to read as follows: Zarembo Island: West coast from 56 degrees 20 minutes north latitude southeastward to a point on the coast at 133 degrees west longitude.

Regulation No. 7 (*mm*) is amended to read as follows: West coasts of Observation Island, Marsh Island, Screen Islands, and Abraham Island.

Southern District

Salmon fishery.—Regulation No. 6 (*e*) is amended to read as follows: Kuiu Island: From Cape Decision northwestward to a point on the coast at 134 degrees 9 minutes west longitude, and from a point on the coast 2 statute miles northeastward from Cape Decision to a point on the coast near the entrance to Port McArthur at 56 degrees 3 minutes north latitude.

Regulation No. 6 (*g*) is amended to read as follows: Southern coast of Mitkof Island between 132 degrees 51 minutes west longitude and 132 degrees 52 minutes 20 seconds west longitude, and the west coast of Zarembo Island from Point St. John to 56 degrees 24 minutes 20 seconds north latitude.

Regulation No. 6 (*v*) is amended to read as follows: Revillagigedo Island: Within ½ statute mile of Escape Point and within ½ statute mile of Indian Point.

Regulation No. 6 (*w*) is amended to read as follows: Betton Island: West coast between the southern extremity of the island and 55 degrees 30 minutes north latitude, and from Tatoosh Point northeastward to the northern extremity of the island.

Regulation No. 6 (*x*) is amended to read as follows: Guard Islands and the westerly side of the Vallenar Rock Island located about 800 yards from the northern extremity of Vallenar Point.

Regulation No. 6 (*mm*) is amended to read as follows: West coast of Kanagunut Island between the northern extremity of the island and Garnet Point, and within ½ statute mile of the southern extremity of Sitklan Island.

SOUTHEASTERN ALASKA AREA

Steelhead fishery.—The regulation applying to commercial fishing for steelhead trout is amended to read as follows: Commercial fishing for steelhead trout shall be subject to the provisions of law and the regulations applicable to commercial fishing for salmon: *Provided,* That, except in respect to weekly close periods, this regulation shall not be effective in the period from March 15 to April 30, both dates inclusive, in the Central, Stikine, Prince of Wales Island, and Southern Districts.

[*February 2, 1928*]

PRINCE WILLIAM SOUND AREA

Salmon fishery.—Regulation No. 10 (*l*) is amended to read as follows: Within ½ statute mile of the southwestern extremity of Bidarka Point, and from a point on the east side of Landlocked Bay at 60 degrees 49 minutes north latitude to a point on the north shore of Port Fidalgo at 146 degrees 32 minutes west longitude.

[*April 16, 1928*]

ALEUTIAN ISLANDS AREA

Herring fishery.—1. Commercial fishing for herring is prohibited in the period from January 1 to May 31, both dates inclusive, and from December 1 to December 31, both dates inclusive, in each calendar year.

2. The closed seasons herein specified for commercial herring fishing shall not apply to the taking of herring for bait purposes in waters otherwise open to fishing.

3. Commercial fishing for herring, except for bait purposes, is prohibited from 6 o'clock postmeridian of Saturday of each week until 6 o'clock antemeridian of the Monday following.

4. Gill nets used in catching herring shall not be of smaller mesh than 3 inches stretched measure.

5. No one shall place, or cause to be placed, across the entrance of any lagoon or bay any net or other device which will prevent the free passage at all times of herring in and out of said lagoon or bay.

KODIAK AREA

Salmon fishery.—Commercial fishing for salmon by means of any trap or gill net is prohibited along the southern coast of Kodiak Island from Cape Trinity to the headland at the south side of the entrance to Kaguyak Bay.

PRINCE WILLIAM SOUND AREA

Herring fishery.—Regulation No. 1 is amended to read as follows: Commercial fishing for herring is prohibited during the period from January 1 to June 15, both dates inclusive, and from November 1 to December 31, both dates inclusive, except that gill nets of not less than 2½ inches stretched measure between knots may be used from November 1 to December 15, both dates inclusive.

SOUTHEASTERN ALASKA AREA

Icy Strait—Cross Sound District

Salmon fishery.—Regulation No. 7 is amended to read as follows: Commercial fishing for salmon, except by trolling, is prohibited for the remainder of each calendar year after 6 o'clock postmeridian August 6: *Provided*, That this prohibition shall not apply to the use of purse seines and gill nets from 6 o'clock antemeridian September 10 to 6 o'clock postmeridian September 29, 1928, in waters open to fishing.

Central District

Salmon fishery.—Regulation No. 5 is amended to read as follows: Commercial fishing for salmon, except by trolling, is prohibited prior to 6 o'clock antemeridian June 20 in each calendar year and for the remainder of each calendar year after 6 o'clock postmeridian August 11: *Provided*, That this prohibition shall not apply to the use of purse seines and gill nets from 6 o'clock antemeridian September 10 to 6 o'clock postmeridian September 29, 1928, in waters open to fishing.

Regulation No. 8 (*n*) is amended to read as follows: Admiralty Island: Southeast coast from a point on the coast ½ statute mile southwest of Point Brightman to Walker Point.

Prince of Wales Island District

Salmon fishery.—Regulation No. 7 (*j*) is amended to read as follows: Heceta Island: Western and southern coasts from a point on the coast 1½ statute miles southeastwardly from Cape Lynch to a point on the coast at 55 degrees 42 minutes 30 seconds north latitude and approximately 133 degrees 29 minutes 25 seconds west longitude.

Regulation No. 7 (*t*) is amended to read as follows: San Fernando Island: Northern coast from Point Garcia to a point on the coast 1 statute mile west of Point Santa Lucia.

Regulation No. 7 (*u*) is amended to read as follows: San Fernando Island: Southeastern coast from a point on the coast 1 statute mile southwest of Fern Point to Point Amargura.

Regulation No. 7 (*w*) is amended to read as follows: San Juan Bautista Island: Coast south of 55 degrees 25 minutes 45 seconds north latitude.

Regulation No. 7 (*cc*) is amended to read as follows: Long Island, east of Dall Island: East and west coasts between 54 degrees 46 minutes north latitude and 54 degrees 47 minutes north latitude.

Regulation No. 7 (*kk*) is amended to read as follows: Etolin Island: West coast from 56 degrees 18 minutes north latitude southward to a point on the coast ½ statute mile southeastward of Steamer Point.

Southern District

Salmon fishery.—Regulation No. 6 (*gg*) is amended to read as follows: Foggy Bay to Cape Fox: From within 1 statute mile northward and eastward of Foggy Point to the southern extremity of Cape Fox, including Cape Fox Island.

Regulation No. 7 (*s*) is amended to read as follows: Bradfield Canal: All waters of Bradfield Canal to the eastward of a line from Point Warde to the point at the east side of the entrance to Fools Inlet.

Regulation effective in each area in which traps are permitted

Salmon fishery.—No trap shall have more than two spillers.

[*May 2, 1928*]

KODIAK AREA

Salmon fishery.—Commercial fishing for salmon by means of any trap is prohibited in waters of the mainland shore and adjacent islands from Cape Douglas southwestward to Cape Kunmik.

[*May 14, 1928*]

SOUTHEASTERN ALASKA AREA

Icy Strait—Cross Sound District

Salmon fishery.—Regulation No. 12 (*o*) is amended to read as follows: Mansfield Peninsula: West coast from Point Retreat to the southern extremity of the peninsula at the north side of the entrance to Hawk Inlet including the Kitten Islands but exclusive of Funter Bay.

[*June 8, 1928*]

SOUTHEASTERN ALASKA AREA

Central District

Salmon fishery.—Regulation No. 6 is amended to read as follows: Commercial fishing for salmon is prohibited in Tenakee Inlet and Freshwater Bay within a line from North Passage Point to South Passage Point: *Provided,* That this prohibition shall not apply to trolling in the period from January 1 to July 15, both dates inclusive, in each calendar year.

[*June 21, 1928*]

BRISTOL BAY AREA

Salmon fishery.—Regulation No. 4 (*a*) is amended to read as follows: Nushagak district, except that stake nets are prohibited along the west shore of Nushagak Bay from a point 2 statute miles south of Bradford Point to Coffee Point and along the east shore from a point 2,000 yards southeast of the northern extremity of Ekuk Spit to Etolin Point.

[*July 11, 1928*]

KODIAK AREA

Salmon fishery.—The use of any beach seine for the capture of salmon after August 15 in each year is prohibited in all waters of Uganik Bay, including Uganik Passage and other tributaries and arms, within a line from West Point to Uganik Island passing through the northern extremity of East Point.

The use of any trap or beach seine for the capture of salmon after August 15 in each year is prohibited as follows:

Uyak Bay: All waters of Uyak Bay and its tributaries and adjoining waters within a line from Uyak Postoffice to Cape Kuliuk.

Terror and Vickoda Bays: All waters within a line from Cape Uganik to Outlet Cape.

Southern coast of Kodiak Island: All waters from Cape Chiniak to Cape Trinity. The waters of Ugak Island, the Trinity Islands, and all other islands lying between or adjacent are included.

[*July 23, 1928*]

KODIAK AREA

Salmon fishery.—Commercial fishing for salmon after August 15 in each calendar year in Alitak Bay and all its branches within a line from Cape Trinity to Cape Alitak is prohibited: *Provided,* That this prohibition shall not apply to traps on the north shore of the entrance to Moser Bay within one statute mile outside Bun Point.

[*July 25, 1928*]

COOK INLET AREA

Salmon fishery.—Commercial fishing for salmon by means of any trap is prohibited from Seldovia Point to a point ¾ of 1 statute mile west of Nubble Point, after 6 o'clock postmeridian July 27 in each calendar year.

[*July 30, 1928*]

KODIAK AREA

Salmon fishery.—Supplementary regulation No. 251–14–8 dated July 11, 1928, and supplementary regulation No. 251–14–9, dated July 23, 1928, shall not apply to commercial fishing for salmon from September 1 to September 30, both dates inclusive, in each calendar year.

All commercial fishing for salmon in the Kodiak area is prohibited after September 30 in each calendar year.

[*August 2, 1928*]

COOK INLET AREA

Salmon fishery.—Regulation No. 1 is amended to read as follows: Commercial fishing for salmon is prohibited from 6 o'clock postmeridian August 4 to 6 o'clock antemeridian August 25, and for the remainder of each year after 6 o'clock postmeridian September 30.

Regulation No. 4 is amended to read as follows: Twenty-five feet of the heart walls on each side next to the pot and the bottom strip of wire of the pots of all hand traps shall be removed during the closed season for commercial salmon fishing from 6 o'clock postmeridian August 4 to 6 o'clock antemeridian August 25 of each calendar year.

[*August 3, 1928*]

KODIAK AREA

Salmon fishery.—Commercial fishing for salmon by means of any beach seine is prohibited (*a*) in all waters of the mainland shore and adjacent islands from Cape Douglas southwestward to Cape Kunmik, and (*b*) in all waters of Kodiak Island and adjacent islands northwestward from Cape Chiniak to Inner Point, Kizhuyak Bay, from August 16 to August 31, both dates inclusive, in each calendar year.

[*August 7, 1928*]

SOUTHEASTERN ALASKA AREA

Central District

Salmon fishery.—Regulation No. 6 is amended to read as follows: Commercial fishing for salmon is prohibited in Tenakee Inlet and Freshwater Bay within a line from North Passage Point to South Passage Point: *Provided,* That this prohibition shall not apply to trolling in the periods from January 1 to July 15, both dates inclusive, and from 6 o'clock antemeridian August 7 to 6 o'clock postmeridian September 29, in each calendar year.

[*August 24, 1928*]

SOUTHEASTERN ALASKA AREA

Salmon fishery.—No purse seine shall be less than 175 meshes nor more than 300 meshes in depth, nor less than 150 fathoms nor more than 200 fathoms in length measured on the cork line.

[*September 1, 1928*]

ALEUTIAN ISLANDS AREA

Herring fishery.—Regulation No. 1 of supplementary regulations dated April 16, 1928, is amended to read as follows: Commercial fishing for herring is prohibited in the period from January 1 to May 31, both dates inclusive, and from October 15 to December 31, both dates inclusive, in each calendar year.

[*September 6, 1928*]

COPPER RIVER AREA

Salmon fishery.—Commercial fishing for salmon, except by trolling, is prohibited after 6 o'clock postmeridian September 22 in each calendar year.

BERING RIVER AREA

Salmon fishery.—Commercial fishing for salmon, except by trolling, is prohibited after 6 o'clock postmeridian September 22 in each calendar year.

[*September 15, 1928*]

SOUTHEASTERN ALASKA AREA

Yakutat District

Salmon fishery.—Regulation No. 8 is amended so as to permit trolling in the period from October 1 to December 31, both dates inclusive, in each calendar year.

Prince of Wales Island District

Salmon fishery.—Regulation No. 5 is amended so as to prohibit commercial fishing for salmon, except by trolling, throughout the remainder of the calendar year after 6 o'clock postmeridian September 29.

Southern District

Salmon fishery.—Regulation No. 5 is amended so as to prohibit commercial fishing for salmon, except by trolling, throughout the remainder of the calendar year after 6 o'clock postmeridian September 29.

[*September 17, 1928*]

SOUTHEASTERN ALASKA AREA

Icy Strait—Cross Sound District

Salmon fishery.—In addition to existing prohibitions commercial fishing for salmon, except by trolling, is prohibited for the remainder of the calendar year after 6 o'clock postmeridian September 18, 1928: *Provided,* That this prohibition shall not apply to the use of gill nets until 6 o'clock postmeridian September 29, 1928, in Lynn Canal and contiguous waters north of the south end of Kochu Island, including Chilkat Inlet outside of a line from Green Point passing across the southern shore of Pyramid Island and Chilkoot Inlet 1,000 yards outside the mouth of Chilkoot River.

Central District

Salmon fishery.—In addition to existing prohibitions commercial fishing for salmon, except by trolling, is prohibited for the remainder of the calendar year after 6 o'clock postmeridian September 18, 1928.

[*September 21, 1928*]

SOUTHEASTERN ALASKA AREA

Prince of Wales Island District

Salmon fishery.—Regulation No. 5 is further amended so as to prohibit commercial fishing for salmon, except by trolling, throughout the remainder of the calendar year after 6 o'clock postmeridian September 22.

Southern District

Salmon fishery.—Regulation No. 5 is further amended so as to prohibit commercial fishing for salmon, except by trolling, throughout the remainder of the calendar year after 6 o'clock postmeridian September 22.

[*September 24, 1928*]

SOUTHEASTERN ALASKA AREA

Herring fishery.—Regulation No. 2 is amended so as to permit commercial fishing for herring with gill nets not less than 2¼ inches stretched measure between knots from October 1 to December 31, 1928, both dates inclusive, in waters otherwise open to fishing.

[*October 13, 1928*]

COOK INLET AREA

Herring fishery.—Regulation No. 1 is amended to read as follows: Commercial fishing for herring is prohibited during the period from January 1 to July 14, both dates inclusive, in each calendar year. Commercial fishing for herring, except by set and drift gill nets, is also prohibited from November 16 to December 31, both dates inclusive, in each calendar year.

[*October 26, 1928*]

KODIAK AREA

Herring fishery.—Regulation No. 2 is amended to read as follows: Commercial fishing for herring, except by gill nets, is prohibited from November 16 to December 31, both dates inclusive.

[*October 31, 1928*]

PRINCE WILLIAM SOUND AREA

Herring fishery.—Regulation No. 1 is amended to read as follows: Commercial fishing for herring is prohibited during the period from January 1 to June 15, both dates inclusive, and from November 16 to December 31, both dates inclusive, except that gill nets of not less than 2½ inches stretched measure between knots may be used from November 16 to December 15, both dates inclusive.

Revised regulations covering the fisheries af Alaska were issued by the Secretary of Commerce under date of December 18, 1928, as follows:

By virtue of the authority vested in the Secretary of Commerce, fishing areas are hereby set apart and regulations governing fishing therein are made effective, as follows:

I. YUKON-KUSKOKWIM AREA

The Yukon-Kuskokwim area is hereby defined to include all territoria coastal and tributary waters of Alaska from Cape Newenham northward to the parallel of 64 degrees north latitude.

1. In the Yukon-Kuskokwim area all commercial fishing for salmon is prohibited at all times: *Provided,* That this prohibition shall not prevent the taking of fish for local food requirements or for use as dog feed.

II. BRISTOL BAY AREA

The Bristol Bay area is hereby defined to include all territorial coastal and tributary waters of Alaska from Cape Newenham to a point on the coast 3 statute miles south of Cape Menshikof.

Salmon fishery.—1. Commercial fishing for salmon is prohibited except within the following-described districts:

(*a*) Nushagak district: Waters of Nushagak Bay within a line from Point Protection to Etolin Point.

(*b*) Kvichak-Naknek district: Waters of Kvichak Bay within a line from Etolin Point to Middle Bluff on the eastern side of Kvichak Bay at approximately 58 degrees 30 minutes north latitude.

(c) Egegik district: Waters between an east and west line 8 statute miles north of South Spit, Egegik Bay, and an east and west line 10 statute miles south of South Spit.

(d) Ugashik district: Waters between an east and west line 3 statutes miles north of Cape Greig and the southern limit of the area at a point on the coast 3 statute miles south of Cape Menshikof.

2. Commercial fishing for salmon shall be conducted solely by drift gill nets and stake nets. The use of all other forms of fishing gear is prohibited.

3. Stake nets shall be operated in substantially a straight line.

4. Commercial fishing for salmon with stake nets shall be limited to beach areas between high and low water marks and shall be confined to the following places:

(a) Nushagak district, except along the west side of Nushagak Bay from a point 2 statute miles south of Bradford Point to Coffee Point and along the east side of that bay from a point 2,000 yards southeast of the northern extremity of Ekuk Spit to Etolin Point.

(b) Along the beach in front of Koggiung Indian village on Kvichak Bay.

(c) Along the beach on the east and west side of Egegik near the Indian village.

(d) Along the beach on Ugashik Bay near the Indian village below the Alaska Packers Association cannery.

5. The total aggregate length of stake nets used by any individual shall not exceed 75 fathoms measurd on the cork line.

6. The total aggregate length of gill nets on any salmon fishing boat, or in use by such boat, shall not exceed 150 fathoms hung measure.

7. King salmon nets shall have a mesh of at least 8½ inches stretched measure between knots, and red salmon nets shall have a mesh of at least 5½ inches stretched measure between knots as measured when actually in use. No red salmon nets shall be over 28 meshes deep.

8. Prior to 6 o'clock antemeridian June 25 in each year commercial fishing for salmon with nets of mesh less than 8½ inches stretched measure between knots is prohibited.

9. Commercial fishing for salmon is prohibited in the period from 6 o'clock postmeridian July 23 to 6 o'clock antemeridian August 6.

10. The trailing of web behind any fishing boat is prohibited above the markers fixing closed waters.

11. The use of motor-propelled fishing boats in catching salmon is prohibited.

12. The use of smelt nets is prohibited in localities where young salmon are migrating.

13. In the waters of Kvichak Bay between the line extending across the bay from the marker on a high point on the east bank of Prosper Creek, about 700 yards above the Koggiung cannery of the Alaska Packers Association, to the marker on the opposite side, the course being about north, 44 degrees west, magnetic, and the line extending at right angles across the bay from a marker at Jensen Creek to a marker on the opposite shore about 1½ miles west of Squaw Creek, the 36-hour weekly closed period for salmon fishing prescribed by section 5 of the act of June 6, 1924, is hereby extended to include the period from 6 o'clock postmeridian of Saturday of each week to 6 o'clock antemeridian of the Tuesday following, making a weekly closed period of 60 hours.

14. All commercial fishing for salmon is prohibited as follows:

(a) Nushagak Bay: All waters northward of a line from Bradford Point through the southern end of Williams Island to a point on the opposite shore near the old cannery site of the Alaska Packers Association south of Kanulik village, except that stake nets limited to beach areas between high and low water marks will be permitted north of 59 degrees north latitude to the old prohibitive markers located at Snag Point.

(b) Kvichak Bay: All waters above a line extending at right angles across Kvichak Bay from the marker on a high point on the east bank of Prosper Creek, about 700 yards above the Koggiung cannery of the Alaska Packers Association, to the marker on the opposite side, the course being about north, 44 degrees west, magnetic.

(c) Ugashik River and Bay: All waters above a line extending at right angles across said river 500 yards below the mouth of King Salmon River.

Steelhead fishery.—Commercial fishing for steelhead trout shall be subject to the provisions of law and the regulations applicable to commercial fishing for salmon.

III. ALASKA PENINSULA AREA

The Alaska Peninsula area is hereby defined to include all territorial coastal and tributary waters of the Alaska Peninsula from a point on the coast 3 statute miles south of Cape Menshikof on the Bering Sea shore, extending in a southwesterly direction to Unimak Pass, thence in a northeasterly direction along the Pacific side of the Alaska Peninsula to Castle Cape (Tuliumnit Point). The waters of Unimak, the Sanak, the Shumagin, and all other adjacent islands are included.

Salmon fishery.—1. In the waters of Nelson Lagoon, and thence along the coast to Cape Seniavin, including Nelson Lagoon, Herendeen Bay, Port Moller, and the fishing grounds off the Bear, Sandy, and Ocean Rivers, the 36-hour closed period for salmon fishing prescribed by section 5 of the act of June 6, 1924, is hereby extended to include the periods from 6 o'clock antemeridian of Wednesday of each week until 6 o'clock antemeridian of the following Thursday, and from 6 o'clock antemeridian of Friday of each week until 6 o'clock antemeridian of the following Saturday, making a weekly closed period in these waters of 84 hours, which shall be effective throughout the entire salmon fishing season of each year.

2. In all other waters of this area the 36-hour closed period for salmon fishing prescribed by section 5 of the act of June 6, 1924, is hereby extended to include the period from 6 o'clock antemeridian of Saturday of each week until 6 o'clock antemeridian of the Monday following, making a weekly closed period of 48 hours: *Provided*, That this extension of 12 hours closed period each week shall not be effective after 6 o'clock antemeridian of July 25 in each year.

3. The total aggregate length of gill nets on any salmon-fishing boat, or in use by such boat, shall not exceed 200 fathoms hung measure.

4. Stake and anchored gill nets shall be operated in substantially a straight line.

5. The use of floating traps for the capture of salmon is prohibited.

6. In all waters along the shores of the Alaska Peninsula west of the longitude of Cape Aliaksin, and in the waters of Unga Island, the distance by most direct water measurement from any part of one trap to any part of another trap, shall not be less than 1 statute mile.

7. The use of purse seines for the capture of salmon is prohibited, except that (*a*) in the waters of the Shumagin Islands seines not to exceed 100 fathoms in length and 150 meshes in depth may be used, and (*b*) purse seines are permitted in waters open to commercial fishing between Lagoon Point and Cape Seniavin.

8. No boat used in operating any purse seine shall be longer than 50 feet, as shown by official register length: *Provided*, That this shall not apply to such boats operated on the north side of the Alaska Peninsula.

9. In Port Heiden waters the catch of red salmon shall not exceed 50,000 in any calendar year.

10. Commercial fishing for salmon is prohibited prior to 6 o'clock antemeridian June 1 in each calendar year and during the remainder of each calendar year after 6 o'clock postmeridian August 15, except that beach seines and gill nets may be used from September 5 to September 30, both dates inclusive.

11. All commercial fishing for salmon is prohibited in Morzhovoi Bay east of 163 degrees 5 minutes west longitude prior to July 25 in each year.

12. All commercial fishing for salmon is prohibited in Cold Bay within a line extending from the eastern extremity of Thin Point to Vodapoini Point prior to July 25 in each year.

13. All commercial fishing for salmon, except by beach seines not exceeding 65 fathoms in length, is prohibited (*a*) in all waters between Cape Tachilni and the southern extremity of Bold Cape and (*b*) in all waters from Cape Tolstoi to the outer extremity of Kupreanof Point. In Orzinski (Orzenoi) Bay the catch of red salmon shall not exceed 25,000 in any calendar year.

14. Commercial fishing for salmon by means of gill nets, including drift nets, stake nets, and set nets, is prohibited west of 161 degrees west longitude, exclusive of waters along the Bering Sea coast.

15. Commercial fishing for salmon is prohibited in the waters of Pavlof and Volcano Bays and their arms within a line from the outer extremity of Moss Cape to the outer extremity of Cape Tolstoi prior to July 5 in each year.

16. The use of any trap for the capture of salmon is prohibited, except as follows:

(*a*) Mainland coast, including adjacent islands from Entrance Point to Lagoon Point.

(*b*) Unimak Island: Along the coast on the west and south sides of Ikatan Bay from a point on False Pass (Isanotski Strait) indicated by a marker to a point on Louisiana Cove at 54 degrees 45 minutes 58 seconds north latitude, 163 degrees 8 minutes 52 seconds west longitude.

(*c*) Unimak Island: Along the coast of East Anchor Cove within 2,500 feet, measured along the coast, from a point at 54 degrees 41 minutes 12 seconds north latitude, 163 degrees 3 minutes 36 seconds west longitude.

(*d*) Along the coast on the west side of Morzhovoi Bay from the outer extremity of Boiler Point to a point at 55 degrees 3 minutes 18 seconds north latitude, 163 degrees 12 minutes 44 seconds west longitude.

(*e*) Along the coast on the east side of Morzhovoi Bay within 2,500 feet, measured along the coast, from a point at 55 degrees 0 minutes 38 seconds north latitude, 162 degrees 57 minutes 48 seconds west longitude.

(*f*) Along the coast on the north side of Belkofski Bay for a distance of 5,000 feet westerly of the point at the north side of the entrance to Captain Harbor, exclusive of any waters in Captain Harbor.

(*g*) Along the coast on the south and east side of Kitchen Anchorage, Belkofski Bay, within a distance of 2,500 feet, measured along the coast, from a point at 55 degrees 7 minutes 30 seconds north latitude, 162 degrees 6 minutes 42 seconds west longitude.

(*h*) Along the mainland coast, between Belkofski Bay and Bear Bay, from a point at 55 degrees 5 minutes 48 seconds north latitude, 162 degrees west longitude, to a point at 55 degrees 8 minutes north latitude, 161 degrees 57 minutes 18 seconds west longitude.

(*i*) Along the coast on the west side of Volcano Bay within 2,500 feet, measured along the coast, from a point at 55 degrees 13 minutes 24 seconds north latitude, 162 degrees 1 minute 30 seconds west longitude.

(*j*) Along the coast on the north side of Volcano Bay within 2,500 feet, measured along the coast, from a point at 55 degrees 14 minutes 6 seconds north latitude, 161 degrees 58 minutes 36 seconds west longitude.

(*k*) Along the mainland coast within 2,500 feet, measured along the coast, from a point at 55 degrees 13 minutes 30 seconds north latitude, 161 degrees 52 minutes 36 seconds west longitude.

(*l*) Mainland coast along the west side of Pavlof Bay from 55 degrees 14 minutes 18 seconds north latitude to 55 degrees 24 minutes north latitude, exclusive of any waters in East Bay (Long John Lagoon).

(*m*) Mainland coast along the east side of Pavlof Bay from the south point of the entrance to Canoe Bay southward to the south side of Cape Tolstoi at 161 degrees 30 minutes west longitude.

(*n*) Unga Island: East coast between Unga Cape and West Head.

(*o*) Mainland coast from the southern extremity of Cape Ikti to Castle Cape.

17. All commercial fishing for salmon is prohibited, as follows:

(*a*) Within 1 statute mile of the mouths of Bear, Sandy, and Ocean Rivers.

(*b*) Thin Point Lagoon, East Bay (Long John Lagoon), Kinzaroff Lagoon, Mortensen Lagoon, Swanson Lagoon, Big Lagoon, and Middle or Lambsport Lagoon: All waters within the lagoons and their streams and within a distance of 500 yards outside the entrances to the lagoons.

(*c*) Captain Harbor, tributary to Belkofski Bay: All waters within the harbor.

(*d*) Volcano and Bear Bays: All waters west of 161 degrees 59 minutes 30 seconds west longitude.

(*e*) Canoe Bay, tributary to Pavlof Bay.

(*f*) All waters between Kupreanof Point and Cape Ikti.

Steelhead fishery.—Commercial fishing for steelhead trout shall be subject to the provisions of law and the regulations applicable to commercial fishing for salmon.

Herring fishery.—1. Commercial fishing for herring, except for bait purposes, is prohibited in the period from January 1 to June 30, both dates inclusive, and from December 1 to December 31, both dates inclusive.

2. During the period from June 1 to October 1, both dates inclusive, commercial fishing for herring, including bait fishing, is prohibited in all waters closed throughout the year to salmon fishing.

3. Commercial fishing for herring, except for bait purposes, is prohibited from 6 o'clock postmeridian of Saturday of each week until 6 o'clock antemeridian of the Monday following.

4. Gill nets used in catching herring shall not be of smaller mesh than 3 inches stretched measure.

5. Commercial fishing for herring, including bait fishing, by means of any trap is prohibited.

6. Commercial fishing for herring, including bait fishing, by means of any purse seine more than 1,400 meshes in depth, more than 180 fathoms in length, or of mesh less than 1½ inches stretched measure between knots is prohibited.

7. No one shall place, or cause to be placed, across the entrance of any lagoon or bay any net or other device which will prevent the free passage at all times of herring in and out of said lagoon or bay.

Clam fishery.—It is prohibited to take for commercial purposes any razor clam measuring less than 4½ inches in total length of shell. Possession of any razor clam of less than this length will be regarded as prima facie evidence of unlawful taking.

IV. ALEUTIAN ISLANDS AREA

The Aleutian Islands area is hereby defined to include all territorial coastal and tributary waters of the Aleutian Islands westward of and including Unimak Pass.

Salmon fishery.—1. The total aggregate length of gill nets on any salmon fishing boat or in use by such boat shall not exceed 200 fathoms hung measure.

2. Stake and anchored gill nets shall be operated in substantially a straight line.

3. Commercial fishing for salmon is prohibited during the period from 6 o'clock postmeridian August 20 to 6 o'clock postmeridian October 1 in each year.

4. The use of any trap is prohibited.

5. The use of any purse seine exceeding 100 fathoms in length or 150 meshes in depth is prohibited.

Steelhead fishery.—Commercial fishing for steelhead trout shall be subject to the provisions of law and the regulations applicable to commercial fishing for salmon.

Herring fishery.—1. Commercial fishing for herring, except for bait purposes, is prohibited in the period from January 1 to June 30, both dates inclusive, and from December 1 to December 31, both dates inclusive.

2. Commercial fishing for herring, except for bait purposes, is prohibited from 6 o'clock postmeridian of Saturday of each week until 6 o'clock antemeridian of the Monday following.

3. Gill nets used in catching herring shall not be of smaller mesh than 3 inches stretched measure.

4. Commercial fishing for herring, including bait fishing, by means of any trap is prohibited.

5. Commercial fishing for herring, including bait fishing, by means of any purse seine more than 1,400 meshes in depth, more than 180 fathoms in length, or of mesh less than 1¼ inches stretched measure between knots is prohibited.

6. No one shall place, or cause to be placed, across the entrance of any lagoon or bay any net or other device which will prevent the free passage at all times of herring in and out of said lagoon or bay.

V. CHIGNIK AREA

The Chignik area is hereby defined to include the territorial coastal and tributary waters of Alaska along the mainland shore from Castle Cape (Tuliumnit Point) to Cape Kunmik. The waters of Chankliut, Sutwik, and all other adjacent islands are included.

Salmon fishery.—1. Commercial fishing for salmon by means of any floating trap, purse seine, beach seine, or gill net is prohibited.

2. The take of salmon within waters in which the runs are tributary to the Chignik River shall not exceed 50 per cent of the total run as determined at the weir in Chignik River operated by the Bureau of Fisheries.

3. Commercial fishing for salmon is prohibited prior to 6 o'clock antemeridian June 1 and after 6 o'clock postmeridian October 1 in each year.

4. Commercial fishing for salmon is prohibited in the waters surrounding Nakchamik and Chankliut Islands.

5. The use of any trap for the capture of salmon is prohibited except as follows:

(*a*) Along the coast of Chignik Lagoon within 2,500 feet from the outer extremity of Hume Point.

(*b*) Along the coast of Chignik Island within 2,500 feet from a point at 56 degrees 17 minutes 30 seconds north latitude, 158 degrees 35 minutes 38 seconds west longitude.

(*c*) Along the east side of the spit at the entrance to Chignik Lagoon from the southern extremity of the spit to a point at 56 degrees 21 minutes 30 seconds north latitude, 158 degrees 30 minutes west longitude.

(*d*) Along the coast of Chignik Bay from a point at 56 degrees 20 minutes 40 seconds north latitude, 158 degrees 27 minutes 30 seconds west longitude, to a point at 56 degrees 20 minutes 48 seconds north latitude, 158 degrees 26 minutes 18 seconds west longitude, including the sand bar offshore.

(*e*) Along the coast on the east side of Anchorage Bay within 2,500 feet from a point at 56 degrees 19 minutes 17 seconds north latitude, 158 degrees 21 minutes 12 seconds west longitude.

(*f*) Along the east side of the spit on the west side of Lake Bay from the northern extremity of the spit at 56 degrees 18 minutes 53 seconds north latitude to a point at 56 degrees 18 minutes 22 seconds north latitude, 158 degrees 16 minutes 41 seconds west longitude.

(*g*) Along the coast on the west side of Hook Bay within 2,500 feet from a point at 56 degrees 30 minutes 54 seconds north latitute, 158 degrees 9 minutes 12 seconds west longitude.

(*h*) Along the coast on the north side of Cape Kumliun within 2,500 feet from a point at 56 degrees 34 minutes north latitude, 157 degrees 56 minutes 8 seconds west longitude.

(*i*) Along the coast on the east side of Kujulik Bay within 2,500 feet from a point at 56 degrees 39 minutes 44 seconds north latitude, 157 degrees 43 minutes 30 seconds west longitude.

(*j*) Along the coast on the south side of Aniakchak Bay for a distance of 5,000 feet westerly and northerly from a point at 56 degrees 40 minutes 20 seconds north latitude, 157 degrees 28 minutes 36 seconds west longitude (as shown on U. S. Coast and Geodetic Survey chart No. 8710).

(*k*) Along the coast on the west side of Aniakchak Bay beginning at a point on the coast 8,000 feet southeasterly of the mouth of the lagoon and extending southeasterly for a distance of 5,000 feet.

(*l*) Along the coast on the west side of Aniakchak Bay beginning at a point on the coast 500 yards southerly of the mouth of Aniakchak River and extending southerly for a distance of 5,000 feet.

6. The distance by most direct water measurement from any part of one trap to any part of another trap shall not be less than 1 statute mile.

Steelhead fishery.—Commercial fishing for steelhead trout shall be subject to the provisions of law and the regulations applicable to commercial fishing for salmon.

Clam fishery.—It is prohibited to take for commercial purposes any razor clam measuring less than 4½ inches in total length of shell. Possession of any razor clam of less than this length will be regarded as prima facie evidence of unlawful taking.

VI. KODIAK AREA

The Kodiak area is hereby defined to include the waters of the mainland shore extending from Cape Douglas southwestward to Cape Kunmik and the territorial coastal and tributary waters of Alaska surrounding Kodiak, Afognak, and adjacent islands.

Salmon fishery.—1. The use of purse seines and floating traps for the capture of salmon is prohibited.

2. Commercial fishing for salmon by means of any beach seine with mesh larger than 3 inches stretched measure between knots is prohibited.

3. The total aggregate length of gill nets on any salmon fishing boat, or in use by such boat, shall not exceed 200 fathoms hung measure.

4. Commercial fishing for salmon in Alitak Bay and all its branches within a line from Cape Trinity to Cape Alitak prior to 6 o'clock antemeridian June 15 in each year is prohibited.

5. Commercial fishing for salmon after August 15, except from September 1 to September 30, both dates inclusive, in each calendar year in Alitak Bay and all its branches within a line from Cape Trinity to Cape Alitak is prohibited: *Provided*, That this prohibition shall not apply to traps on the north shore of the entrance to Moser Bay within 1 statute mile outside Bun Point.

6. Commercial fishing for salmon within a line from Cape Trinity to Cape Alitak shall be conducted solely by beach seines and traps.

7. The take of salmon within waters in which the runs are tributary to Olga Bay shall not exceed 50 per cent of the total run as determined at the weirs on tributary waters of Olga Bay operated by the Bureau of Fisheries.

8. Commercial fishing for salmon in Karluk waters, extending from Cape Karluk to West Point, prior to 6 o'clock antemeridian June 1 in each year is prohibited. The take of red salmon in these waters shall not exceed 50 per cent of the total run as determined at the weir in Karluk River operated by the Bureau of Fisheries.

9. Commercial fishing for salmon between Cape Karluk and Cape Uyak except by beach seines, and between Cape Uyak and Uyak Postoffice, except by beach seines and gill nets, is prohibited.

10. Commercial fishing for salmon in all waters of Kizhuyak Bay within a line from Kekur Point to Inner Point is prohibited prior to 6 o'clock antemeridian July 21 in each calendar year.

11. Commercial fishing for salmon in all waters of Ugak Bay within a line from Gull Point to Narrow Cape is prohibited prior to 6 o'clock antemeridian July 21 in each calendar year.

12. Commercial fishing for salmon in all waters of Kiliuda Bay within a line from Right Cape to Left Cape is prohibited prior to 6 o'clock antemeridian July 21 in each calendar year.

13. All commercial fishing for salmon in the Kodiak area is prohibited after September 30 in each calendar year.

14. The distance by most direct water measurement from any part of one trap to any part of another trap, except in those waters of Alitak Bay in which the runs are tributary to streams where counting weirs are maintained, shall not be less than 1 statute mile.

15. Commercial fishing for salmon by means of any beach seine is prohibited from August 16 to August 31, both dates inclusive, in each calendar year, as follows:

(*a*) In all waters of the mainland shore and adjacent islands from Cape Douglas southward to Cape Kunmik.

(*b*) In all waters of Kodiak Island and adjacent islands northwestward from Cape Chiniak to Inner Point, Kizhuyak Bay.

(*c*) In all waters of Terror and Viekoda Bays south of 57 degrees 54 minutes north latitude.

(*d*) In all waters of Uganik Bay, including Uganik Passage and other tributaries and arms within a line from West Point to Uganik Island passing through the northern extremity of East Point.

(*e*) All waters of Shuyak Island, Afognak Island (exclusive of Malina Beach), Marmot Island, Hog Island, and of all other islands north of 58 degrees north latitude adjacent to those islands; all waters of Whale Island, Deranof Island, and Little Raspberry Island; all waters of other islands between Whale and Raspberry Islands; and all waters of Raspberry Strait.

16. Commercial fishing for salmon by means of any trap or beach seine is prohibited from August 16 to August 31, both dates inclusive, in each calendar year, as follows:

(*a*) In all waters of Uyak Bay and its tributaries and adjoining waters within a line from Uyak Postoffice to Cape Kuliuk.

(*b*) In all waters of Kodiak Island from Cape Chiniak to Cape Kiavak. The waters of Ugak Island, Sitkalidak Island, and of other adjacent islands between those capes are included.

17. The use of any trap for the capture of salmon is prohibited, except as follows:

(*a*) Raspberry Island: Coast west of 153 degrees 14 minutes 30 seconds west longitude.

(*b*) Kodiak Island: Coast from a point near the western entrance to Whale Passage at 152 degrees 54 minutes west longitude to Outlet Cape.

(*c*) Uganik Island: East coast from 57 degrees 54 minutes north latitude to a point indicated by marker approximately 2 statute miles northeast of Cape Uganik.

(*d*) Uganik Island: West coast from a point at 153 degrees 27 minutes west longitude to a point indicated by marker approximately 3 statute miles southwest of Cape Uganik.

(*e*) Kodiak Island: Along the coast on the west side of Uganik Bay between West Point and Broken Point.

(*f*) Kodiak Island: Along the coast from the point at 57 degrees 41 minutes 48 seconds north latitude, 153 degrees 54 minutes 45 seconds west longitude, to a point on the north side of Spiridon Bay (or northeast arm of Uyak Bay) at 57 degrees 41 minutes 39 seconds north latitude, 153 degrees 50 minutes west longitude.

(*g*) Kodiak Island: Coast from the point on the south side of the entrance to Spiridon Bay (or northeast arm of Uyak Bay) southeastward to a point on the east side of Zachar Bay at 57 degrees 34 minutes 35 seconds north latitude.

(*h*) Kodiak Island: Coast from the southern extremity of the point of land at the north side of the entrance to Larsen Bay northward to a point on the west side of Uyak Bay at 57 degrees 35 minutes 42 seconds north latitude.

(*i*) Kodiak Island: Coast from Gull Point southwestward to the southwest extremity of Right Cape.

(*j*) Kodiak Island: Coast from the outer extermity of Left Cape westward to a point on the south shore of Kiliuda Bay at 153 degrees 3 minutes west longitude.

(*k*) Kodiak Island: Coast from a point 1 statute mile westward of Sitkalidak or Old Harbor Narrows southwestward to the headland on the north side of Kiavak Bay, exclusive of waters between headlands of Barling, Three Saints, and Kaiugnak Bays.

(*l*) Kodiak Island: Coast along east side of Alitak Bay within 800 feet from a point at 56 degrees 51 minutes 20 seconds north latitude, 154 degrees west longitude.

(*m*) Kodiak Island: Coast along east side of Alitak Bay within 800 feet from a point at 56 degrees 53 minutes 10 seconds north latitude, 153 degrees 58 minutes 52 seconds west longitude.

(*n*) Kodiak Island: Coast along east side of Alitak Bay within 800 feet from a point at 56 degrees 57 minutes north latitude, 153 degrees 57 minutes 50 seconds west longitude.

(*o*) Kodiak Island: Coast along west side of Alitak Bay within 800 feet from a point at 56 degrees 59 minutes 35 seconds north latitude, 154 degrees 3 minutes 40 seconds west longitude.

(*p*) Kodiak Island: Coast along west side of Alitak Bay within 800 feet from a point at 56 degrees 58 minutes 25 seconds north latitude, 154 degrees 3 minutes 40 seconds west longitude.

(*q*) Kodiak Island: Coast along west side of Alitak Bay within 800 feet from a point at 56 degrees 57 minutes 40 seconds north latitude, 154 degrees 4 minutes 10 seconds west longitude.

(*r*) Kodiak Island: Coast along west side of Alitak Bay, near Bun Point, within 800 feet from a point at 56 degrees 58 minutes 20 seconds north latitude, 154 degrees 5 minutes west longitude.

(*s*) Turn Island, in Alitak Bay: Coast along east side of Turn Island within 1,000 feet from the northern extremity of the island.

18. All commercial fishing for salmon is prohibited, as follows:

(*a*) Olga and Moser Bays: All waters of Olga and Moser Bays and contiguous waters within a line from Bun Point through Turn Island at the entrance of Moser Bay to Akhiok village.

(*b*) Western shore of Kodiak Island: All waters along the western shore of Kodiak Island between Cape Alitak and Cape Karluk.

(*c*) Karluk River: All waters within Karluk River and within 100 yards of its mouth where it breaks through Karluk Spit into Shelikof Strait.

(*d*) East Arm, Uganik Bay, Kodiak Island: All waters within the arm, as designated by markers on Packers Spit and Mink Point.

(*e*) Southern coast of Kodiak Island: All waters along the southern coast of Kodiak Island between Cape Kiavak and Cape Trinity and all waters of the adjacent islands between those capes, also all waters of the Trinity Islands.

(*f*) All bays of Afognak Island: All waters of the bays within lines indicated by markers erected for the purpose.

(*g*) Kaflia Bay, on north shore of Shelikof Strait: All waters within a line from Cape Ugyak to Cape Gull.

Steelhead fishery.—Commercial fishing for steelhead trout shall be subject to the provisions of law and the regulations applicable to commercial fishing for salmon.

Herring fishery.—1. Commercial fishing for herring, except for bait purposes, is prohibited during the period from January 1 to June 30, both dates inclusive.

2. Commercial fishing for herring, except for bait purposes, is prohibited from November 16 to December 31, both dates inclusive: *Provided,* That this prohibition shall not apply to the use of gill nets.

3. During the period from July 15 to October 1, both dates inclusive, commercial fishing for herring, including bait fishing, is prohibited in all waters closed throughout the year to salmon fishing.

4. Gill nets used in catching herring shall not be of smaller mesh than 2½ inches stretched measure.

5. Commercial fishing for herring, including bait fishing, by means of any trap is prohibited.

6. Commercial fishing for herring, including bait fishing, by means of any purse seine more than 1,400 meshes in depth, more than 180 fathoms in length, or of mesh less than 1½ inches stretched measure between knots is prohibited.

7. No one shall place, or cause to be placed, across the entrance of any lagoon or bay any net or other device which will prevent the free passage at all times of herring in and out of said lagoon or bay.

Clam fishery.—It is prohibited to take for commercial purposes any razor clam measuring less than 4½ inches in total length of shell. Possession of any razor clam of less than this length will be regarded as prima facie evidence of unlawful taking.

VII. COOK INLET AREA

The Cook Inlet area is hereby defined to include Cook Inlet, its tributary waters, and all adjoining waters north of Cape Douglas and west of Point Gore. The Barren Islands are included within this area.

Salmon fishery.—1. North of the latitude of Anchor Point commercial fishing for salmon is prohibited prior to 6 o'clock antemeridian June 5 and after 6 o'clock postmeridian August 1 in each year. South of the latitude of Anchor Point commercial fishing for salmon is prohibited prior to 6 o'clock antemeridian June 10 and after 6 o'clock postmeridian August 5 in each year.

2. The 36-hour weekly closed period for salmon fishing prescribed by section 5 of the act of June 6, 1924, is hereby extended to include the period from 6 o'clock antemeridian of Saturday of each week to 6 o'clock antemeridian of the Monday following, making a weekly closed period of 48 hours.

3. The use of purse seines and floating traps for the capture of salmon is prohibited.

4. The distance by most direct water measurement from any part of one trap to any part of another trap shall not be less than 2,500 feet.

5. Twenty-five feet of the heart walls next to the pot of each hand trap in Cook Inlet shall be constructed of flexible webbing other than wire.

6. The total aggregate length of gill nets on any salmon fishing boat, or in use by such boat, shall not exceed 200 fathoms hung measure.

7. No set or anchored gill net shall exceed 25 fathoms in length measured on the cork line.

8. Stake and set or anchored gill nets shall be operated in substantially a straight line.

9. The distance by most direct water measurement from any part of one set or anchored gill net to any part of another set or anchored gill net or to any part of any trap shall not be less than 600 feet.

10. All set or anchored gill nets shall be removed from the water throughout the weekly closed periods extending from 6 o'clock antemeridian of Saturday of each week to 6 o'clock antemeridian of the Monday following.

11. No salmon fishing boat shall carry or operate more than one seine of any description, and no additional net of any kind shall be carried on such boat. The carrying of any additional seine or net of any kind on a boat towed by any salmon fishing boat is prohibited.

12. No beach seine shall be less than 125 meshes in depth or less than 90 fathoms in length measured on the cork line. For the purpose of determining the depths of seines measurements will be upon the basis of 3½ inches stretched measure between knots.

13. The use of any trap for the capture of salmon is prohibited, except as follows:

(*a*) Along the mainland coast on the west side of Cook Inlet from a point at 61 degrees 9 minutes 15 seconds north latitude, 151 degrees 3 minutes 30 seconds west longitude, southwesterly to a point at 61 degrees 0 minutes 40 seconds north latitude, 151 degrees 24 minutes 40 seconds west longitude, exclusive of 2 statute miles each side of the mouth of Chuit River and 1 statute mile each side of the mouths of all other salmon streams.

(*b*) Along the mainland coast on the west side of Cook Inlet from a point at 60 degrees 48 minutes 55 seconds north latitude, 151 degrees 47 minutes 30 seconds west longitude, to the southeast point of West Foreland at 60 degrees 42 minutes 33 seconds north latitude, 151 degrees 43 minutes 20 seconds west longitude.

(*c*) Along the mainland coast on the west side of Cook Inlet from a point at 60 degrees 24 minutes 10 seconds north latitude, 152 degrees 16 minutes 15 seconds west longitude, to Harriet Point at 60 degrees 23 minutes 30 seconds north latitude, 152 degrees 14 minutes 22 seconds west longitude.

(*d*) Along the north coast of Kalgin Island from a point at 60 degrees 30 minutes 32 seconds north latitude, 151 degrees 57 minutes 30 seconds west longitude, easterly to a point at 60 degrees 30 minutes 20 seconds north latitude, 151 degrees 55 minutes west longitude.

(*e*) Along the east coast of Kalgin Island from a point at 60 degrees 26 minutes 42 seconds north latitude, 151 degrees 53 minutes 35 seconds west longitude, southerly to a point at 60 degrees 26 minutes north latitude, 151 degrees 56 minutes west longitude, exclusive of 1 statute mile each side of the mouths of all salmon streams.

(*f*) Along the east coast of Chisik Island between the northern and southern extremities of the island.

(*g*) Along the mainland coast on the east side of Cook Inlet from the northern extremity of Point Possession southwesterly to a point at 60 degrees 46 minutes 45 seconds north latitude, 151 degrees 10 minutes 30 seconds west longitude, exclusive of 2 statute miles each side of the mouth of Swansons Creek, 2 statute miles each side of Bishop Creek, and 1 statute mile each side of the mouths of all other salmon streams.

(*h*) Along the mainland coast on the east side of Cook Inlet from a point north of Boulder Point at 60 degrees 46 minutes 18 seconds north latitude, 151 degrees 15 minutes 40 seconds west longitude, southerly to a point 2 statute miles northward from the mouth of Anchor Point River, exclusive of 2½ statute miles each side of the mouth of Kenai River, 2½ statute miles each side of the mouth of Kasilof River, 2 statute miles each side of the mouth of Ninilchik River, 2 statute miles each side of the mouth of Deep Creek, and 1 statute mile each side of the mouths of all other salmon streams.

(*i*) Along the mainland coast on the east side of Cook Inlet from a point at 59 degrees 41 minutes 45 seconds north latitude, 151 degrees 47 minutes 10 seconds west longitude, southeasterly to a point at 59 degrees 41 minutes 22 seconds north latitude, 151 degrees 46 minutes west longitude.

(*j*) Along the mainland coast on the east side of Cook Inlet from the northern extremity of Nubble Point westerly along the west side of Nubble Point Spit to a point at 59 degrees 28 minutes 30 seconds north latitude, 151 degrees 37 minutes 30 seconds west longitude.

(*k*) Along the mainland coast on the east side of Cook Inlet from a point at 59 degrees 26 minutes 30 seconds north latitude, 151 degrees 46 minutes west longitude, westerly to a point at 59 degrees 26 minutes 40 seconds north latitude, 151 degrees 46 minutes 45 seconds west longitude.

(*l*) Along the mainland coast on the east side of Cook Inlet from a point at 59 degrees 25 minutes 15 seconds north latitude, 151 degrees 53 minutes 30 seconds west longitude, southwesterly to a point at 59 degrees 23 minutes 12 seconds north latitude, 151 degrees 54 minutes west longitude.

(*m*) Along the mainland coast on the east side of Cook Inlet from a point at 59 degrees 21 minutes 28 seconds north latitude, 151 degrees 55 minutes west longitude, southwesterly to a point at 59 degrees 19 minutes 20 seconds north latitude, 151 degrees 58 minutes 30 seconds west longitude, exclusive of 1 statute mile each side of the mouths of all salmon streams.

(*n*) Along the coast of Cook Inlet within 600 yards of Claim Point at 59 degrees 12 minutes 5 seconds north latitude, 151 degrees 49 minutes 11 seconds west longitude.

14. All commercial fishing is prohibited, as follows:

(*a*) Within 2½ statute miles of the mouths of Kasilof and Kenai Rivers, and within 1 statute mile of all other salmon streams.

(*b*) Turnagain Arm and Knik Arm: All waters above a line from Point Possession to the western limit of the closed area around the mouth of the Susitna River.

(*c*) Chinik Inlet, Kamishak Bay: All waters within the inlet.

(*d*) Kachemak Bay: All waters above a line from Indian Island to a point on the opposite shore one-half mile below the mouth of Swift Creek.

Steelhead fishery.—Commercial fishing for steelhead trout shall be subject to the provisions of law and the regulations applicable to commercial fishing for salmon.

Herring fishery.—1. Commercial fishing for herring, except for bait purposes, is prohibited during the period from January 1 to June 30, both dates inclusive, and from November 16 to December 31, both dates inclusive: *Provided*, That this prohibition shall not apply to the use of set and drift gill nets in the period from November 16 to December 31, both dates inclusive.

2. During the period from July 1 to October 1, both dates inclusive, commercial fishing for herring, including bait fishing, is prohibited in all waters closed throughout the year to salmon fishing.

3. Commercial fishing for herring in Halibut Cove, including the waters within a line from the western end of Ismailof Island to the outermost point on Glacier Spit, is limited to gill nets.

4. Commercial fishing for herring in Halibut Cove Lagoon is limited to set gill nets not exceeding 50 fathoms in length, hung measure. All such nets shall be anchored in a substantial manner not less than 150 yards apart.

5. Nets operated within areas marked at the north and south ends of Halibut Cove Lagoon shall be anchored at right angles to the line joining the markers. Nets operated between these areas shall be anchored in a general direction paralleling the shore line.

6. The maintaining of a herring pound or the dumping of offal and dead herring in the waters of Halibut Cove and Lagoon is prohibited.

7. Gill nets used in catching herring shall not be of smaller mesh than 3 inches stretched measure.

8. Commercial fishing for herring, including bait fishing, by means of any trap is prohibited.

9. Commercial fishing for herring, including bait fishing, by means of any purse seine more than 1,400 meshes in depth, more than 180 fathoms in length, or of mesh less than 1½ inches stretched measure between knots is prohibited.

10. No one shall place, or cause to be placed, across the entrance of any lagoon or bay any net or other device which will prevent the free passage at all times of herring in and out of said lagoon or bay.

Clam fishery.—It is prohibited to take for commercial purposes any razor clam measuring less than 4½ inches in total length of shell. Possession of any razor clam of less than this length will be regarded as prima facie evidence of unlawful taking.

VIII. RESURRECTION BAY AREA

The Resurrection Bay area is hereby defined to include all territorial coastal and tributary waters of the Gulf of Alaska between Point Gore on the west and Cape Fairfield on the east.

Salmon fishery.—1. The use of any trap for the capture of salmon is prohibited.

2. The total aggregate length of gill nets on any salmon fishing boat, or in use by such boat, shall not exceed 200 fathoms hung measure.

3. No set or anchored gill net shall exceed 300 yards in length, and each shall be set in substantially a straight line: *Provided,* That not to exceed 20 yards of each net may be used as a hook. Only one such hook is permitted on a net. There shall be a distance interval of at least 200 yards, both endwise and laterally, at all times between all set or anchored gill nets operated.

4. King salmon nets shall have a mesh at least 8½ inches stretched measure between knots, and red salmon nets shall have a mesh at least 5½ inches stretched measure between knots, as measured when actually in use.

5. No boat used in operating any purse seine shall be longer than 50 feet, as shown by official register length.

6. Prior to 6 o'clock antemeridian June 6 in each year commercial fishing for salmon with nets of mesh less than 8½ inches stretched measure between knots is prohibited.

7. Commercial fishing for salmon is prohibited during the remainder of each calendar year after 6 o'clock postmeridian September 22.

8. In the waters of Resurrection Bay, within a line from Cape Resurrection to the western side of Bear Glacier at its mouth, the 36-hour closed period for salmon fishing prescribed by section 5 of the act of June 6, 1924, is hereby extended to include the period from 6 o'clock postmeridian of Friday of each week until 6 o'clock antemeridian of the Monday following, making a weekly closed period of 60 hours: *Provided,* That this extension shall not be effective after August 23 in each year.

9. Commercial fishing for salmon within 1,000 yards of the mouths of Bear Creek and Resurrection River is prohibited at all times; and in the period from June 7 to August 23, both dates inclusive, commercial fishing for salmon is prohibited within 1,700 yards of the mouths of these streams.

Steelhead fishery.—Commercial fishing for steelhead trout shall be subject to the provisions of law and the regulations applicable to commercial fishing for salmon.

Clam fishery.—It is prohibited to take for commercial purposes any razor clam measuring less than 4½ inches in total length of shell. Possession of any razor clam of less than this length will be regarded as prima facie evidence of unlawful taking.

IX. PRINCE WILLIAM SOUND AREA

The Prince William Sound area is hereby defined to include all territorial coastal and tributary waters of the Gulf of Alaska between Cape Fairfield on the west and Point Whitshed on the east.

Salmon fishery.—1. The total aggregate length of gill nets on any salmon fishing boat, or in use by such boat, shall not exceed 200 fathoms hung measure.

2. No salmon fishing boat shall carry or operate more than one seine of any description, and no additional net of any kind shall be carried on such boat. The carrying of any additional seine or net of any kind on a boat towed by any salmon fishing boat is prohibited. No purse seine shall be less than 125 meshes nor more

than 150 meshes in depth, nor less than 90 fathoms nor more than 150 fathoms in length measured on the cork line. For the purpose of determining depths of seines, measurements will be upon the basis of 3½ inches stretched measure between knots. No extension to any seine in the way of leads will be permitted.

3. No boat used in operating any purse seine shall be longer tham 50 feet, as shown by official register length.

4. No set or anchored gill net shall exceed 300 yards in length and each shall be set in substantially a straight line: *Provided,* That not to exceed 20 yards of each net may be used as a hook. Only one such hook is permitted on a net. There shall be a distance interval of at least 200 yards both endwise and laterally at all times between all set or anchored gill nets operated.

5. The use of purse seines and beach seines for the capture of salmon is prohibited in the waters along the western coast, from the outer point on the north shore of Granite Bay (known as Granite Bay Point) to the light on the south shore of the entrance to Port Nellie Juan.

6. The 36-hour closed period for salmon fishing prescribed by section 5 of the act of June 6, 1924, is hereby extended to include the period from 6 o'clock antemeridian of Saturday of each week until 6 o'clock antemeridian of the Monday following, making a weekly closed period of 48 hours.

7. Commercial fishing for salmon, except by trolling from boats propelled wholly by oars or sails, is prohibited prior to 6 o'clock antemeridian June 20 in each calendar year: *Provided,* That in Drier Bay below Williams Creek this prohibition shall not apply to commercial fishing for salmon after May 28 in each calendar year.

8. Commercial fishing for salmon is prohibited during the remainder of each calendar year after 6 o'clock postmeridian August 7, except that in the waters along the western coast from the outer point on the north shore of Granite Bay (known as Granite Bay Point) to the light on the south shore of the entrance to Port Nellie Juan commercial fishing for salmon by trolling and gill netting is permitted through August 15.

9. The distance by most direct water measurement from any part of one trap to any part of another trap shall not be less than 1½ statute miles.

10. Commercial fishing for salmon in the waters of Port Fidalgo east of 146 degrees 20 minutes west longitude is prohibited after 6 o'clock antemeridian July 11 in each year.

11. The use of any trap for the capture of salmon is prohibited except as follows:

(*a*) Along the coast of Squire Island within ½ statute mile of its southern extremity.

(*b*) Eastern coast of Chenega Island from a point 1 statute mile southward of its northern extremity to a point 1 statute mile eastward of Chenega village.

(*c*) The coast within 1 statute mile eastward of the point where the one hundred and forty-eighth meridian of west longitude intersects the north shore of Granite Bay, west coast of Prince William Sound.

(*d*) Eastern coast of Culross Island from a point on the southeast coast at 148 degrees 8 minutes 45 seconds west longitude to the southern point of entrance to Culross Bay, excluding Hidden Bay.

(*e*) Within 1 statute mile eastward of the southwestern extremity of Naked Island.

(*f*) Along the mainland eastward and northward from the outermost extremity of Point Pellew to 60 degrees 51 minutes north latitude.

(*g*) Along the mainland within 1 statute mile of the outer extremity of Granite Point, near Fairmount Island.

(*h*) Western side of Valdez Arm from Point Freemantle to 60 degrees 59 minutes 30 seconds north latitude.

(*i*) From the north side of the entrance to Sawmill Bay to a point on the coast 1 statute mile northeastward.

(*j*) Southwest coast of Bligh Island from 60 degrees 49 minutes 45 seconds north latitude to 146 degrees 44 minutes 20 seconds west longitude.

(*k*) Within ½ statute mile of the southwestern extremity of Bidarka Point.

(*l*) From a point on the east side of Landlocked Bay at 60 degrees 49 minutes north latitude to a point on the north shore of Port Fidalgo at 146 degrees 32 minutes west longitude.

(*m*) Within ½ statute mile of the northern extremity of the land between Two Moon Bay and Snug Corner Cove.

(*n*) Within ½ statute mile of Porcupine Point.

(*o*) Goose Island: West coast between the northern and southern extremities of the island.

(*p*) Mainland coast from a point due east of the southern extremity of Goose Island to a point east of Knowles Head at 146 degrees 36 minutes 20 seconds west longitude.

(*q*) Within 1 statute mile of Red Head.

(*r*) From a point on the coast 1 statute mile northwestward of the light at Gravina Point to a point on the coast 2 statute miles northwestward of the light at Gravina Point, making an open space of 1 statute mile.

(*s*) Along the coast within 1 statute mile southwesterly of the outer point on the southwest side of the entrance to Cedar Bay, Hawkins Island.

(*t*) Within 1 statute mile of Makaka Point, Hawkins Island.

(*u*) Hinchinbrook Island: Within 3,000 feet, measured westerly along the north side of a peninsula, from a point at 60 degrees 28 minutes 47 seconds north latitude, 146 degrees 23 minutes 27 seconds west longitude.

(*v*) Hinchinbrook Island: Within 3,000 feet, measured easterly along the coast, from a point at 60 degrees 27 minutes 58 seconds north latitude, 146 degrees 27 minutes west longitude, on the north side of a spit.

(*w*) Hinchinbrook Island: Within 2,500 feet, measured along the coast, from a point at 60 degrees 28 minutes 54 seconds north latitude, 146 degrees 32 minutes 11 seconds west longitude.

(*x*) Hinchinbrook Island: From a point on the coast at 60 degrees 27 minutes north latitude, 146 degrees 39 minutes 48 seconds west longitude, northward to the light at Johnstone Point.

(*y*) Hinchinbrook Island: From a point on the coast 2½ statute miles north of the southwestern extremity of Bear Cape northward to a point at 60 degrees 24 minutes 53 seconds north latitude, 146 degrees 42 minutes 24 seconds west longitude.

(*z*) Hinchinbrook Island: Within ½ statute mile eastward of a point on the south side of Port Etches at 146 degrees 40 minutes west longitude.

(*aa*) Montague Island: Along the coast within 2,500 feet from a point at 59 degrees 47 minutes north latitude, 147 degrees 56 minutes west longitude.

(*bb*) Montague Island: Along the coast from a point on the south side of Macleod Harbor 2,500 feet easterly of the outer extremity of Point Bryant to a point at 59 degrees 50 minutes 49 seconds north latitude, 147 degrees 54 minutes 27 seconds west longitude.

(*cc*) Western coast of Montague Island from Point Woodcock to a point on the south side of Hanning Bay at 147 degrees 42 minutes 40 seconds west longitude.

(*dd*) Western coast of Montague Island from the north side of the entrance to Hanning Bay to the southern entrance of Port Chalmers.

(*ee*) Northern coast of Montague Island from Graveyard Point to Montague Point.

12. All commercial fishing for salmon is prohibited, as follows:

(*a*) Constantine Harbor, northwest arm of Port Etches: All waters within the harbor and its tributary waters and within 100 yards outside the narrows at the entrance to the harbor.

(*b*) Port Etches: All waters within 2 statute miles of the mouth of the salmon stream flowing into the head of Port Etches.

(*c*) Boswell Bay, indenting Hinchinbrook Island: All waters in the bay west of 146 degrees 8 minutes west longitude.

(*d*) Twin Lake Creek: All waters within 1,000 yards of the mouth of Twin Lake Creek flowing into the southeast arm of Simpson Bay.

(*e*) Gravina River: All waters within 1 statute mile of the mouth of the river.

(*f*) Port Fidalgo: All waters within 1,000 yards of the mouth of the stream at the head of Port Fidalgo.

(*g*) Robe River, Lowe River, and other unnamed streams flowing into Port Valdez in the immediate vicinity of Valdez: All waters within 1 statute mile of the mouths.

(*h*) Columbia Bay, Long Bay, and their tributaries, indenting mainland on north shore of Prince William Sound: All waters within 1,000 yards of the mouth of any salmon stream.

(*i*) Unakwik Inlet, indenting mainland on north shore of Prince William Sound: All waters north of an east and west line passing through the northern side of the entrance to Jonah Bay and all waters of the inlet within 1,000 yards of the mouth of any salmon stream.

(*j*) Coghill River, tributary to College Fiord: All waters within 2,000 yards outside of the mouth of the river.

(*k*) Long Bay, tributary to Culross Passage: All waters within the bay.

(*l*) Gumboot Creek, on northwest shore of Eshamy Bay: All waters within 1,000 yards of the mouth of the creek.

(*m*) Eshamy Lagoon and its tributary waters: All waters within the lagoon and its tributaries and within 100 yards outside the narrows at the entrance to the lagoon.

(*n*) Jackpot Bay: All waters within 3,000 yards of the mouth of the red salmon stream at the head of the bay.

(*o*) Port Bainbridge: All waters in the middle north arm of Port Bainbridge.

(*p*) Crab Bay, on north shore of Evans Bay, Evans Island: All waters within 1,000 yards of the mouth of any salmon stream.

(*q*) Bay of Isles, indenting east shore of Knight Island: All waters within the west arm of the bay.

Steelhead fishery.—Commercial fishing for steelhead trout shall be subject to the provisions of law and the regulations applicable to commerical fishing for salmon.

Herring fishery.—1. Commercial fishing for herring, except for bait purposes, is prohibited from January 1 to June 30, both dates inclusive, and from November 16 to December 31, both dates inclusive, except that gill nets with mesh of not less than 2½ inches stretched measure between knots may be used from November 16 to December 15, both dates inclusive.

2. During the period from July 1 to October 1, both dates inclusive, commercial fishing for herring, including bait fishing, is prohibited in all waters closed throughout the year to salmon fishing.

3. Gill nets used in catching herring shall not be of smaller mesh than 2¼ inches stretched measure.

4. Commercial fishing for herring, including bait fishing, by means of any trap is prohibited.

5. Commercial fishing for herring, including bait fishing, by means of any purse seine more than 1,400 meshes in depth, more than 180 fathoms in length, or of mesh less than 1½ inches stretched measure between knots is prohibited.

6. No one shall place, or cause to be placed, across the entrance of any lagoon or bay any net or other device which will prevent the free passage at all times of herring in and out of said lagoon or bay.

Clam fishery.—1. It is prohibited to take for commercial purposes any razor clam measuring less than 4½ inches in total length of shell. Possession of any razor clam of less than this length will be regarded as prima facie evidence of unlawful taking.

2. The taking of clams for commercial purposes is prohibited from 6 o'clock postmeridian July 15 to 6 o'clock postmeridian August 31 in each calendar year.

Crab fishery.—DUNGENESS CRAB (*Cancer magister*).—No female of this species shall be taken at any time, and no male of this species measuring less than 6½ inches in greatest width shall be taken for commercial purposes.

X. COPPER RIVER AREA

The Copper River area is hereby defined to include all territorial coastal and tributary waters of Alaska between Point Whitshed on the west and Point Martin on the east, including Egg Islands and the other islands between these points.

Salmon fishery.—1. Commercial fishing for salmon is prohibited from 6 o'clock postmeridian July 5 to 6 o'clock antemeridian August 10 in each year.

2. Prior to 6 o'clock antemeridian May 15 in each year commercial fishing with nets of mesh less than 8½ inches stretched measure between knots is prohibited.

3. From May 15 to July 5, both dates inclusive, the 36-hour closed period for salmon fishing prescribed by section 5 of the act of June 6, 1924, is hereby extended to include the period from 6 o'clock antemeridian of Saturday of each week until 6 o'clock antemeridian of the Monday following, making a weekly closed period of 48 hours.

4. Commercial fishing for salmon is prohibited after 6 o'clock postmeridian September 22 in each calendar year.

5. Commercial fishing for salmon shall be conducted solely by drift gill nets, except that gill nets attached to anchored boats or other anchored floating equipment and stake nets may also be used from 6 o'clock antemeridian August 10 to 6 o'clock postmeridian September 22 in each calendar year.

6. Prior to 6 o'clock antemeridian August 10 in each calendar year the total aggregate length of drift gill nets on any salmon fishing boat, or in use by such boat, shall not exceed 250 fathoms hung measure: *Provided*, That during the period from 6 o'clock antemeridian May 15 to 6 o'clock postmeridian May 31 any gill net boat on the Copper River flats may carry and operate not to exceed

100 fathoms of net of mesh not less than 8½ inches stretched measure between knots in addition to 250 fathoms of smaller mesh net.

7. Commercial fishing for salmon is prohibited within 500 yards of the Grass Banks, except that from 6 o'clock antemeridian August 10 to 6 o'clock postmeridian September 22 in each calendar year such fishing is permitted within 500 yards of the Grass Banks by means of gill nets and stake nets not exceeding 300 fathoms each in length: *Provided,* That all stakes, pegs to which guy wires or lines are attached, or other pieces of equipment used in connection with stake nets shall be removed at or before the end of the fishing season. All fishing is prohibited at all times within the sloughs and within 500 yards of their mouths.

8. Stake and anchored gill nets shall be operated in substantially a straight line.

Steelhead fishery.—Commercial fishing for steelhead trout shall be subject to the provisions of law and the regulations applicable to commercial fishing for salmon.

Clam fishery.—1. It is prohibited to take for commercial purposes any razor clam measuring less than 4½ inches in total length of shell. Possession of any razor clam of less than this length will be regarded as prima facie evidence of unlawful taking.

2. The taking of clams for commercial purposes is prohibited from 6 o'clock postmeridian July 15 to 6 o'clock postmeridian August 31 in each calendar year.

Crab fishery.—DUNGENESS CRAB (*Cancer magister*).—No female of this species shall be taken at any time, and no male of this species measuring less than 6½ inches in greatest width shall be taken for commercial purposes.

XI. BERING RIVER AREA

The Bering River area is hereby defined to include all territorial coastal and tributary waters of Alaska between Point Martin on the west and Cape Suckling on the east.

Salmon fishery.—1. In the Bering River area all commercial fishing for salmon is prohibited prior to 6 o'clock antemeridian August 10 in each year: *Provided,* That this prohibition shall not prevent the taking of fish for local food requirements or for use as dog feed.

2. Commercial fishing for salmon is prohibited after 6 o'clock postmeridian September 22 in each calendar year.

3. Stake and anchored gill nets shall be operated in substantially a straight line.

Steelhead fishery.—Commercial fishing for steelhead trout shall be subject to the provisions of law and the regulations applicable to commercial fishing for salmon.

Clam fishery.—It is prohibited to take for commercial purposes any razor clam measuring less than 4½ inches in total length of shell. Possession of any razor clam of less than this length will be regarded as prima facie evidence of unlawful taking.

XII. SOUTHEASTERN ALASKA AREA

The Southeastern Alaska area is hereby defined to include all territorial coastal and tributary waters of Alaska extending from Dixon Entrance on the south to and including Yakutat Bay on the north.

Salmon fishery.—This area is subdivided into the following districts, wherein regulations shall be effective as follows:

Yakutat district.—All territorial waters within a line extending from Cape Fairweather at 58 degrees 49 minutes north latitude, 138 degrees west longitude, to Mount Fairweather, thence following the international boundary to a point at 140 degrees 28 minutes west longitude, thence south to a point at 59 degrees 36 minutes north latitude, 140 degrees 28 minutes west longitude, thence to Cape Fairweather at the point of beginning.

1. The total aggregate length of gill nets on any salmon fishing boat, or in use by such boat, shall not exceed 250 fathoms hung measure.

2. Stake and anchored gill nets shall be operated in substantially a straight line.

3. No salmon fishing boat shall carry or operate more than one seine of any description, and no additional net of any kind shall be carried on such boat. The carrying of any additional seine or net of any kind on a boat towed by any salmon fishing boat is prohibited.

4. Commercial fishing for salmon by means of any beach seine less than 75 fathoms hung measure in length or less than 4 fathoms hung measure in depth is prohibited. For the purpose of determining depths of seines measurements will be upon the basis of 3½ inches stretched measure between knots.

5. Commercial fishing for salmon in Dry Bay is prohibited prior to May 21 in each year.

6. Commercial fishing for salmon, except in Dry Bay, is prohibited prior to June 24 in each year: *Provided,* That this prohibition shall not apply to trolling.

7. Commercial fishing for salmon, except by trolling, is prohibited for the remainder of each calendar year after September 30.

8. Commercial fishing for salmon by trolling, except from boats propelled wholly by oars or sails, is prohibited prior to April 1 in each calendar year.

9. The use of any trap or purse seine is prohibited.

10. No trolling boat shall operate more than six trolling lines.

11. The 36-hour closed period for salmon fishing prescribed by section 5 of the act of June 6, 1924, is hereby extended to include the period from 6 o'clock postmeridian of Friday of each week until 6 o'clock antemeridian of the Monday following, making a weekly closed period of 60 hours.

12. All commercial fishing for salmon is prohibited, as follows:

(*a*) Ankau Creek and Inlet.

(*b*) Akwe or Ahquay River.

(*c*) The "Basin" above Dry Bay.

Icy Strait district.—All territorial waters within a line extending from a point west of Yakobi Island at 58 degrees north latitude, 136 degrees 51 minutes west longitude, to a point at 58 degrees north latitude, 134 degrees 58 minutes west longitude, thence north to a point on the coast of Chichagof Island near Point Augusta at 58 degrees 2 minutes 43 seconds north latitude, 134 degrees 58 minutes west longitude, thence to the southeastern extremity of Point Couverden, thence to Mount Harris, thence following the international boundary to Mount Fairweather, thence to Cape Fairweather, at 58 degrees 49 minutes north latitude, 138 degrees west longitude, thence to the point of beginning at 58 degrees north latitude, 136 degrees 51 minutes west longitude.

1. The total aggregate length of gill nets on any salmon fishing boat, or in use by such boat, shall not exceed 250 fathoms hung measure.

2. Stake and anchored gill nets shall be operated in substantially a straight line.

3. The distance by most direct water measurement from any part of one trap to any part of another trap shall not be less than 1½ statute miles.

4. No floating trap shall exceed 900 feet in length when any part of such trap is in a greater depth of water than 100 feet at mean high tide. The length of any such trap shall be as measured along the lead from shore at mean high tide to the outer face of the pot.

5. No salmon fishing boat shall carry or operate more than one seine of any description, and no additional net of any kind shall be carried on such boat. The carrying of any additional seine or net of any kind on a boat towed by any salmon fishing boat is prohibited. No purse seine shall be less than 175 meshes nor more than 250 meshes in depth nor less than 150 fathoms nor more than 200 fathoms in length, measured on the cork line. For the purpose of determining depths of seines measurements will be upon the basis of 3½ inches stretched measure between knots. No extension to any seine in the way of leads will be permitted.

6. Commercial fishing for salmon, except by trolling, is prohibited prior to 6 o'clock antemeridian June 15 in each calendar year and for the remainder of each calendar year after 6 o'clock postmeridian August 3: *Provided,* That in the waters of Icy Strait and its tributaries easterly of a line from Point Adolphus to Point Gustavus the closing date shall be 6 o'clock postmeridian August 6.

7. Commercial fishing for salmon by trolling, except from boats propelled wholly by oars or sails, is prohibited prior to April 1 in each calendar year.

8. The use of any beach seine is prohibited.

9. No boat used in operating any purse seine shall be longer than 50 feet, as shown by official register length.

10. No trolling boat shall operate more than six trolling lines.

11. Commercial fishing for salmon, except by gill nets, is prohibited in Dundas Bay north of 58 degrees 21 minutes north latitude, also in the western section of the bay southward of that latitude.

12. Commercial fishing for salmon by means of any seine is prohibited in Idaho Inlet south of 58 degrees 8 minutes 12 seconds north latitude.

13. Commercial fishing for salmon is prohibited in Port Frederick, northern shore of Chichagof Island, in all waters east of a line from Inner Point Sophia to Game Point and in all waters south of 58 degrees 4 minutes north latitude, except that trolling will be permitted from November 1 to June 1, both dates inclusive. A portion of the waters closed is in the western district.

14. The use of any trap for the capture of salmon is prohibited, except as follows:

(*a*) Mainland: From the east side of Dundas Bay at 58 degrees 20 minutes north latitude to a point 1,000 feet east of Point Dundas.

(*b*) Inian Islands: (1) North of 58 degrees 15 minutes 42 seconds north latitude, exclusive of the east end of the northeastern island, and (2) southwest coast of the northwestern island between 58 degrees 15 minutes 42 seconds north latitude and 58 degrees 15 minutes 18 seconds north latitude.

(*c*) George Islands: That island of the George Islands group located at 58 degrees 12 minutes 18 seconds north latitude.

(*d*) Three Hill Island, Cross Sound: West coast between the northern and the southern extremities.

(*e*) Chichagof Island: East coast of Port Althorp between 58 degrees 9 minutes 42 seconds and 58 degrees 11 minutes north latitude.

(*f*) Chichagof Island: From Point Lavinia eastward to a point on the west side of Idaho Inlet at 58 degrees 12 minutes 18 seconds north latitude.

(*g*) Chichagof Island: From a point on the east side of Idaho Inlet at 58 degrees 12 minutes 18 seconds north latitude northward and eastward to 136 degrees 6 minutes 18 seconds west longitude.

(*h*) Chichagof Island: North coast within 1,000 feet westerly from Eagle Point.

(*i*) Chichagof Island: North coast from a point 1,000 feet southerly from Pinta Cove Point westward to a point on the east side of Mud Bay at 58 degrees 12 minutes 6 seconds north latitude.

(*j*) Lemesurier Island: Northwest coast between the western and the northern extremities of the island.

(*k*) Mainland: From Point Gustavus to 135 degrees 50 minutes west longitude.

(*l*) Pleasant Island: Southern coast from the western extremity of the island to Noon Point.

(*m*) Mainland: From a point on the east side of Excursion Inlet at 58 degrees 23 minutes north latitude southward to 135 degrees 8 minutes 40 seconds west longitude.

(*n*) Chichagof Island: Northeastern coast from Point Sophia to a point on the south side of Icy Strait at 135 degrees 11 minutes 20 seconds west longitude.

(*o*) Chichagof Island: Northeastern coast from a point on the south side of Icy Strait at 135 degrees 2 minutes 40 seconds west longitude to North Passage Point, exclusive of False Bay. A part of these waters is in the western district.

15. All commercial fishing for salmon is prohibited in Glacier Bay within a line from Point Carolus to Point Gustavus.

Western district.—All territorial waters within a line extending from a point off Cape Ommaney at 56 degrees 6 minutes north latitude, 134 degrees 51 minutes west longitude, to a point off Cape Edgecumbe at 57 degrees north latitude, 136 degrees 4 minutes west longitude, thence to a point at 58 degrees north latitude, 136 degrees 51 minutes west longitude, thence east to 134 degrees 58 minutes west longitude, thence north to a point on the coast of Chichagof Island near Point Augusta at 58 degrees 2 minutes 43 seconds north latitude, 134 degrees 58 minutes west longitude, thence to the southeastern extremity of Point Couverden, thence to Mount Harris, thence following the international boundary to Mount Ogilvie, thence to the northern extremity of Shelter Island, thence to the northern extremity of Mansfield Peninsula, thence following the watersheds on Mansfield Peninsula and Admiralty Island to the southern extremity of Point Gardner, thence west to the watershed on Baranof Island, thence following the watershed to the southern extremity of Cape Ommaney, thence to the point of beginning at 56 degrees 6 minutes north latitude, 134 degrees 51 minutes west longitude.

1. The total aggregate length of gill nets on any salmon fishing boat, or in use by such boat, shall not exceed 250 fathoms hung measure.

2. Stake and anchored gill nets shall be operated in substantially a straight line.

3. The distance by most direct water measurement from any part of one trap to any part of another trap shall not be less than 1 statute mile: *Provided*, That in waters north of 58 degrees north latitude such distance interval shall not be less than 1½ statute miles.

4. No floating trap shall exceed 900 feet in length when any part of such trap is in a greater depth of water than 100 feet at mean high tide. The length of any such trap shall be as measured along the lead from shore at mean high tide to the outer face of the pot.

5. No salmon fishing boat shall carry or operate more than one seine of any description, and no additional net of any kind shall be carried on such boat.

The carrying of any additional seine or net of any kind on a boat towed by any salmon fishing boat is prohibited. No purse seine shall be less than 175 meshes nor more than 250 meshes in depth, nor less than 150 fathoms nor more than 200 fathoms in length measured on the cork line. For the purpose of determining depths of seines measurements will be upon the basis of 3½ inches stretched measure between knots. No extension to any seine in the way of leads will be permitted.

6. Commercial fishing for salmon, except by trolling, is prohibited prior to 6 o'clock antemeridian June 15 in each calendar year and for the remainder of each calendar year after 6 o'clock postmeridian August 10: *Provided*, That commercial fishing for salmon south of 58 degrees north latitude is permitted from 6 o'clock antemeridian October 1 to 6 o'clock postmeridian October 15: *And provided further*, That this prohibition shall not apply to the use of gill nets from 6 o'clock antemeridian September 5 to 6 o'clock postmeridian September 30 in Lynn Canal and contiguous waters north of the south end of Kochu Island, including Chilkat Inlet outside of a line from Green Point passing across the southern shore of Pyramid Island and Chilkoot Inlet 1,000 yards outside the mouth of Chilkoot River.

7. Commercial fishing for salmon by trolling, except from boats propelled wholly by oars or sails, is prohibited prior to April 1 in each calendar year.

8. The use of any beach seine is prohibited.

9. No boat used in operating any purse seine shall be longer than 50 feet, as shown by official register length.

10. No trolling boat shall operate more than six trolling lines.

11. Purse seines are prohibited in Lynn Canal and contiguous waters north of 58 degrees 26 minutes north latitude.

12. Commercial fishing for salmon in Lynn Canal and contiguous waters north of the south end of Kochu Island is prohibited, except that in these closed waters, including Chilkat Inlet outside of a line from Green Point passing across the southern shore of Pyramid Island and Chilkoot Inlet 1,000 yards outside the mouth of Chilkoot River, such fishing is permitted by gill nets from 6 o'clock antemeridian September 5 to 6 o'clock postmeridian September 30 in each year.

13. Commercial fishing for salmon is prohibited in Tenakee Inlet and Freshwater Bay within a line from North Passage Point to South Passage Point: *Provided*, That this prohibition shall not apply to trolling from January 1 to July 15, both dates inclusive, and from 6 o'clock antemeridian August 11 to 6 o'clock postmeridian September 30.

14. Commercial fishing for salmon is prohibited in Port Frederick, northern shore of Chichagof Island, in all waters east of a line from Inner Point Sophia to Game Point, and in all waters south of 58 degrees 4 minutes north latitude, except that trolling will be permitted from November 1 to June 1, both dates inclusive. A portion of the waters closed is in the Icy Strait district.

15. The use of any trap for the capture of salmon is prohibited except as follows:

(*a*) Krugloi Islands, Salisbury Sound: Along the coast on the south side of that island of the Krugloi Islands group located at 57 degrees 21 minutes 44 seconds north latitude, 135 degrees 43 minutes 26 seconds west longitude.

(*b*) Baranof Island: Northwest coast, beginning at a point 1,000 yards southward of Point Kakul and extending southward ½ statute mile.

(*c*) Chichagof Island: Northeastern coast from a point on the south side of Icy Strait at 135 degrees 2 minutes 40 seconds west longitude to North Passage Point, exclusive of False Bay. A part of these waters is in the Icy Strait district.

(*d*) Chichagof Island: Eastern coast from South Passage Point to Point Hayes, exclusive of Basket Bay and within ½ statute mile of each side of its entrance.

(*e*) Baranof Island: From a point ½ statue mile south of Point Thatcher to Point Lull.

(*f*) Baranof Island: East coast from a point ½ statute mile southeasterly of South Point to the north side of the entrance to Kasnyku Bay, exclusive of Cosmos Cove.

(*g*) Baranof Island: East coast from a point at the south side of the entrance to Kasnyku Bay at 57 degrees 12 minutes north latitude to a point 1 statute mile northwesterly of Point Turbot.

(*h*) Mansfield Peninsula: West coast from a point 500 feet north of False Retreat to the southern extremity of the peninsula at the north side of the entrance to Hawk Inlet, including the Kitten Islands but exclusive of Funter Bay.

(i) Admiralty Island: West coast from Parker Point to 58 degrees 3 minutes north latitude.

(j) Admiralty Island: West coast from Village Point to Distant Point.

(k) Admiralty Island: West coast from a point north of Wilson Cove at 57 degrees 10 minutes 30 seconds north latitude to Point Caution.

16. All commercial fishing for salmon is prohibited, as follows:

(a) Wilson Cove, southwestern shore of Admiralty Island: All waters within the cove.

(b) Whitewater Bay, southwestern shore of Admiralty Island: All waters within a line from Point Caution to Woody Point.

(c) Chaik Bay, southwestern shore of Admiralty Island: All waters east of 134 degrees 29 minutes west longitude.

(d) Warm Spring Bay, eastern shore of Baranof Island: All waters within the bay.

(e) Kelp Bay, east coast of Baranof Island: All waters in Middle Arm, and all waters in South Arm west of 134 degrees 57 minutes west longitude.

(f) Hanus Bay, northeast shore of Baranof Island: All waters in the bay south of a line from Point Hanus to Point Moses.

(g) Rodman Bay, northeast coast of Baranof Island: All waters west of 135 degrees 22 minutes west longitude.

(h) Sitkoh Bay, southeast shore of Chichagof Island: All waters within 1,000 yards of the mouths of all salmon streams.

(i) Basket Bay, east coast of Chichagof Island: All waters within the bay.

(j) Hawk Inlet, west coast of Admiralty Island: All waters of the inlet and its tributaries.

(k) Salt Lake Lagoon, Takanis Bay, southwest shore of Yakobi Island: All waters in the lagoon and within 500 yards of its mouth.

(l) Redfish Bay, southwest shore of Baranof Island: All waters above a true east and west line passing through the southern end of the Second Narrows.

(m) Still Harbor, west coast of Baranof Island: All waters in the harbor.

(n) Port Banks, off Whale Bay, west coast of Baranof Island: All waters in Port Banks.

(o) Redoubt Bay, west coast of Baranof Island: All waters within 1,000 yards of the mouth of the stream flowing from Redoubt Lake.

Eastern district.—All territorial waters within a line extending from a point near the Hazy Islands at 55 degrees 54 minutes north latitude, 134 degrees 34 minutes west longitude, to the southern end of Cape Decision, thence following the watershed on Kuiu Island to a point on the east side of Kuiu Island at 56 degrees 40 minutes north latitude, 133 degrees 44 minutes 15 seconds west longitude, thence east across Keku Strait, thence across Kupreanof Island, passing north of Duncan Canal, to a point on the east coast of Kupreanof Island at 56 degrees 54 minutes north latitude, thence across Frederick Sound to Horn Cliffs on the mainland, thence to Castle Mountain, thence following the international boundary to Mount Ogilvie, thence to the northern extremity of Shelter Island, thence to the northern extremity of Mansfield Peninsula, thence following the watersheds on Mansfield Peninsula and Admiralty Island to the southern extremity of Point Gardner, thence west to the watershed on Baranof Island, thence following the watershed to the southern extremity of Cape Ommaney, thence to a point at 56 degrees 6 minutes north latitude, 134 degrees 51 minutes west longitude, thence to the point of beginning at 55 degrees 54 minutes north latitude, 134 degrees 34 minutes west longitude.

1. The total aggregate length of gill nets on any salmon fishing boat, or in use by such boat, shall not exceed 250 fathoms hung measure.

2. Stake and anchored gill nets shall be operated in substantially a straight line.

3. The distance by most direct water measurement from any part of one trap to any part of another trap shall not be less than 1 statute mile: *Provided*, That in waters north of 58 degrees north latitude such distance interval shall not be less than 1½ statute miles.

4. No floating trap shall exceed 900 feet in length when any part of such trap is in a greater depth of water than 100 feet at mean high tide. The length of any such trap shall be as measured along the lead from shore at mean high tide to the outer face of the pot.

5. No salmon fishing boat shall carry or operate more than one seine of any description, and no additional net of any kind shall be carried on such boat. The carrying of any additional seine or net of any kind on a boat towed by any salmon-fishing boat is prohibited. No purse seine shall be less than 175 meshes nor more than 250 meshes in depth, nor less than 150 fathoms nor more than 200 fathoms in length measured on the cork line. For the purpose of determining depths of

seines measurements will be upon the basis of 3½ inches stretched measure between knots. No extension to any seine in the way of leads will be permitted.

6. Commercial fishing for salmon, except by trolling, is prohibited prior to 6 o'clock antemeridian June 25 in each calendar year: *Provided*, That this prohibition shall not apply to the use of gill nets in Taku Inlet after 6 o'clock antemeridian May 10.

7. Commercial fishing for salmon, except by trolling, is prohibited for the remainder of each calendar year after 6 o'clock postmeridian August 14: *Provided*, That commercial fishing for salmon south of 58 degrees north latitude is permitted from 6 o'clock antemeridian October 1 to 6 o'clock postmeridian October 15.

8. Commercial fishing for salmon by trolling, except from boats propelled wholly by oars or sails, is prohibited prior to April 1 in each calendar year.

9. The use of any beach seine is prohibited.

10. No boat used in operating any purse seine shall be longer than 50 feet, as shown by official register length.

11. No trolling boat shall operate more than six trolling lines.

12. Purse seines are prohibited in Lynn Canal and contiguous waters north of 58 degrees 26 minutes north latitude.

13. No gill net used in Taku Inlet shall exceed 150 fathoms in length, hung measure.

14. The use of any trap for the capture of salmon is prohibited, except as follows:

(*a*) Douglas Island: West coast from Middle Point to Outer Point.

(*b*) Mainland: From the south side of Limestone Inlet at 58 degrees 1 minute 45 seconds north latitude southward to a point ½ statute mile northwest of Point Styleman.

(*c*) Mainland, east side of Stephens Passage: From a point on the north side of Windham Bay at 133 degrees 33 minutes west longitude to Point League.

(*d*) Mainland, between Hobart Bay and Windham Bay: From a point at 57 degrees 26 minutes north latitude to a point at 57 degrees 30 minutes north latitude.

(*e*) Mainland: From a point on the north side of Port Houghton at 133 degrees 26 minutes west longitude to a point north of Point Hobart at 57 degrees 23 minutes north latitude.

(*f*) Mainland, Frederick Sound: From a point on the south side of Fanshaw Bay at 133 degrees 31 minutes 48 seconds west longitude to Cape Fanshaw, thence southeasterly to a point at 57 degrees 7 minutes 23 seconds north latitude, 133 degrees 21 minutes west longitude.

(*g*) Admiralty Island: Southeast coast from Point Pybus to False Point Pybus.

(*h*) Admiralty Island: Southeast coast from a point at 57 degrees 13 minutes north latitude southward to Deepwater Point.

(*i*) Admiralty Island: Southeast coast from a point ½ statute mile southwest of Point Brightman to a point at 57 degrees 3 minutes 19 seconds north latitude, 134 degrees 27 minutes 20 seconds west longitude.

(*j*) Admiralty Island: Southeast coast within 2,500 feet northeasterly of the southern extremity of Walker Point.

(*k*) Kupreanof Island: Northwest coast from a point ½ statute mile southeast of the outer extremity of Point Macartney northward to a point on the north shore at 57 degrees 5 minutes 46 seconds north latitude, 133 degrees 53 minutes 18 seconds west longitude.

(*l*) Kuiu Island: Within ¼ statute mile of the western extremity of Cornwallis Point.

(*m*) Kuiu Island: Northwest coast from a point 1 statute mile north of the north side of the entrance to Washington Bay northward to the point at the east side of the entrance to Band Cove.

15. All commercial fishing for salmon is prohibited as follows:

(*a*) Port Houghton, indenting mainland: All waters in Sanborn Canal.

(*b*) Windham Bay, indenting mainland: All waters of the bay within a line 1,000 yards outside the mouth of the narrows.

(*c*) Taku Inlet: All waters to the eastward of a line beginning on the shore northward of Taku Point at 133 degrees 59 minutes west longitude, thence running due north to the opposite shore, thence following the shore line to the mouth of the Taku River.

(*d*) Mole Harbor, tributary to Seymour Canal, east coast of Admiralty Island: All waters of the harbor west of 134 degrees 2 minutes 25 seconds west longitude.

(*e*) Gambier Bay, east coast of Admiralty Island: All waters west of 134 degrees west longitude.

(*f*) Portage Bay, north end of Kupreanof Island: All waters within the bay and all waters within 1 statute mile outside the entrance to the bay.

(*g*) Port Camden, east coast of Kuiu Island: All waters of Port Camden south of 56 degrees 40 minutes north latitude.

(*h*) Kadake Bay, east coast of Kuiu Island: All waters of Kadake Bay within a line from a point at 56 degrees 48 minutes 20 seconds north latitude, 133 degrees 56 minutes 18 seconds west longitude, to a point at 56 degrees 48 minutes 40 seconds north latitude, 133 degrees 57 minutes 30 seconds west longitude.

(*i*) Hamilton Bay, west coast of Kupreanof Island: All waters east of 133 degrees 49 minutes west longitude.

(*j*) Keku Strait, east coast of Kuiu Island: Waters of Keku Strait, including all waters of Big Johns Bay, inclosed by a line from a point at 56 degrees 35 minutes north latitude, 133 degrees 42 minutes 35 seconds west longitude, to a point at 56 degrees 35 minutes north latitude, 133 degrees 40 minutes west longitude, and a line from the northern extremity of Point Camden to a point at 56 degrees 48 minutes 40 seconds north latitude, 133 degrees 46 minutes west longitude. A portion of the closed waters of Big Johns Bay is north of 56 degrees 48 minutes 40 seconds north latitude. A part of the waters closed is in the North Prince of Wales Island district.

(*k*) Tebenkof Bay, west coast of Kuiu Island: All waters in north arm of bay.

(*l*) Bay of Pillars, west coast of Kuiu Island: All waters in south arm of bay.

(*m*) Security Bay, northwest coast of Kuiu Island: All waters within 1,000 yards of all salmon streams.

(*n*) Saginaw Bay, northwest coast of Kuiu Island: All waters of the bay inside of a line beginning at the point of land at the northwest side of the entrance to Halleck Harbor and passing in a southwesterly direction at right angles to the general trend of the bay to the opposite shore.

(*o*) Red Bluff Bay, east coast of Baranof Island: All waters in the bay; the waters of Falls Creek Bay are included.

(*p*) Gut Bay, east coast of Baranof Island: All waters of the bay.

(*q*) Little Port Walter, east coast of Baranof Island: All waters in Little Port Walter.

Stikine district.—All territorial waters within a line extending from Horn Cliffs on the mainland to Frederick Point on Mitkof Island, thence to Point Howe, thence to South Craig Point on Zarembo Island, thence to Drag Island in Chichagof Pass, thence to Chichagof Peak on Wrangell Island, thence to Babbler Point on the mainland, thence to Mount Cote, thence following the international boundary to Castle Mountain, thence to the point of beginning at Horn Cliffs.

1. Commercial fishing for salmon shall be conducted solely by trolling and by drift gill nets which shall not exceed 250 fathoms in length each.

2. Commercial fishing for salmon, except by trolling, is prohibited during the period from 6 o'clock postmeridian June 10 to 6 o'clock postmeridian June 30 in each year and for the remainder of each year after 6 o'clock postmeridian September 30.

3. From April 1 to September 30, both dates inclusive, the 36-hour closed period for salmon fishing prescribed by section 5 of the act of June 6, 1924, is hereby extended to include the period from 6 o'clock antemeridian of Saturday of each week to 6 o'clock antemeridian of the Monday following, making a weekly closed period of 48 hours.

4. Commercial fishing for salmon by trolling, except from boats propelled wholly by oars or sails, is prohibited prior to April 1 in each calendar year.

5. No trolling boat shall operate more than six trolling lines.

North Prince of Wales Island district.—All territorial waters within a line extending from a point near the Hazy Islands at 55 degrees 54 minutes north latitude, 134 degrees 34 minutes west longitude, to the southern end of Cape Decision, thence following the watershed on Kuiu Island to a point on the east side of Kuiu Island at 56 degrees 40 minutes north latitude, 133 degrees 44 minutes 15 seconds west longitude, thence east across Keku Strait, thence across Kupreanof Island, passing north of Duncan Canal, to a point on the east coast of Kupreanof Island at 56 degrees 54 minutes north latitude, thence across Frederick Sound to Horn Cliffs on the mainland, thence to Frederick Point on Mitkof Island, thence to Point Howe, thence to South Craig Point on Zarembo Island, thence to Drag Island in Chichagof Pass, thence to Chichagof Peak on Wrangell Island, thence to Babbler Point on the mainland, thence to Mount Cote, thence following the international boundary to Mount Lewis Cass, thence southerly and westerly along the watershed to the southern extremity of Caamano Point, thence southerly to the international boundary at 131 degrees 44 minutes west longitude, thence westerly to the southern extremity of Cape Chacon, thence in a northwesterly direction along the watershed of Prince of Wales Island to a point at 55 degrees 35 minutes 30 seconds north latitude, 133 degrees 14 minutes west longitude, thence south to a point at 55 degrees 25 minutes 30 seconds north latitude, 133 degrees 14 minutes west longitude, thence west to 55 degrees 25 minutes 30 seconds north latitude, 134 degrees west longitude, thence to the point of beginning at 55 degrees 54 minutes north latitude, 134 degrees 34 minutes west longitude.

1. The total aggregate length of gill nets on any salmon fishing boat, or in use by such boat, shall not exceed 250 fathoms hung measure.

2. Stake and anchored gill nets shall be operated in substantially a straight line.

3. The distance by most direct water measurement from any part of one trap to any part of another trap shall not be less than 1 statute mile.

4. No floating trap shall exceed 900 feet in length when any part of such trap is in a greater depth of water than 100 feet at mean high tide. The length of any such trap shall be as measured along the lead from shore at mean high tide to the outer face of the pot.

5. No salmon fishing boat shall carry or operate more than one seine of any description, and no additional net of any kind shall be carried on such boat. The carrying of any additional seine or net of any kind on a boat towed by any salmon fishing boat is prohibited. No purse seine shall be less than 175 meshes nor more than 250 meshes in depth nor less than 150 fathoms nor more than 200 fathoms in length, measured on the cork line. For the purpose of determining depths of seines measurements will be upon the basis of 3½ inches stretched measure between knots. No extension to any seine in the way of leads will be permitted.

6. Commercial fishing for salmon, except by trolling, is prohibited prior to 6 o'clock antemeridian July 10 in each calendar year, from 6 o'clock postmeridian August 20 to 6 o'clock antemeridian October 1 in each year, and for the remainder of each calendar year after 6 o'clock postmeridian October 15.

7. Commercial fishing for salmon by trolling, except from boats propelled wholly by oars or sails, is prohibited prior to April 1 in each calendar year.

8. The use of any beach seine is prohibited.

9. No boat used in operating any purse seine shall be longer than 50 feet, as shown by official register length.

10. No trolling boat shall operate more than six trolling lines.

11. The use of any gill net is prohibited in all waters of the west coast of Prince of Wales Island and adjacent islands northward to Point Baker.

12. Commercial fishing for salmon, except by trolling, is prohibited in Anita Bay, opening into Zimovia Strait, Etolin Island.

13. The use of any trap for the capture of salmon is prohibited, except as follows:

(*a*) San Juan Bautista Island: From a point on the west coast at 55 degrees 25 minutes 45 seconds north latitude southerly and easterly to a point on the south coast at 133 degrees 17 minutes 30 seconds west longitude. A part of these waters is in the South Prince of Wales Island district.

(*b*) Noyes Island: North coast between 133 degrees 40 minutes west longitude and 133 degrees 42 minutes 16 seconds west longitude.

(*c*) San Fernando Island: Northern coast from Point Garcia to a point on the coast 1 statute mile west of Point Santa Lucia.

(*d*) San Fernando Island: Southeastern coast from a point on the coast 1 statute mile southwest of Fern point to Point Amargura.

(*e*) Culebra Island: Coast west of 133 degrees 26 minutes 30 seconds west longitude.

(*f*) St. Philip Island: Coast west of 133 degrees 25 minutes west longitude.

(*g*) Blanquizal Island: Coast west of 133 degrees 24 minutes west longitude.

(*h*) Prince of Wales Island: Coast along San Christoval Channel from a point at 55 degrees 37 minutes north latitude southward to 133 degrees 16 minutes west longitude.

(*i*) Esquibel Island: East coast from the southern extremity of the island to a point at 55 degrees 38 minutes 40 seconds north latitude.

(*j*) Heceta Island: Western and southern coasts from a point on the coast 1½ statute miles southeasterly from Cape Lynch to a point on the coast at 55 degrees 42 minutes 40 seconds north latitude, 133 degrees 29 minutes 20 seconds west longitude.

(*k*) Heceta Island: Northern shore from a point on the east side of Port Alice at 55 degrees 49 minutes 45 seconds north latitude to the point at approximately 55 degrees 49 minutes 10 seconds north latitude and 133 degrees 31 minutes west longitude.

(*l*) Tuxekan Island: Western coast from a point at 55 degrees 52 minutes 50 seconds north latitude southerly to a point at 55 degrees 52 minutes 15 seconds north latitude.

(*m*) Tuxekan Island: Western coast within 1,000 feet of the western extremity of Turn Point.

(*n*) Tuxekan Island: Western coast within 3,000 feet northwesterly of a point 1,000 feet northwesterly of the southern extremity of Tuxekan Island.

(*o*) Kosciusko Island: Western coast from a point 1,000 feet northwesterly from the southern extremity of land at the west side of Halibut Harbor to 55 degrees 56 minutes 15 seconds north latitude.

(*p*) Kosciusko Island: Western coast from the south point at the entrance of Pole Anchorage to Ruins Point at 133 degrees 40 minutes west longitude, including the small islet at the north point of the entrance of Pole Anchorage.

(*q*) Kosciusko Island: Eastern coast from a point ½ statute mile west of Van Sant Cove to a point ½ statute mile east of the east side of the entrance to Edna Bay.

(*r*) Cap Island, near Tuxekan Island: West side of Cap Island from the southern extremity to a point on the north shore at 133 degrees 21 minutes west longitude.

(*s*) Warren Island, near Kosciusko Island: East coast of Warren Island between 55 degrees 51 minutes north latitude and 55 degrees 56 minutes north latitude, exclusive of Warren Cove and False Cove.

(*t*) Kuiu Island: From a point on the coast 2 statute miles northeasterly from Cape Decision to a point on the coast near the entrance to Port McArthur at 56 degrees 3 minutes north latitude.

(*u*) Kuiu Island: East coast within 2,500 feet from a point at 56 degrees 13 minutes 19 seconds north latitude, 133 degrees 52 minutes 35 seconds west longitude.

(*v*) Kuiu Island: East coast of peninsula between Port Beauclerc and Reid Bay from 56 degrees 17 minutes north latitude northward to 56 degrees 19 minutes north latitude.

(*w*) Prince of Wales Island: Northwest coast from a point at 56 degrees 17 minutes north latitude southerly to a point ½ statute mile northerly from the entrance to Hole in the Wall.

(*x*) Barrier Islands, near northwest coast of Prince of Wales Island: The west coast of the westerly of the two principal islands of the Barrier Islands Group.

(*y*) Prince of Wales Island: North coast between Point Baker and 133 degrees 22 minutes west longitude.

(*z*) Prince of Wales Island: North coast from Pine Point to Point Colpoys.

(*aa*) Kupreanof Island: Southern coast within 2,500 feet from a point at 56 degrees 26 minutes 8 seconds north latitude, 133 degrees 29 minutes 35 seconds west longitude.

(*bb*) Zarembo Island: West coast from Point St. John to 56 degrees 24 minutes 20 seconds north latitude.

(*cc*) Zarembo Island: West coast from 56 degrees 20 minutes north latitude southeasterly to a point on the coast at 133 degrees west longitude.

(*dd*) Etolin Island: West coast from 56 degrees 18 minutes north latitude southward to Steamer Point.

(*ee*) Etolin Island: West coast within 2,500 feet northeasterly from a point on the coast at 56 degrees 11 minutes 39 seconds north latitude.

(*ff*) Etolin Island: West coast from 56 degrees 9 minutes 15 seconds north latitude southward to 56 degrees 8 minutes north latitude.

(*gg*) Etolin Island: West coast from 56 degrees 4 minutes 30 seconds north latitude southeasterly to 56 degrees 3 minutes north latitude, 132 degrees 38 minutes 54 seconds west longitude.

(*hh*) West coasts of Observation Island, Marsh Island, Screen Islands, and Abraham Island.

(*ii*) East Island: East coast between the northern and the southeastern extremities.

(*jj*) Blashke Island: Coast west of 132 degrees 55 minutes west longitude.

(*kk*) Coffman Island: East coast between the northern and the southern extremities.

(*ll*) Prince of Wales Island: Within ½ statute mile southeastward of the extremity of land at approximately 56 degrees 1 minute 16 seconds north latitude, 132 degrees 49 minutes 40 seconds west longitude.

(*mm*) Prince of Wales Island: East coast from a point ½ statute mile northwest of Luck Point to a point at 55 degrees 46 minutes 30 seconds north latitude, exclusive of 1 statute mile each side of the mouth of Eagle Creek.

(*nn*) Onslow Island: West coast from Gull Point to Ernest Point.

(*oo*) Brownson Island: From the southern extremity of the island eastward and northward to 55 degrees 57 minutes north latitude.

(*pp*) Cleveland Peninsula: West coast from ½ statute mile east of Watkins Point southward to a point 1 statute mile north of Emerald Bay.

(*qq*) Deer Island: West coast from a point at 56 degrees 3 minutes north latitude to Kuakan Point.

(*rr*) Cleveland Peninsula: East side of Clarence Strait within 2,000 feet southerly of a point at 55 degrees 45 minutes 43 seconds north latitude, 132 degrees 17 minutes 10 seconds west longitude.

(*ss*) Cleveland Peninsula: From a point on the east side of Clarence Strait at 55 degrees 44 minutes 7 seconds north latitude, 132 degrees 15 minutes 36 seconds west longitude, southerly to Caamano Point, thence northeasterly to a point at 55 degrees 34 minutes 30 seconds north latitude near the south side of the entrance to Smugglers Cove. A part of these waters is in the southern district.

(*tt*) Grindall Island, off Grindall Point, Prince of Wales Island: Within 2,500 feet northwesterly of the eastern extremity of Approach Point.

(*uu*) Prince of Wales Island: East coast from the eastern end of Grindall Point at 55 degrees 27 minutes 30 seconds north latitude northwesterly to a point southeasterly of Tolstoi Point at 55 degrees 39 minutes 30 seconds north latitude.

(*vv*) Prince of Wales Island: East coast from the northern extremity of Clover Point to a point at 55 degrees 23 minutes 35 seconds north latitude, 132 degrees 14 minutes west longitude.

(*ww*) Prince of Wales Island: East coast from 55 degrees 8 minutes 20 seconds north latitude to the northern extremity of Chasina Point, including Wedge Island.

(*xx*) Prince of Wales Island: East coast from Point Halliday to Adams Point.

(*yy*) Prince of Wales Island: East coast from Ingraham Point to Rip Point, including Polk Island.

(*zz*) Prince of Wales Island: East coast from 54 degrees 57 minutes north latitude to the south side of the entrance to Ingraham Bay.

(*aaa*) Prince of Wales Island: From the outer point of land on the north side of Kendrick Bay at approximately 131 degrees 58 minutes 30 seconds west longitude northward to 54 degrees 55 minutes 10 seconds north latitude.

(*bbb*) Prince of Wales Island: From Island Point northward to a point on the south side of Kendrick Bay at 132 degrees west longitude.

(*ccc*) Prince of Wales Island: East coast from McLean Point to a point ½ statute mile southward.

(*ddd*) Prince of Wales Island: From a point near Nichols Bay at 132 degrees 5 minutes west longitude eastward and northward to a point at approximately 54 degrees 45 minutes north latitude, 132 degrees west longitude. A part of these waters is in the South Prince of Wales Island district.

14. All commercial fishing for salmon is prohibited, as follows:

(*a*) Moira Sound, east coast of Prince of Wales Island: All waters in South Arm, Frederick Cove, Kegan Cove, and within 1,000 yards of the mouths of all salmon streams in Johnson Cove.

(*b*) Dolomi Bay, tributary to Port Johnson, east coast of Prince of Wales Island: All waters within the outermost points of the bay.

(*c*) Cholmondeley Sound, east coast of Prince of Wales Island: All waters in Dora Bay and Sunny Cove.

(*d*) Skowl Arm, Prince of Wales Island: All waters within a line from Old Kasaan village to Khayyam Point.

(*e*) Kasaan Bay, east coast of Prince of Wales Island: All waters north of a line from Sandy Point to the east shore of the bay.

(*f*) Thorne and Tolstoi Bays, indenting the eastern shore of Prince of Wales Island: All waters within a line from Tolstoi Point to Thorne Head.

(*g*) Eagle Creek, about 1 mile south of Luck Point, northeast coast of Prince of Wales Island: All waters within 1 statute mile of the mouth of the creek.

(*h*) Barnes Lake, at head of Lake Bay, northeast coast of Prince of Wales Island: All waters in Barnes Lake and within 50 yards outside its entrance.

(*i*) Whale Passage, northeast coast of Prince of Wales Island: All waters within 1,000 yards from mouths of all salmon streams.

(*j*) Salmon Bay, northeast coast of Prince of Wales Island: All waters within the bay and all waters within 1 statute mile of the mouth of the bay.

(*k*) Red Bay, north shore of Prince of Wales Island: All waters south of a true east and west line passing through the north shore of Dead Island.

(*l*) McHenry Inlet, southwest coast of Etolin Island: All waters within 1,000 yards of the salmon streams emptying into the head of McHenry Inlet.

(*m*) Rocky Bay, west coast of Etolin Island: All waters within 1 statute mile of the head of the bay.

(*n*) Olive Cove, indenting the northeastern shore of Etolin Island.

(*o*) Thoms Place, indenting the southwestern shore of Wrangell Island, Zimovia Strait.

(*p*) Bradfield Canal: All waters of Bradfield Canal to the eastward of a line from Point Warde to the point at the east side of the entrance to Fools Inlet.

(*q*) Blake Channel: All waters of Blake Channel south of 56 degrees 14 minutes 30 seconds north latitude.

(*r*) Wrangell Narrows: All waters between Point Alexander and Prolewy Point.

(*s*) Duncan Canal, Kupreanof Island: All waters within 1 statute mile of all salmon streams tributary to Duncan Canal.

(*t*) Barrie Creek, north of Point Barrie, southwest shore of Kupreanof Island: All waters within 1 statute mile of the mouth of the creek.

(*u*) Keku Strait, east coast of Kuiu Island: Waters of Keku Strait, including all waters of Big Johns Bay, enclosed by a line from a point at 56 degrees 35 minutes north latitude, 133 degrees 42 minutes 35 seconds west longitude, to a point at 56 degrees 35 minutes north latitude, 133 degrees 40 minutes west longitude, and a line from the northern extremity of Point Camden to a point at 56 degrees 48 minutes 40 seconds north latitude, 133 degrees 46 minutes west longitude. A portion of the closed waters of Big Johns Bay is north of 56 degrees 48 minutes 40 seconds north latitude. A part of the waters closed is in the eastern district.

(*v*) Three Mile Arm, east coast of Kuiu Island: All waters within 1,000 yards of the mouths of all salmon streams.

(*w*) Seclusion Harbor, east coast of Kuiu Island: All waters within the outermost points of the harbor.

(*x*) Port Beauclerc, southeastern coast of Kuiu Island: All waters within 1,000 yards of the mouths of all salmon streams tributary to Port Beauclerc.

(*y*) Affleck Canal, southeastern coast of Kuiu Island: All waters within 1,000 yards of the mouths of all salmon streams tributary to Affleck Canal and all waters north of 56 degrees 13 minutes 30 seconds north latitude.

(*z*) Hole in the Wall, west coast of Prince of Wales Island: All waters within the outermost points of the cove.

(*aa*) Calder Bay, west coast of Prince of Wales Island: All waters north of 56 degrees 11 minutes 6 seconds north latitude.

(*bb*) El Capitan Passage, between Kosciusko Island and Prince of Wales Island: El Capitan Passage and contiguous waters between a line extending due east from a point on the west side of Tenass Pass at 56 degrees north latitude and a line extending due north from the point of land on Kosciusko Island at 56 degrees 8 minutes 47 seconds north latitude, 133 degrees 27 minutes 40 seconds west longitude.

(*cc*) Shipley Bay, west coast of Kosciusko Island: All waters east of 133 degrees 33 minutes 8 seconds west longitude.

(*dd*) Davidson Inlet, Kosciusko Island: All waters of the inlet north of 56 degrees 1 minute 45 seconds north latitude.

(*ee*) Tokeen Bay, Kosciusko Island: All waters of the bay north of 56 degrees 1 minute 45 seconds north latitude.

(*ff*) Sarkar Cove, west coast of Prince of Wales Island, tributary to El Capitan Passage: All waters inside of a line across the entrance.

(*gg*) Naukati Bay, west coast of Prince of Wales Island: All waters within the bay.

(*hh*) Staney Creek, west coast of Prince of Wales Island: All waters within 1 statute mile of the mouth of the creek.

South Prince of Wales Island district.—All territorial waters within a line extending from a point west of Cape Addington at 55 degrees 25 minutes 30 seconds north latitude, 134 degrees west longitude, thence to a point southwest of Forrester Island at 54 degrees 40 minutes north latitude, 133 degrees 35 minutes west longitude, thence to the southern extremity of Cape Muzon, thence to the southern extremity of Cape Chacon, thence in a northwesterly direction along the watershed of Prince of Wales Island to a point at 55 degrees 35 minutes 30 seconds north latitude, 133 degrees 14 minutes west longitude, thence south to a point at 55 degrees 25 minutes 30 seconds north latitude, 133 degrees 14 minutes west longitude, thence west to the point of beginning at 55 degrees 25 minutes 30 seconds north latitude, 134 degrees west longitude.

1. The total aggregate length of gill nets on any salmon-fishing boat, or in use by such boat, shall not exceed 250 fathoms hung measure.

2. Stake and anchored gill nets shall be operated in substantially a straight line.

3. The distance by most direct water measurement from any part of one trap to any part of another trap shall not be less than 1 statute mile.

4. No floating trap shall exceed 900 feet in length when any part of such trap is in a greater depth of water than 100 feet at mean high tide. The length of any such trap shall be as measured along the lead from shore at mean high tide to the outer face of the pot.

5. No salmon-fishing boat shall carry or operate more than one seine of any description, and no additional net of any kind shall be carried on such boat. The carrying of any additional seine or net of any kind on a boat towed by any salmon-fishing boat is prohibited. No purse seine shall be less than 175 meshes nor more than 250 meshes in depth nor less than 150 fathoms nor more than 200 fathoms in length, measured on the cork line. For the purpose of determining depths of seines measurements will be upon the basis of 3½ inches stretched measure between knots. No extension to any seine in the way of leads will be permitted.

6. Commercial fishing for salmon, except by trolling, is prohibited prior to 6 o'clock antemeridian July 15 in each calander year, from 6 o'clock postmeridian August 24 to 6 o'clock antemeridian October 1 in each year, and for the remainder of each calendar year after 6 o'clock postmeridian October 15.

7. Commercial fishing for salmon by trolling, except from boats propelled wholly by oars or sails, is prohibited prior to April 1 in each calendar year.

8. The use of any beach seine is prohibited.

9. No boat used in operating any purse seine shall be longer than 50 feet, as shown by official register length.

10. No trolling boat shall operate more than six trolling lines.

11. The use of any gill net is prohibited in all waters of the west coast of Prince of Wales Island and adjacent islands form Cape Chacon northward.

12. The use of any trap for the capture of salmon is prohibited, except as follows:

(*a*) San Juan Bautista Island: Within 2,000 feet of a point on the east coast at 55 degrees 24 minutes 27 seconds north latitude, 133 degrees 15 minutes west longitude.

(*b*) San Juan Bautista Island: From a point on the west coast at 55 degeees 25 minutes 45 seconds north latitude southerly and easterly to a point on the south coast at 133 degrees 17 minutes 30 seconds west longitude. A part of these waters is in the North Prince of Wales Island district.

(*c*) St. Ignace Island: Within ⅜ statute mile of the southern extremity of the island.

(*d*) Baker Island: East coast from Point San Roque to Pepper Point and from Point Maria to Point Capones.

(*e*) Suemez Island: Northern coast from Point Arboleda to a point at 55 degrees 20 minutes north latitude and approximately 133 degrees 19 minutes west longitude.

(*f*) Prince of Wales Island: Coast between Point Providence and Point Lomas.

(*g*) Dall Island: East coast from 54 degrees 59 minutes north latitude to 55 degrees 30 seconds north latitude.

(*h*) Dall Island: From Kaigani Village to a point on the coast 1 statute mile northwestward.

(*i*) Long Island, east of Dall Island: East and west coasts between 54 degrees 46 minutes north latitude and 54 degrees 47 minutes north latitude.

(*j*) Sukkwan Island: Southwestern coast from 55 degrees 2 minutes 30 seconds north latitude to the southern extremity of the island, exclusive of the waters of Kasook Inlet and its tributaries and branches.

(*k*) Prince of Wales Island: From Point Webster southeasterly to 54 degrees 54 minutes 45 seconds north latitude, exclusive of the waters of Kassa Inlet and its tributaries and branches.

(*l*) Ship Islands, Cordova Bay: West coast of the western of the two largest islands of the Ship Islands group and within 300 yards west of the southern extremity of the eastern large island of this group.

(*m*) Coast line within 450 feet of the eastern extremity of the island situated at 54 degrees 42 minutes 51 seconds north latitude, 132 degrees 16 minutes 15 seconds west longitude.

(*n*) Prince of Wales Island: South coast between Brownson Bay and Nichols Bay from a point at 54 degrees 42 minutes 30 seconds north latitude, 132 degrees 10 minutes west longitude, easterly to a point at 54 degrees 41 minutes 22 seconds north latitude, 132 degrees 8 minutes west longitude.

(*o*) Prince of Wales Island: From a point near Nichols Bay at 132 degrees 5 minutes west longitude eastward and northward to a point at approximately 54 degrees 45 minutes north latitude, 132 degrees west longitude. A part of these waters is in the North Prince of Wales Island district.

13. All commercial fishing for salmon is prohibited, as follows:

(*a*) Klawak Inlet, west coast of Prince of Wales Island: All waters in the head of the inlet east of 133 degrees 5 minutes west longitude.

(*b*) Klawak Harbor, west coast of Prince of Wales Island: All waters south of 55 degrees 33 minutes 22 seconds north latitude.

(*c*) Trocadero Bay, west coast of Prince of Wales Island: All waters in the bay east of a true north and south line passing through the eastern extremity of the peninsula just south of Copper Mine.

(*d*) North Bay, northeast coast of Dall Island: All waters within 1,000 yards of the mouths of all salmon streams.

(*e*) Sawmill Cove, east coast of Dall Island: All waters of the cove within a line indicated by markers erected for the purpose.

(*f*) Kasook Inlet, southern coast of Sukkwan Island: All waters within 1 statute mile of head of inlet.

(*g*) Hetta Inlet, west coast of Prince of Wales Island: All waters within a true north and south line passing through the western extremity of Gould Island.

(*h*) Deer Bay, Hetta Inlet: All waters within the bay.

(*i*) Copper Harbor, Hetta Inlet: All waters within the harbor.

(*j*) Hetta Harbor, Hetta Inlet: All waters within the harbor.

(*k*) Eek Inlet, Hetta Inlet: All waters within the inlet.

(*l*) Nutkwa and Keete Inlets, west coast of Prince of Wales Island: All waters of the inlets, including their tributaries, within a line from Lime Point at 55 degrees 3 minutes 8 seconds north latitude, 132 degrees 37 minutes 33 seconds west longitude, to a point at 55 degrees 2 minutes 23 seconds north latitude, 132 degrees 35 minutes west longitude.

(*m*) Hunter Bay, southwest coast of Prince of Wales Island: All waters of the bay and its tributaries within a line from Turn Point to the southwestern extremity of Gusdagane Point.

Southern district.—All territorial waters within a line beginning at a point on the international boundary at 131 degrees 44 minutes west longitude and following that boundary to Mount Lewis Cass, then southerly and westerly along the watershed to the southern extremity of Caamano Point, thence southerly to the point of beginning on the international boundary at 131 degrees 44 minutes west longitude.

1. The total aggregate length of gill nets on any salmon fishing boat, or in use by such boat, shall not exceed 250 fathoms hung measure.

2. Stake and anchored gill nets shall be operated in substantially a straight line.

3. The distance by most direct water measurement from any part of one trap to any part of another trap shall not be less than 1 statute mile.

4. No floating trap shall exceed 900 feet in length when any part of such trap is in a greater depth of water than 100 feet at mean high tide. The length of any such trap shall be as measured along the lead from shore at mean high tide to the outer face of the pot.

5. No salmon fishing boat shall carry or operate more than one seine of any description, and no additional net of any kind shall be carried on such boat. The carrying of any additional seine or net of any kind on a boat towed by any salmon fishing boat is prohibited. No purse seine shall be less than 175 meshes nor more than 250 meshes in depth nor less than 150 fathoms nor more than 200 fathoms in length measured on the cork line. For the purpose of determining depths of seines measurements will be upon the basis of 3¼ inches stretched measure between knots. No extension to any seine in the way of leads will be permitted.

6. Commercial fishing for salmon, except by trolling, is prohibited prior to 6 o'clock antemeridian July 5 in each calendar year, from 6 o'clock postmeridian August 16 to 6 o'clock antemeridian October 1 in each year, and for the remainder of each calendar year after 6 o'clock postmeridian October 15.

7. Commercial fishing for salmon by trolling, except from boats propelled wholly by oars or sails, is prohibited prior to April 1 in each calendar year.

8. The use of any beach seine is prohibited.

9. No boat used in operating any purse seine shall be longer than 50 feet, as shown by official register length.

10. No trolling boat shall operate more than six trolling lines.

11. Commercial fishing for salmon by trolling is prohibited in Burroughs Bay (indenting mainland north of Revillagigedo Island) for the remainder of each calendar year after 6 o'clock postmeridian August 16: *Provided*, That this prohibition shall not apply to the period from 6 o'clock antemeridian October 1 to 6 o'clock postmeridian October 15 in each year.

12. The use of any trap for the capture of salmon is prohibited, except as follows:

(*a*) Cleveland Peninsula: From a point on the east side of Clarence Strait at 55 degrees 44 minutes 7 seconds north latitude, 132 degrees 15 minutes 36 seconds west longitude, southerly to Caamano Point, thence northeasterly to a point at 55 degrees 34 minutes 30 seconds north latitude near the south side of the entrance to Smugglers Cove. A part of these waters is in the North Prince of Wales Island district.

(*b*) Westerly side of the Vallenar Rock Island located about 800 yards from the northern extremity of Vallenar Point.

(*c*) Gravina Island: Western and southern coasts from South Vallenar Point to a point at 55 degrees 11 minutes 30 seconds north latitude near the south side of the entrance to Bostwick Inlet, including the Bronaugh Islands and the rocky islets adjacent to the west coast of Gravina Island south of South Vallenar Point.

(*d*) Gravina Island: East coast from Bostwick Point northward to the outer extremity of Blank Point.

(*e*) Annette Island: West coast from a point 1½ statute miles south of Walden Point to Davison Point.

(*f*) Annette Island: East coast from Reef Point to a point 1 statute mile northeast of Annette Point.

(*g*) Revillagigedo Island: Southwest coast from Carroll Point southward and eastward to a point on the west side of Moth Bay due west of the southern extremity of Moth Point.

(*h*) Revillagigedo Island: From Cone Point southeasterly to a point at 55 degrees 11 minutes 36 seconds north latitude, 131 degrees 10 minutes 42 seconds west longitude, including Cone Island.

(*i*) Revillagigedo Island: Within ½ statute mile of Escape Point and within 5,000 feet northwesterly of Indian Point.

(*j*) Betton Island: West coast between the southern extremity of the island and 55 degrees 30 minutes north latitude, and from Tatoosh Point northeasterly to the northern extremity of the island.

(*k*) Mainland peninsula between Smeaton Bay and Boca de Quadra: From Point Sykes at 55 degrees 11 minutes 36 seconds north latitude, 131 degrees 5 minutes 30 seconds west longitude, southerly and easterly to a point near Quadra Point at 131 degrees west longitude.

(*l*) Southwestern coast of island located southwesterly from Kah Snakes Point at 55 degrees 2 minutes 42 seconds north latitude, 131 degrees 0 minutes 33 seconds west longitude.

(*m*) Mainland south of Boca de Quadra: From a point south of Kah Shakes Cove at 55 degrees 1 minute 54 seconds north latitude, 131 degrees west longitude, southward to Kirk Point.

(*n*) Foggy Bay to Cape Fox: From within 1 statute mile northward and eastward of Foggy Point to the southern extremity of Cape Fox, including Cape Fox Island.

(*o*) Duke Island: East coast from a point on the north side of Ray Anchorage at 54 degrees 56 minutes 35 seconds north latitude northward to the outer extremity of Flag Point.

(*p*) Duke Island: East coast from a point on the south shore near Kelp Island at 131 degrees 15 minutes 12 seconds west longitude northward to a point on the south side of Ray Anchorage at 131 degrees 13 minutes west longitude.

(*q*) Duke Island: Southwest coast from a point on the east side of Hall Cove at 54 degrees 53 minutes 24 seconds north latitude to the southern extremity of Cape Northumberland.

(*r*) Percy Islands: Coast along the west and north sides of the westernmost island of the Percy Islands group.

(*s*) Kelp Island: Southern coast between the eastern and western extremities of the island.

(*t*) The Lord Islands.

(*u*) Kanagunut Island: West coast between the northwestern extremity of the island and Garnet Point, and along the east coast within 2,000 feet of Garnet Point.

(v) Sitklan Island: Within ½ statute mile of the southern extremity of the island.

13. All commercial fishing for salmon is prohibited, as follows:

(a) Hidden Inlet, indenting mainland: All waters in the inlet north of 55 degrees north latitude.

(b) Fillmore Inlet, indenting mainland: All waters east of 130 degrees 30 minutes west longitude.

(c) Willard Inlet, indenting mainland: All waters north of 54 degrees 56 minutes 30 seconds north latitude.

(d) Ray Anchorage, east coast of Duke Island: All waters in Ray Anchorage.

(e) Very Inlet, indenting mainland: All waters within the inlet.

(f) Boca de Quadra, indenting mainland: All waters within 1 statute mile of the mouth of Sockeye Creek.

(g) George Inlet, southern coast of Revillagigedo Island: All waters north of a line from Bat Point to Tsa Cove.

(h) Smeaton Bay, indenting mainland: All waters in Wilson and Bakewell Arms east of 130 degrees 40 minutes west longitude.

(i) Rudyerd Bay, indenting mainland: All waters in the north arm within 2 statute miles of the mouths of all salmon streams.

(j) Walker Cove, indenting mainland, tributary to Behm Canal: All waters within a line from Ledge Point to Hut Point.

(k) Chickamin River: All waters within a line from Fish Point to Trap Point.

(l) Yes Bay, Cleveland Peninsula: All waters within the bay and all waters outside the entrance within 1,000 yards of a line from Bluff Point to Syble Point.

(m) Shrimp Bay, west coast of Revillagigedo Island: All waters east of a line running south from Dress Point to the opposite shore.

(n) Traitors Cove, west coast of Revillagigedo Island: All waters of the cove within a line 50 yards outside the neck of the salt-water lagoon.

(o) Naha and Moser Bays, west shore of Revillagigedo Island: The waters of Long Arm and Moser Bay inside of a line from Cod Point to the opposite shore at 131 degrees 40 minutes west longitude and the waters of Naha Bay inside of a line extending due north from Cod Point.

Steelhead fishery.—Commercial fishing for steelhead trout shall be subject to the provisions of law and the regulations applicable to commercial fishing for salmon: *Provided*, That, except in respect to weekly close periods, this regulation shall not be effective in the period from March 15 to April 30, both dates inclusive, in waters south of 58 degrees north latitude.

Herring fishery.—1. During the period from June 1 to October 15, both dates inclusive, commercial fishing for herring, including bait fishing, is prohibited in all waters closed throughout the year to salmon fishing.

2. Commercial fishing for herring, except for bait purposes, is prohibited from January 1 to May 31, both dates inclusive, and from October 1 to December 31, both dates inclusive: *Provided*, That this prohibition shall not apply to the use of gill nets of mesh not less than 2¼ inches stretched, measured between knots, in the period from October 1 to December 31, both dates inclusive.

3. Commercial fishing for herring, except for bait purposes, is prohibited from 6 o'clock postmeridian of Saturday of each week until 6 o'clock antemeridian of the Monday following.

4. Commercial fishing for herring, including bait fishing, by means of any trap is prohibited.

5. No herring fishing boat shall carry or operate more than one seine of any description, and no additional net of any kind shall be carried on such boat. The carrying of any additional seine or net of any kind on a boat towed by any herring fishing boat is prohibited.

6. Commercial fishing for herring, including bait fishing, by means of any purse seine more than 1,200 meshes in depth, more than 180 fathoms in length, or of mesh less than 1½ inches stretched measure between knots is prohibited: *Provided*, That any purse seine may have in addition a strip along the bottom not to exceed 30 meshes in depth and of mesh not less than 4 inches stretched measure between knots. No extension to any seine in the way of leads will be permitted.

7. No one shall place, or cause to be placed, across the entrance to any lagoon or bay any net or other device which will prevent the free passage at all times of herring in and out of said lagoon or bay.

8. All commercial fishing, including bait fishing, for herring is prohibited throughout the year in the waters of Kanalku Bay, Admiralty Island.

9. Seines used in commercial fishing, including bait fishing, for herring in Klawak Harbor within a true east and west line passing through the northern extremity of Klawak Island shall not exceed 90 fathoms hung measure in length

nor 500 meshes in depth. For the purpose of determining depths of such seines measurements will be upon the basis of 1½ inches stretched measure between knots. No such seine shall have a mesh of less than 1½ inches stretched measure between knots.

Clam fishery.—It is prohibited to take for commercial purposes any razor clam measuring less than 4½ inches in total length of shell. Possession of any razor clam of less than this length will be regarded as prima facie evidence of unlawful taking.

Shrimp fishery.—Commercial fishing for shrimps is prohibited in the period from March 15 to April 30, both dates inclusive, in each year.

Crab fishery—DUNGENESS CRAB (*Cancer magister*).—No female of this species shall be taken at any time, and no male of this species measuring less than 6½ inches in greatest width shall be taken for commercial purposes.

GENERAL REGULATIONS

By virtue of the authority conferred by the acts approved June 6, 1924, and June 26, 1906, the following regulations shall be effective in all waters of Alaska, including the special areas already described above:

1. During closed periods the heart walls of all salmon traps within the areas affected shall be lifted or lowered in accordance with the method prescribed by section 5 of the act of June 6, 1924. The tunnels from hearts to pots of all salmon traps shall be constructed of flexible webbing other than wire, and during all closed periods they shall be completely closed by pulling to one side of the pot. In addition, the spillers of all driven traps shall be raised to within 4 feet of the capping and the spillers of floating traps shall be raised to within 4 feet of the surface within 36 hours after the beginning of any seasonal closed period. Within 36 hours after the beginning of any seasonal closed period the tunnels from pots to spillers of all traps shall be entirely disconnected. In respect to traps not provided with spillers, the requirements in regard to spillers shall apply to the pots. In any prescribed fishing area prior to the first date when salmon traps may be operated in any calendar year, no trap or any part thereof, whether under construction or after completion, shall be so arranged or adjusted as to prevent the free and unobstructed passage at all times of all fish.
2. No trap shall have more than two spillers.
3. The operation of any so-called "hammer-head" type of trap is prohibited.
4. All trap leads shall be operated in substantially a straight line.
5. While in operation no purse seine shall be anchored or fastened to the shore or to a boat anchored or fastened to the shore, nor shall it be fastened to more than one power boat. The seine shall be attached only to the seine boat and skiff normally used in its operation.
6. No salmon trolling boat shall carry or operate any seine or more than one gill net. The gill net shall be of mesh not more than 2½ inches stretched measure between knots, shall not be of greater than No. 20 gill-net thread, and shall not exceed 10 fathoms in length and 100 meshes in depth.
7. The time used in the various areas for the enforcement of the law and the regulations that specify hours and days shall be as follows:

(*a*) In the southeastern Alaska area: Standard time of the one hundred and thirty-fifth meridian of west longitude, which is 1 hour slower than Seattle standard time.

(*b*) In the Bering River, Copper River, Prince William Sound, Resurrection Bay, Cook Inlet, Kodiak, Chignik, Alaska Peninsula, and Bristol Bay areas: Standard time of the one hundred and fiftieth meridian of west longitude, which is 2 hours slower than Seattle standard time.

(*c*) In the Aleutian Islands and Yukon-Kuskokwim areas: Standard time of the one hundred and sixty-fifth meridian of west longitude, which is 3 hours slower than Seattle standard time.

8. All persons engaged in fishery operations are warned to give due regard to all markers erected by the Department of Commerce.
9. In waters where a rack or weir is maintained by the Bureau of Fisheries for the purpose of counting salmon ascending to the spawning grounds, records of the catch of salmon shall be furnished daily by all operators to the local representative of the Bureau of Fisheries in charge, and upon notification by the Commissioner of Fisheries or his authorized representative that an excessive proportion of the run is being taken so that the escapement of any species is less than the 50 per cent specified by section 2 of the act of June 6, 1924, all commercial fishing operations shall at once be discontinued and shall not be resumed until permission therefor is granted by the Commissioner of Fisheries or his duly

authorized representative. And if in any year it shall appear that the run of salmon in such waters has diminished there shall be required a correspondingly increased escapement, and upon notification by the Commissioner of Fisheries or his authorized representative all commercial fishery operations shall cease and shall not be resumed until such increased escapement has been secured.

10. The driving of salmon downstream and the causing of salmon to go outside the protected area at the mouth of any salmon stream are expressly prohibited.

11. During the inspection of the salmon fisheries by the agents and representatives of this department they shall have at all times free and unobstructed access to all canneries, salteries, and other fishing establishments and to all hatcheries.

12. All persons, companies, or corporations owning, operating, or using any stake net, set net, trap net, pound net, or fish wheel for taking salmon or other fishes shall cause to be placed in a conspicuous place on said trap net, pound net, stake net, set net, or fish wheel the name of the person, company, or corporation owning, operating, or using same, together with a distinctive number, letter, or name which shall identify each particular stake net, set net, trap net, pound net, or fish wheel, said lettering and numbering to consist of black figures and letters, not less than 6 inches in length, painted on white ground.

13. If in the process of curing salmon bellies the remaining edible portion of the fish is not used, such action will be regarded as wanton waste within the meaning of section 8 of the act of June 26, 1906, and those who engage in this practice will be reported for prosecution as provided for in the act.

14. The taking of salmon for fox feed shall be considered as commercial fishing and subject to all of the limitations in respect thereto.

15. Any increase in the amount of fishing gear employed or any expansion of fishery operations in any district in any season shall, in the discretion of the Secretary of Commerce, result in the immediate imposition of such additional restrictions as may appear necessary.

16. These regulations shall be subject to such change or revision by the Secretary of Commerce as may appear advisable from time to time. They shall be in full force and effect immediately from and after January 1, 1929.

AFOGNAK RESERVE

Permits to fish salmon in Afognak Reserve waters were granted to 44 native residents of Afognak and adjacent islands. Fishing operations, which were carried on chiefly by beach seines in nine localities, began on June 1 and ended September 30. A patrol of the area was maintained throughout the season. The total commercial catch was 318,908 salmon, of which 237,489 were pinks, 45,513 cohos, 34,011 reds, 1,816 chums, and 79 kings. As compared with the number taken in 1927, pinks increased 63,014, cohos 10,692, and reds 5,301, while chums decreased 1,427 and kings 162. Although there was an increase over the preceding year in the number of red salmon taken, the catch was small in comparison with that of prior years, when this species normally constituted the largest part of the season's take. The fish were sold to the Grimes Packing Co., Kadiak Fisheries Co., Katmai Packing Co., and Pajoman & Trout. In addition to the catch for commercial purposes, salmon were taken by natives for local food requirements.

The runs of red salmon in all Afognak streams except Litnik were very light. Several bays had fair runs of pinks and cohos, which species were more plentiful in the reserve than in waters of Kodiak Island. In streams tributary to Paramanof and Seal Bays bears were particularly destructive to spawning salmon.

The weir in Litnik River below the Afognak hatchery was again maintained for fish-cultural purposes, and 20,862 red salmon were counted through from June 4 to August 17, after which the racks were closed to prevent the ascent of cohos to the lake. About 20,000 predatory fishes were destroyed.

Fifty-nine natives were engaged in the herring fishery in waters of the reservation, but very few fish were taken as no large herring appeared. Small herring were numerous, but they could not be captured with gill nets of 2½-inch mesh.

ANNETTE ISLAND FISHERY RESERVE

The lease of the canning and fishing privileges of the Annette Island Fishery Reserve by the Annette Island Packing Co. under contract dated March 26, 1923, having expired in December, 1927, a new contract was entered into with that company on February 25, 1928, by the Acting Secretary of the Interior on behalf of the inhabitants of the reserve. The new lease was made effective as of December 1, 1927, for a 5-year period. Its terms provide for a decided change in the nature of certain payments to the Metlakatlans from those in effect under previous agreements. Instead of the fees and royalties heretofore specified, the company now operates the cannery in consideration of one-half of the net profits, with a minimum guaranty to the natives varying in accordance with amounts expended by the company for the purchase of cannery machinery and equipment.

In 1928 the company operated 5 traps within the reservation, the catch of which totaled 602,800 salmon, and 63,032 fish taken in purse seines were purchased from the natives. In addition, 463,328 salmon were purchased from independent operators of traps and seines outside the reserve and packed at the cannery. In the operation of the cannery and of the fish traps employment was given to 29 whites, 205 natives, and 1 Chinese.

ALASKA FISHERY INTELLIGENCE SERVICE

As has been the practice for several years, the bureau continued to report by telegraph to the important points in southeastern and central Alaska the prices of fresh fish (chiefly halibut) at Ketchikan. During the closed season on halibut the service was discontinued, as the quantities of other fresh fish sold during that period are negligible.

STREAM IMPROVEMENT

Each year some stream-improvement work is done by bureau employees in the way of removing obstructions that prevent or impede the ascent of salmon to the spawning grounds. With the cooperation of the salmon packers in southeastern Alaska special attention was given to this work in 1928, particularly in the spring, when the patrol boat *Murre*, under the direction of Warden F. W. Hynes, was used to visit a number of streams that had been reported as containing obstructions such as log jams, bowlders, and beaver dams. Among the streams examined at that time were Harris River, Maybeso Creek, Karta River, Dolomi Creek, Cabin Creek, Thunder Creek, and tributaries of Kegan Cove, Dickman Bay, Harry Bay, Traitors Cove, Rudyerd Bay, and Keete Inlet, some of which were found to contain barriers that would be impassable only at low stages of water.

In the stream entering the northeast cove of Keete Inlet there was a log jam of such density that it had caused gravel to pile up behind it, forming an impassable barrier. After the logs were sawed out and the brush removed the force of the current washed out the accumulated gravel, leaving a passage more than 8 feet wide through the jam. A passage was cleared also through log jams in a stream flowing into Harry Bay, and a small beaver dam in the right branch of Dolomi Creek was removed. At the dam of the Kasaan Gold Mining Co. on Harris River the fish ladder had an ample flow of water in the spring and early summer, but toward the end of August, when the pink and chum salmon runs were well under way, this ladder did not function. The company, having been notified that adequate provision must be made for the free passage of the fish, had a section of the dam torn out, and the salmon immediately passed into the upper stream.

Other stream-improvement work was done during the season, including the removal of small log jams in Whale Bay Creek and Olive Cove Creek, the cutting of a channel through a log jam in Log Jam Creek, and the clearing of brush and weeds from Ankau Creek.

In all of this work extreme care is necessary, especially in the matter of blasting waterfalls and log jams, in order not to injure the stream for spawning purposes. In streams subject to flood and with reasonably swift water, the removal of all the obstructions that help to break the current might result in washing out the gravel from the stream bottom and thus defeat the purpose for which the work was undertaken—the making available of all spawning areas for adequate seeding. Therefore it is essential that stream-improvement work be undertaken only under the supervision of competent authority to avoid the possibility of doing more damage than good.

STREAM MARKING

The erection of markers at a distance of 500 yards from the mouths of all salmon streams and at the limits of other waters closed to commercial fishing, together with the maintenance of such markers from year to year, constitutes an important feature of the work in connection with the enforcement of regulations for the protection of the salmon fisheries and was given careful attention during the season. Virtually all salmon streams in the several districts have been marked, but as the markers at times become defaced or removed it is necessary to inspect the grounds periodically, especially in the early spring, and to make replacements where necessary. Certain changes in the regulations from time to time also necessitate the erection of new markers or the moving of old ones in various localities.

STREAM GUARDS

The bureau employed 201 men as stream guards and special workmen in connection with law-enforcement duties in 1928. Of these, 95 were stationed in southeastern Alaska, 70 in central, and 36 in western Alaska. The period of employment generally ranged from two to five months, although in some instances, as in the case of extra guards placed in certain localities of southeastern Alaska during the fall season, it was for only a few days.

In southeastern Alaska 40 stream watchmen furnished their own launches and were assigned to the more important spawning areas, which in some regions included from 2 to 10 salmon streams. Four guards were placed on chartered patrol boats.

In central Alaska 16 guards were stationed in the Seward-Katalla district, 9 on Cook Inlet, 32 in the Kodiak-Afognak district, 3 at Chignik, and 10 in the Ikatan-Shumagin district. Fourteen of these guards, most of whom were in the Seward-Katalla district, provided their own launches.

In western Alaska 33 were on Bristol Bay and 3, of whom 1 furnished his own boat, were in the Yukon-Kuskokwim district.

There were also 6 special employees engaged in scientific work—1 on herring, 1 on clam, and 4 on salmon investigations, this work being conducted chiefly in central and western Alaska. In addition, there were 11 statutory employees, 47 men on the bureau's vessels, and 15 on the 8 chartered boats. The foregoing makes a grand total of 280 persons identified with fishery-protective work in Alaska in 1928, as compared with 222 in 1927.

VESSEL PATROL

Fourteen vessels owned by the bureau were operated in fishery-patrol work in Alaska in 1928. Of these, the *Widgeon*, *Murre*, *Auklet*, and *Petrel* were used in southeastern Alaska throughout the season; the *Blue Wing* and *Red Wing* at Kodiak and Afognak Islands; the *Ibis* at Chignik; the *Merganser* in the Ikatan-Shumagin region; the *Scoter* on Bristol Bay; and the *Tern* on the Yukon River. The *Brant* was in the southeastern district during much of the season, being used chiefly in connection with the work of general supervision, for which purpose one cruise was made westward as far as Kodiak in July. Vessels used in southeastern Alaska for a few weeks in the fall after their return from duty to the westward were the *Crane*, which in May transported bureau employees and supplies to Bristol Bay and later was engaged in patrol work in the Alaska Peninsula district; the *Teal*, which was on Cook Inlet throughout the summer months; and the *Kittiwake*, which was operated in the Seward-Katalla district until the end of August.

The *Crane* is a new vessel in the bureau's Alaska service, having been built at Port Blakeley, Wash., in the winter of 1927–28. It is 90 feet in length and 20 feet in breadth, and is equipped with a 200-horsepower Diesel engine. The vessel is of sturdy, seaworthy construction, and well adapted for use in the exposed waters of western Alaska, where it performed important work during the season.

The *Red Wing*, a small power vessel that had been transferred to the bureau from the Department of Agriculture in 1926 and assigned to the Afognak hatchery, where it remained idle for some time pending the installation of another engine, was equipped with a 3-cylinder Standard gas engine and new gas tanks in the spring of 1928, and was then detailed to patrol duty during part of the season.

The following chartered vessels were used in fisheries patrol: *Valkyrie*, *Anona*, *Bear*, *Santa Rita*, and *Typhoon* in southeastern Alaska; *Pilot* and *Prospector* in Prince William Sound; and *Auk* in the Port Moller region.

COMPLAINTS AND PROSECUTIONS

Three salmon traps in southeastern Alaska were seized in 1928 for illegal fishing. A trap on the south side of Sukkwan Island, which was owned by E. R. Carlson and A. L. Schuler and operated by the Alaska Consolidated Canneries, was found fishing at 7.10

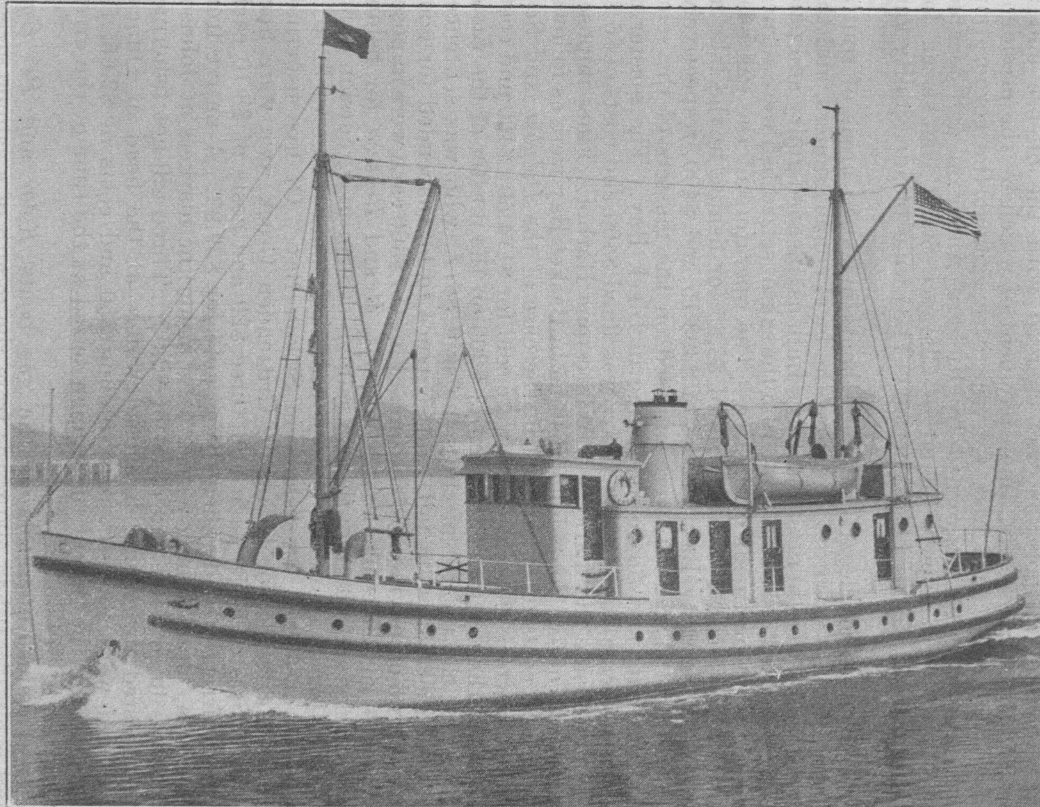


FIGURE 1.—Alaska fisheries patrol vessel *Crane*

o'clock p. m., August 22, after the close of the fishing season. The owners pleaded guilty and paid the imposed fine of $200 and costs of $5.85. The location of a trap belonging to the Dixon Entrance Fish Co., which was set and operated by the Nakat Packing Corporation in the channel between Misery Island and Lemesurier Point, was in violation of section 3 of the act of June 6, 1924, the distance from shore to shore at that place being less than 1,000 feet. The Nakat Packing Corporation was charged with the offense and a fine of $1,200 was assessed, upon payment of which by the president of the Dixon Entrance Fish Co. the case against the corporation was dismissed. A trap owned by Richard Anderson and located 1½ miles south of Windy Island in Clarence Strait was seized for fishing during a weekly closed period. The owner pleaded guilty and was fined $1,200.

Several cases of illegal fishing by boats in closed areas of southeastern Alaska were brought before the local commissioners, and the offenders, who were in most instances Indians, pleaded guilty and paid the fines imposed. The receipts from the sale of seized fish were turned over to the Department of Justice. The operators of the gas boat *Loomis* were fined $400 and costs of $4.85 for fishing in the lake at the head of Security Bay. Fines of $393.15 and $400, respectively, with costs of $6.85 each, were imposed on the masters of the seine boats *Henrietta* and *Sayso* for fishing in Black Bay. The master of the herring seine boat *Mount Baker* was fined $400 and costs of $6.85 for fishing inside the markers in Whitestone Harbor. Fines imposed on operators of five boats found fishing in Basket Bay were as follows: $393.15 and costs of $6.85 each in the case of the *Dolphin* and *Seymour*, from which the seized fish were sold for $114.50; $400 and costs of $6.85 on the master of the *Active*; $200 on the master of the *Elsie*; and $50 on the master of the seine skiff *361L*, who was sentenced also to serve 90 days in jail, said sentence to be suspended for good behavior and on payment of the fine. Fines of $300 each were imposed on masters of the seine boats *Marjorie M* and *Rebecca* for fishing inside markers at the mouth of a salmon stream in Excursion Inlet. The operator of the seine boat *Dreadnaught* paid a fine of $260.15 and costs of $40.85 for fishing in Sitkoh Bay. Of five fishermen who were arrested for fishing in Crittenden Creek, two were fined $10 and costs of $4.80 each and three $20 and costs of $8.10 each, the fish surrendered by them being sold for $59.82. A native from Metlakatla, found fishing with a seine inside the markers at Johnson Cove, was fined $400 and costs of $2.95. Three gill-net fishermen were arrested for fishing in closed waters at the head of Duncan Canal and were assessed fines totaling $50 and costs of $2.65, the proceeds from the sale of the salmon seized at the time of the arrest amounting to $74.36.

Cases against operators of the gas boats *Kotor* and *Per Gynt* found fishing less than 500 yards from the mouth of a salmon stream at the head of Coco Harbor on the east coast of Dall Island, were dismissed, inasmuch as the limits of the closed waters were not marked. The money obtained from the sale of the fish taken from the seized boats was returned to the defendants.

For violations of the fishery regulations in respect to the weekly closed period fines of $400 each with costs of $33.85, $37.60, and $43.85, respectively, were imposed on the masters of the gas boats *Dubrovnik*, *Over the Top*, and *Verbus Unitas*, who were found fishing in Klawak Inlet; a troller operating the power boat *Snook 186 U* off the southeastern shore of San Lorenzo Island was fined $100; and six natives of Metlakatla, operating troll boats *T623*, *T859*, and *Prince U280* near Stonerock Bay, were fined $25 each, a total of $150, of which amount $2 was remanded to one man who was unable to raise money for the fine immediately and spent one night in jail. A fine of $300, together with costs of $10.70, was imposed on the master of the gas boat *Morning Glory*, convicted of fishing illegally with gill nets during a closed season.

Two boats, *Fosna T1523* and *T1518*, were seized for fishing in Shipley Bay with seines less than the minimum length and depth specified in the regulations and were fined $400 each, the costs being included. Salmon on these boats were sold for $50.99.

The Sunny Point Packing Co. on August 11 pleaded guilty to a charge of dumping, or wantonly wasting, approximately 35,000 salmon near its Kake plant, the violation having been committed because deliveries of fish the latter part of July exceeded the capacity of the cannery, thus preventing their utilization before spoiling. The facts were submitted voluntarily to a representative of the bureau and an information was sworn to in commissioner's court at Ketchikan, where a fine of $250 and costs of $2.95 were imposed. Information was filed later by the United States Attorney charging this company and the superintendent of its cannery at Kake with the destruction of food fish, to which the company entered a plea of not guilty, claiming former jeopardy to the same charge. The case was called before Judge E. Coke Hill in November, and after four days trial the jury returned a verdict of not guilty.

Information was filed by the United States Attorney at Juneau charging the Sebastian Stuart Fish Co., of Tyee, and Sam Morris and the New England Fish Co., of Juneau, with mild-curing salmon more than 48 hours dead, and charging E. B. Dudden, superintendent of the Douglas Island Packing Co., with canning salmon more than 48 hours dead, said fish having been taken in the Yakutat district. These cases have been continued to the next term of court.

In the commissioner's court at Cordova cases were brought against four gill-net fishermen who were apprehended fishing in the sloughs of the Copper River district, and fines of $25 each were imposed. Two fishermen operating a purse seine in Hummer Bay during a weekly closed period were fined $75 each.

The watchmen on three traps in Cook Inlet (two belonging to Gorman & Co. and one to the Kenai River Packing Co.) were apprehended for violation of that part of the law that prescribes that during the weekly closed period the tunnel of all traps shall be closed. A hearing was held at the commissioner's court at Anchorage on June 11, where testimony disclosed that in each case the watchmen had lifted or lowered 25 feet of the heart walls next to the pot, although they had failed to close the tunnel. The defendants, having been admonished, were dismissed on the ground that it was the first offense and there was insufficient evidence of intent to violate the law. Another trap of the Kenai River Packing Co. in Cook Inlet was seized during a weekly closed period toward the end of July because the heart walls had not been lifted or lowered as required by law. The company and the watchman jointly were charged with illegal operation of the trap and, pleading guilty, were fined $100 each. The master of the gas boat *Rolph*, having been apprehended for fishing during a closed season in the west arm of Port Dick, was tried in the district court and fined $250.

In the Kodiak district the master of the gas boat *Reliance*, the deck hand, and three fishermen were arrested for fishing above the markers in the large stream at the head of Terror Bay. They pleaded guilty before the commissioner at Kodiak, who imposed fines of $300 on the master and $250 on each of the others. The boat and gear were released to the owners, and the proceeds from the sale of some 5,000 seized salmon were turned over to the Department of Justice.

DECISION REGARDING LOCATION OF STREAM MOUTHS IN ALASKA

An important interpretation of that part of sections 3 and 4 of the White Fisheries Act of June 6, 1924, in regard to the location of the mouth of a salmon stream was contained in the decision of the United States Circuit Court of Appeals for the Ninth Circuit, which was handed down on June 29, 1925. In the opinion of the court, which reversed the decision of the district court at Juneau in a case brought in 1924 against Booth Fisheries Co. for the illegal operation of a trap within 500 yards of the mouth of a salmon stream, it was held that the place where the mouth of the stream shall be located rests in the discretion of the Secretary of Commerce, and the location of the mouth of the stream by the Secretary is indispensable to give certainty and precision to the statute. Official markers, accordingly, were erected at the mouths of all known salmon streams of the Territory, and very little misunderstanding has arisen since then concerning this point of law. The decision of the Circuit Court is printed herewith as a matter of permanent record:

The court below was of opinion that the amendment of 1924, providing that the mouth of a stream shall be taken to be the point determined as such by the Secretary of Commerce and marked in accordance with his determination, made no change in the then existing law unless and until the Secretary of Commerce saw fit to exercise the authority thus conferred. In other words, that the question whether the law has been changed or not depends not upon the law itself but upon the action or inaction of the Secretary of Commerce. With this construction of the amendatory act we are unable to agree. Counsel for the Government says in his brief:

> At first glance, the mouth of a stream might be at any one of four places: (1) At low tide; (2) at high-tide line on the sea beach; (3) at any point between low and high tide, the mouth shifting on the beach with the tide; (4) above high-tide line, the mouth shifting with the rise and fall of the tidal waters.

Whether counsel is correct or not we need not inquire, but the mouth of a stream can not be ascertained with mathematical precision, and the uncertainty of the situation demonstrates the necessity for some fixed rule on the subject. Congress might itself define the mouth of a stream or it might delegate that authority to the Secretary of Commerce or some other officer. It chose the latter course here, and the determination of the Secretary of Commerce, when made, has the force and effect of law, at least in the absence of fraud or gross error from which fraud might be implied. The record in this case shows the difficulties encountered in the administration of the old law and the injustice that might result from such administration. The fish trap complained of has been located at the same point for a considerable number of years without objection or protest on the part of the Government. During 1923 measurements were made by Government officers or agents from the trap to the mouth of the stream, and the distance was found to be upward of 500 yards. These measurements were made from the trap to the point where the stream enters the cove. In 1924 other measurements were made, and the distance was found to be much less than the 500 yards prescribed by law. These latter measurements were made from the trap to a point on the stream where it crosses the tide flats at low tide, presumably the point where the salt and fresh waters meet at low tide. The present prosecutions are based upon these latter measurements. Where the Secretary of Commerce might locate the mouth of the stream we, of course, do not know. A point 500 yards from the place where the fresh and salt waters meet at low tide might in some cases be less than 500 yards from the point where the stream enters the cove, and it may well be that the purposes of the statute would be best subserved by locating the mouth of the stream at the point where it enters the cove, rather than at the point on the tide flats where the fresh and salt waters meet at low tide. If located at the former point there has been no violation of the law. But, in any event, the place where the mouth of the stream shall be located rests in the discretion of the Secretary of Commerce, and the location of the mouth of the stream by the Secretary is indispensable to give certainty and precision to the statute. Until that has been done, the initial point from which measurements are to be made can not be known, and without an initial point from which to measure it would, of course, be impossible to determine the boundaries of the prohibited area.

For these reasons we are of opinion that the instructions complained of are erroneous. It is suggested by counsel that these objections do not extend to the information based on section 4 of the act, because that section does not contain the provision that the mouth of a stream is the point determined to be such by the Secretary of Commerce, but, in our opinion, Congress never contemplated that a stream could have two mouths for the purposes of the act—one to be determined and marked by the Secretary of Commerce, the other to be fixed or ascertained by the court or jury. If the contention of counsel is correct, the trap might be lawfully maintained under section 3, but could not be lawfully used or operated under section 4. Such a contention is sufficiently absurd to refute itself.

The judgment is reversed and the cause is remanded for a new trial.

TERRITORIAL FISHERY LEGISLATION

The case of the Territory of Alaska *v.* Alaska Consolidated Canneries, et al., a suit for the payment of taxes on fish traps, was in the nature of a test of the constitutionality of the act passed by the Legislature of Alaska on May 5, 1923, imposing additional taxes at the rate of $2 per 1,000 for all fish caught in any one fish trap in excess of 100,000. Judge Reed, of the district court at Juneau, held that the law was valid, and his decision was affirmed by the Circuit Court of Appeals for the Ninth Circuit on December 4, 1928. The decision of the Circuit Court is as follows:

In February and March, 1923, the appellant companies took out several licenses to operate fish traps in Alaskan waters and paid as fees at the rate of $200 per trap, as was then required by the laws of the territory. On May 5, 1923, the legislature passed an amendatory act (Laws of Alaska, 1923, c. 101) by which there was added to the $200 fee at the rate of $2 per 1,000 for all fish caught in any one trap in excess of 100,000, and by virtue of an emergency clause the act became immediately effective. Up to that time the appellants had caught no fish, but during the remainder of the calendar year they took in excess of 100,000 in each trap. They declined to make any further license payment, and this suit was brought to recover from them an amount arrived at by computing the excess catch at the rate of $2 per 1,000 as provided in the amendatory act. To an answer setting up certain legal defenses, a demurrer was sustained, and, the appellants declining to plead further, judgment was entered against them, from which they prosecute this appeal.

1. They first contend that the exaction is void, because it is essentially a property tax, and is not according to value, as required by the organic act of the territory. But we think it is an excise and not a property tax; we so held in Alaska Pacific Fisheries *v.* Territory of Alaska (C. C. A.) 236 F. 52. The slight differences between the law as it then stood and as now amended are inconsequential. See, also, Pacific American Fisheries *v.* Territory of Alaska (C. C. A.), 2 Fed. (2d) 9; id., 269 U. S. 269, 46 S. Ct. 110, 70 L. Ed. 270, and Alaska Consolidated Canneries *v.* Territory of Alaska (C. C. A.), 16 Fed. (2d) 256.

2, 3. It is also contended that by the amendatory act the legislature did not intend that its provisions should apply where, prior to its passage, licenses had issued, and further that, if such was the intent, it can not be given effect, for a license so issued constitutes a contract which the legislature is without power to impair. Both contentions we think are ruled adversely by Alaska Consolidated Canneries v. Territory of Alaska, supra. The distinction attempted to be made by putting a strained construction upon the clause "where the taxes were not a fixed sum," found in the latter part of that decision, is unsubstantial. In principle the two cases are the same, and the reasoning there employed is equally cogent here. To hold otherwise would be to say that only a contract, the obligations of which have been fully performed by the one party thereto, is protected against impairment.

Affirmed.

TERRITORIAL LICENSE TAX

Fisheries license taxes were collected by the Territory under the general revenue law of 1921, as amended in 1923, 1925, and 1927. A statement from W. G. Smith, Territorial treasurer, under date of April 13, 1929, gives the collections made to that date for the year 1928. It was stated that collections under the several schedules were fairly complete, with the exception of pack taxes due from a few of the smaller canneries, salteries, and fish-oil and fish-meal plants. Approximately $12,000 was still to be collected on the pack of canned salmon and about $7,000 on fish oil and fertilizer, while $8,925 was due under the whale oil and fertilizer schedule.

Fishery license taxes collected by Territory for fiscal year ended December 31, 1928

Schedule	Division No. 1	Division No. 2	Division No. 3	Total
Salmon canneries (pack)	$159, 454. 04	$13. 60	$363, 847. 20	$523, 314. 84
Clam canneries			157. 31	157. 31
Salteries	2, 085. 92	72. 15	1, 956. 42	4, 114. 49
Cold-storage plants	1, 585. 00		260. 00	1, 845. 00
Fresh-fish dealers	3, 091. 02		6. 00	3, 097. 02
Fish-oil works and fertilizer and fish-meal plants	14, 960. 59		1, 882. 68	16, 843. 27
Fish traps	111, 136. 35		60, 146. 05	171, 282. 40
Gill nets	633. 34	34. 00	4, 512. 00	5, 179. 34
Seines	6, 315. 00		2, 755. 00	9, 070. 00
Total	299, 261. 26	119. 75	435, 522. 66	731, 903. 67
Salmon canneries (net income), not possible of segregation as to judicial division				26, 656. 33
Total collections				761, 560. 00

WATER-POWER PROJECTS IN ALASKA

In 1928 the Federal Power Commission referred to the bureau two applications for permits for development of water-power projects in southeastern Alaska, one on Davis River and one on Karta River, requesting information as to whether these rivers were of any considerable value for the propagation of food fish and what conditions to protect the fishing interests should be included in any permit that might be authorized. The subject was referred to field agents of the bureau for investigation, and on the basis of reports submitted the commission was advised that in the case of the Davis River, owing to many high falls that started almost at tidewater, the stream was not of importance as a spawning area for food fishes and could not conceivably be improved sufficiently to allow the ascent of salmon; therefore, as far as the bureau was concerned, there appeared to be no objection to granting the desired permit.

Concerning the other application, however, the bureau expressed unqualified objection to any project that contemplated the diversion or reduction of the natural flow of water down Karta River. The Commissioner of Fisheries advised the Federal Power Commission on December 19, 1928, as follows:

> The Karta River has been known for many years as an important salmon stream. It contains extensive and valuable spawning areas for red, humpback, chum, and coho salmon. In my opinion, it is of immeasurably more value for the propagation of these important food fishes than it possibly could be for power purposes.
>
> It is noted * * * that in the ordinary operation of this proposed project the stream would be dry from the lake to its mouth for approximately 100 days a year during portions of January, March, July, and October. Attention is invited to the fact that these periods coincide in large degree with the times of great spawning activity and the development of young salmon as well as with seasons when the young fish are migrating to the sea. It is obvious, therefore, that should the project under discussion be put into operation, Karta River would cease to be of value as a spawning area. To my mind this is an unthinkable situation, and I strongly recommend that the application for power purposes be denied.

Protests against the issuance of a permit for power development on the Karta River were filed with the Federal Power Commission by the Association of Pacific Fisheries and by various companies owning canneries whose operations would be jeopardized by the loss of this valuable stream as a producer of salmon. It was pointed out that the Karta River was one of the principal spawning streams for salmon in southeastern Alaska, and that any power project on the river would very seriously deplete the salmon run and thus entail heavy losses on the packers, whose aggregate investment in the salmon industry in that vicinity is reported to be more than $3,000,000. Even though a proper fish ladder were provided at the dam site, the water above the dam would necessarily change in height from time to time. If salmon were to spawn in the gravel at one water level, such eggs would likely be destroyed through a decrease of that level, as the spawning beds would be left dry and exposed.

In view of the facts and arguments presented in this case, the applicant for the proposed power development on Karta River was notified by the Federal Power Commission that the application was rejected.

BRISTOL BAY DISTRICT

The bureau's activities in the Bristol Bay district in 1928, under the supervision of Agent Dennis Winn, were conducted along the same general lines as in previous years, except that no work of exterminating predatory fishes was undertaken.

In May the bureau's new patrol boat *Crane*, which was assigned to duty in the Alaska Peninsula region, transported 15 employees to Bristol Bay, together with supplies and small items of equipment. Passage for 12 men was secured on regular transportation steamer from Seattle, and Agent Dennis Winn and 5 others went north on vessels of the Alaska-Portland Packers Association, Red Salmon Canning Co., Alaska Packers Association, and Libby, McNeill & Libby.

At the close of the season the *Scoter* was ordered to Seattle for repairs, and eight men were detailed as operating crew on the trip south. Eleven others returned to Seattle on the *Crane* and 10 on regular transportation vessel. The services of 4 men had been dispensed with early in the season because of necessary curtailment of weir operations. Two of these men obtained employment in canneries and two returned to the States on transportation vessel. Mr. Winn's report on the season's operations is as follows:

GENERAL REPORT OF SEASON'S OPERATIONS

The writer sailed from Portland, Oreg., on the *North King* on May 10, arriving at Naknek on May 17. Work on the marine ways and bureau launches was begun at once, and upon the arrival of the *Crane* on May 22 a tent camp was established at the ways. Within the next few days all the special employees from the States had arrived. Considerable work of rebuilding and repairing the marine ways was accomplished, a small crew being detailed to this work throughout the season. Besides the rebuilding, an extension of about 40 feet was added, and excavating was necessary in order to move back the house scow toward the high bank about 5 feet to give sufficient room for hauling boats on and off the ways. Through the courtesy of the Alaska Packers Association at Koggiung several tent-house frames at Carlisle were obtained by dismantling and were transported to the ways, where they were set up for future use. This will facilitate operations on arrival another year.

The wreck of the schooner *Star of Falkland*, belonging to the Alaska Packers Association, on the rocks off Akun Island late in May, with the consequent loss of lumber for counting weirs, prevented the establishment of the proposed new weir for tallying salmon ascending the Naknek River. Further curtailment of weir operations was necessitated by reason of the fact that the wire forwarded for the weir at Kvichak was unsuited for weir purposes, the mesh being large enough to gill salmon. Oils for vessel operation that were lost in the shipwreck were replaced by a later shipment, the Alaska-Portland Packers Association at Naknek in the meantime lending a supply to take care of immediate needs, thus preventing any serious handicap of the bureau's activities.

Dr. Willis H. Rich, chief investigator of the salmon fisheries, accompanied by the writer, visited all important fishing localities in Bristol Bay on the bureau's patrol boat *Scoter* and on various river launches to get a comprehensive picture of activities in the district.

Two representatives of the Alaska Fishermen's Union accompanied the bureau's force of special employees from the States to perform labor assigned to them and primarily to check up on counting-weir operations. Due to the curtailment of the weir program, as a result of the loss of construction materials, only one man could be detailed to weir work, and the other returned to the States.

RUNS AND ESCAPEMENT OF SALMON

The runs of salmon over the entire Bristol Bay district, except at Ugashik, were the most satisfactory that have occurred for several years. Heretofore one side of the bay has harbored a good run while the opposite side had a poor or mediocre run, but in 1928 the runs were heavy and well distributed, with the exception mentioned. As a whole, the escapement was very satisfactory and the commercial catch was above the average.

Nushagak River.—On Monday, July 2, the main red-salmon run started at Nushagak, and the fishermen farthest out made good catches, while those nearer the head of the bay caught very few. The following morning the heavy run had passed well up the bay and every fishing boat was taking all it could handle. The canneries were virtually blocked with fish, and it was necessary to make shipments to other canneries across Bristol Bay, about 500,000 red salmon being transported away from Nushagak during the week. This situation caused some anxiety as to the future supply, but the run continued heavy, especially so over the weekly closed period, which gave assurance of a good escapement. The run remained heavy, with intermittent slack periods of short duration, throughout the season. The escapements were watched closely and were unbelievably heavy over the weekly closed periods.

During the period from July 9 to 14, inclusive, all canneries were on limit more or less of the time. At times fishermen were using only a small part of their web to secure a boat load of fish, and the stake nets were loaded after each flood. Many of the canners had all available cans filled by July 16 to 18 and discontinued fishing. The run slackened perceptibly on the 18th and continued light to the end of the season.

Kvichak and Naknek Rivers.—On the Kvichak side the first salmon made their appearance far out in the bay on July 3, and a little activity was noticed near the mouth of Naknek River on July 5, but small and irregular catches were the order in Kvichak Bay and no appreciable takes were made until the fish were about abreast of the Bristol Bay Packing Co's plant en route to Kvichak River on July 7, when an exceptionally heavy run appeared, and all canneries received a liberal supply. While attempts were made by fishermen to operate gill nets in the vicinity of the ship anchorage, they met with failure because of the clear water, and no catches of importance were reported until the fish reached murky water.

The run continued heavy over the weekly closed period but was virtually exhausted the following Monday afternoon. The fish held well offshore from Naknek, and nearly all of the ascending salmon passed by Naknek River and entered the Kvichak. The run in this area was moderate or scant until the afternoon tide on July 12, when an extremely heavy run set in and continued over the weekly closed period to the following Wednesday (July 18), after which it tapered off to small numbers.

The escapement into Naknek River was never large, but during most of the season there was very little fishing near the river mouth, and some escapement occurred on every flood. A fair escapement occurred near the close of the commercial season and for a few days thereafter, and later observations on the lake showed a fair final escapement.

Egegik River.—The run in the vicinity of Egegik River was at all times consistent, but never extreme, and the escapement into the river was adequate. From the beginning of the season the number of ascending red salmon showed a steady increase, and on July 6 the fish were running heavy for this district. A severe storm toward the end of the season prevented any extensive fishing, and a good escapement passed up the river at that time. Very few fish were taken after July 20.

Ugashik River.—Ugashik was the only locality in Bristol Bay where the escapement was deemed insufficient. The weir-count records show a serious falling off there within the last three years, the escapement in 1926 being 786,775; in 1927, 443,283; and in 1928, 227,966 red salmon. Weather conditions were not particularly favorable for fishing operations, and several days were lost by the fishermen.

RESIDENT FISHERMEN

There was a decided increase in the number of independent fishermen in the various areas of Bristol Bay during the season, chiefly natives who operated boats furnished by the canneries. The total number of independent gill-net boats thus operated was 118, of which 30 were used by white residents and 88 by natives. In 1927 the total number of independent boats was 63, of which 28 were operated by whites and 35 by natives. The number of commercial stake nets increased from 67 in 1927 to 104 in 1928.

EFFICIENCY OF FISHING GEAR

At the beginning of the season considerable dissatisfaction was expressed by the fishermen as to the regulation limiting the minimum size of mesh of red-salmon nets to 5½ inches. They claimed such mesh was large enough for the fish to pass through, making it impossible to gill them. This was true in the early part of the season in the Kvichak-Naknek area, but it was believed that the inability to make good catches at that time was due partly to the clear water in the vicinity of the ship anchorage. There was very little comment on this subject later when the fish reached murky water and good catches were taken.

During the season various sizes of gill-net mesh were used experimentally to determine the effect on catch and escapement. Analysis of the results leads to the belief that the gear now in use—that is, 5½ inch mesh—is the most suitable for all purposes. The records show that this size of mesh takes about an equal number of males and females. It is indicated that the 5-inch mesh net delivered larger catches of red salmon than the 6-inch mesh or the 5½-inch regulation mesh, with a much larger percentage of females than males and relatively few kings or chums. The 6-inch mesh net caught fish of more than average length and weight, about 76 per cent males, and a greater variety of salmon as to species and size than the other sizes of gear.

Nets of 4-inch mesh and 4½-inch mesh were also fished experimentally in the hope of securing a reasonable number of pink salmon by smaller mesh than now permitted under the regulations. The reports indicate that these nets caught only small red salmon, with very few of any other species, and their catches of red salmon were considerably less than by the regulation mesh. Very few pink salmon were taken during the period these small mesh nets were fished.

PATROL

Launches for patrol were used in the Kvichak, Naknek, Ugashik, Nushagak, and Igushik areas. A dory with outboard motor was used at Egegik, where a local launch was chartered over the weekly closed periods whenever possible. The *Scoter* patrolled all waters of Bristol Bay. The various patrols were established in sufficient time before the opening of the commercial season to permit the replacing and repairing of stream markers and the erection of new ones where necessary.

No violations of sufficient importance to prosecute were reported or observed throughout the season. The agreement relative to towing empty boats to the fishing grounds was generally observed. While the patrol was very effective, the observance of the law and regulations was attributed in part to the cooperative spirit shown by the packers and the fishermen as a whole.

PREDATORY WORK

No work of consequence has been accomplished in the destruction of predatory enemies of salmon for the last two years. Investigations at the various rivers and lakes during the past season give convincing evidence of the return of Dolly Vardens and other species of predatory trout in alarming numbers, which, if not checked, will threaten the future productiveness of the different Bristol Bay areas. Trips to Aleknagik Lake indicated that the Dolly Vardens were nearly as numerous and active as in former years before the canners and the bureau began their cooperative work of extermination.

As most of these trout are migratory, a continuous plan of elimination is necessary. In Naknek River, when the red-salmon fingerlings were passing downstream there were certain places where the water appeared boiling with trout feeding on the migrators. In accordance with the bureau's agreement, when taking over the small launches of the Bristol Bay packers, that it would devote $10,000 to predatory work, a reward of 5 cents each was offered for every Dolly Varden, lake trout, or pike taken in the Bristol Bay district, the fish tails to be furnished as evidence. Rewards amounting to $1,944.70 were paid on a total of 38,894 trout, mainly Dolly Vardens. This was less than was anticipated, but the natives and locals claimed they did not believe they would receive a bounty on trout. They stated that next year special efforts would be made. In many cases the collectors were careless and dogs destroyed several thousand tails.

INSPECTION OF ILIAMNA AND LAKE CLARK SPAWNING AREAS IN 1928

On the evening of August 8 the writer left Naknek on the bureau's patrol launch *No. 2* to inspect the salmon spawning grounds in the Iliamna and Lake Clark region, proceeding as far as Koggiung that evening. The next day departure up river was made on the morning flood, and at night the boat was anchored at the lake entrance. Two families of native reindeer herders camped here were curing fish for their home use. It was learned that they had transported several loads of cured fish to their permanent home, about 3 miles back from the river. Few fish were passing at the time of the visit. There were about 500 salmon drying on the racks, with very few fresh ones. The natives were about through fishing and had sufficient cured for their winter use.[2]

Early the following morning a trip was started up the lake, touching at Belinda Creek. Two families of natives (reindeer herders) camped here were curing fish. They appeared to have plenty of fish cured in their caches and had discontinued fishing. The number of salmon in the caches and drying on the racks was estimated at about 3,000. Very few salmon were noted in the stream, and but small numbers were schooling near its mouth. This stream, however, is a small producer in comparison with other streams around the lake.

The next stream examined was Kokhonak Creek. Good schools of red salmon were noted around the stream mouth. The five families of natives had their racks full and some in their caches, about 5,000 salmon in all, and they were making a substantial addition to this number each day. They stated that the salmon had entered the creek only about eight days before, or on August 2. During the

---

[2] The salmon referred to in this report are red salmon, and the natives are Indians.

ascent of the river for about 3 miles small schools were noted in the eddies, but there was not the distribution over the spawning grounds that was expected. The water in the lower reaches was discolored; therefore it was difficult to estimate the number of salmon.

On the following morning a trip was made overland to the lake at the head of this stream. Very encouraging signs were observed at the lake outlet, where at least 75,000 salmon were in one school. These salmon enter the lake only a few hundred yards, spawning either along the shore or in three small mountain streams that enter the lake a short distance above the outlet. Fish were continually passing into these streams. It was estimated that the above-mentioned school, with many small schools in the eddies and around the mouths of the small creeks, would contain about 125,000 salmon, and this total, with the small schools in the main stream and good schools at the creek mouth, would bring the grand total to about 200,000 salmon now in this stream. The fish were late in entering, and it was believed the number would be increased before the spawning season ended. One native fisherman, camped with his family on the lake and curing salmon for home use, had several hundred fish on his racks. This is the first family noted camped here and curing fish at this season of the year.

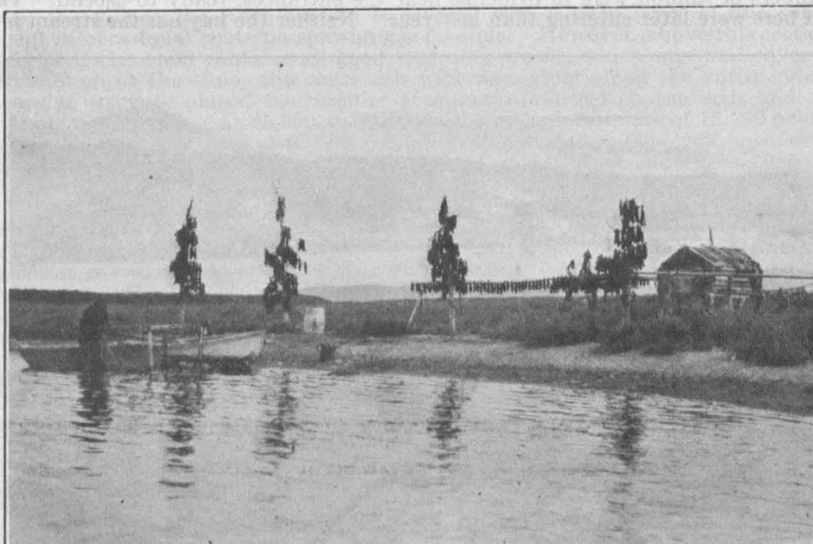


FIGURE 2.—Native method of drying salmon on trees, western Alaska

Proceeding to Copper River on the morning of August 12, very little activity was observed en route, but excellent schools were seen at the river mouth, and there was a most satisfactory showing throughout the ascent of the stream for about 8 miles. The river was high and had the appearance of heavy recent floods, numerous small new channels having been opened in the lower reaches of the river. Salmon were well distributed through each of these channels, mostly in the early stages of spawning. The water was somewhat discolored, making it difficult to estimate the number of salmon accurately, but enough were noted to place the escapement on a par with that of 1926, or about 250,000 red salmon in the stream and schooling near its mouth. There were about three times as many fish as were seen here last year. All noted were in excellent condition, with very few net marks, and generally in early stages of spawning.

Departure from Copper River was made in the early morning of August 13 across the lake to Newhalen River. Salmon were noted working everywhere in the lower reaches of the river, but this stream is always too greatly discolored from glacier water for fish to be seen unless they jump. The natives, of which there were several families camped on both sides of the river, had all the fish they could handle, and all but two families had discontinued fishing. It was estimated that about 18,000 salmon were cured.

From information received, there is every assurance of a very heavy escapement into Lake Clark, far in excess of the escapement last year. As the spawning season at Lake Clark is late, there seemed to be no advantage in endeavoring to make observations there at this time.

Kokokotna Creek was then inspected, ascent of the stream continuing as far as the salmon were noted. Few salmon had been seen here a year ago, but the signs this year were the best since 1922. About 5,000 salmon had already passed up, and fair numbers were continually entering. Outside the stream there was a school of about 20,000 salmon milling around preparing to enter. About 3 miles upstream a beaver dam was encountered, a section of which had been washed out by floods, making it possible for the salmon to ascend. This dam had been partly removed at the time of the inspection last year and was again destroyed this season. No signs of fresh beaver workings in the vicinity were observed, and it is believed the animals were all trapped during the spring and that no further trouble will occur here.

The launch then proceeded to Goose Bay and Youngs Creek, where good numbers of salmon were in evidence near the entrances, ready to ascend. The fish here were later entering than last year. Neither the bay nor the stream is a

FIGURE 3.—Native dip-netting for salmon, Copper River, Alaska

large producer, and from present indications the seeding will be about 75 per cent of that in 1927.

On the morning of August 14 the trip was continued to Chekok and Kinney Creeks. Both of these streams were high and somewhat roily. There was very little spawning in either creek, but a steady line of salmon was ascending, and the lake for about 100 yards each side of the mouth of each stream, extending about 100 feet offshore, was black with fish. It was difficult to estimate the number, because of the riffles, but there seemed to be at least 50,000 salmon near the entrance of Chekok Creek and about 20,000 near the entrance of Kinney Creek.

The course was next directed to Woody Island, where, aside from a few small schools near the entrance to Woody Lakes and along the outside shore of the island, there was little evidence of spawners.

Pedro Bay Creek was then examined. This stream, like every other stream visited, contained a sufficient supply of salmon for effective spawning purposes. Schools aggregating about 10,000 salmon were noted at the creek entrance and there were good numbers along the entire stream. This stream is fed by springs, and a few hundred feet from the mouth it opens into a network of deep-meadow, quiet-water channels. No spawning is possible in the channels, but back near the foothills there are numerous shallow spring ponds with ideal spawning gravel. The number of salmon observed bound for these ponds was estimated at about

30,000, which is deemed adequate for efficient seeding. Bear trails were in evidence everywhere, the locality being very suitable for easy fishing by bears.

The journey was then continued to Pile Bay, and the launch was anchored overnight in Back Bay. A few fair schools of salmon were noted milling around this bay, where they spawn along the shore. There had been reported a large number of salmon in the lake near the entrance to Pile River, but investigation proved the information in error; the lake is muddy and grassy, more suitable for pike than salmon. The only salmon in evidence were about 20 in a small school near the head of the lake.

On August 15 we proceeded to Iliamna. Indications of an excellent escapement were noted en route from the river mouth to the village, the number of salmon schooling in eddies and outside small stream mouths in this 3 miles of river being estimated at 15,000. The following day the launch was sent back to Naknek and the examination of the spawning area was continued by means of a dory and outboard motor obtained from a local school-teacher of the Bureau of Education. A trip was made up the river for about 10 miles above the village. This stream shows the effect of summer floods, and for a stretch of about 4 miles above the village the river bottom is covered with a deep layer of fine sand. Except in occasional spots no spawning is possible. However, above this section the river is clear and contains all good spawning gravel, which was well covered with salmon at the time, and more fish were ascending along the entire river. A careful estimate placed the number of salmon observed on the beds and en route above the village at 45,000 at least, which, with an estimate of 15,000 below the village, makes a total of 60,000 salmon in the stream. This was considered a conservative estimate. In some former years more salmon have been seen on the beds near the village, but never more in the upper reaches of the river, even in the years of greatest abundance.

Summarizing the escapement for the year into the Kvichak area, it compares very favorably with the 1926 escapement, which was considered good, and is slightly in excess of that of 1923. It covers the area more uniformly, with better numbers in the smaller streams, than in either of those years. There will probably be considerable loss in streams of good spawning possibilities on account of numerous shallow channels, created by floods, which flow sufficient water for the salmon at present and in which salmon are spawning, but which, without doubt, will be dry bars when the water recedes to normal.

The salmon this year were late in entering the streams, in a few cases later than last year. The extremely cold season may have had something to do with this. As a whole, it is believed that an excellent escapement over the important area occurred before the close of commercial fishing, and the weekly closed period was mainly responsible for this fine showing on the spawning beds.

BECHAROF LAKE DISTRICT

Clarence Olsen, who was in charge of the patrol of the Egegik region during the season, and William Sullivan, an experienced hatchery man, made a trip to Becharof Lake to inspect the spawning grounds after the commercial season closed and to transfer bureau equipment from the head of the lake to Egegik. Their observations on the trip are as follows:

Departure from Egegik for Becharof Lake occurred on July 27, the rapids being reached that evening, where camp was made for the night. Heavy storms of wind and rain prevented continuing the trip until August 1. Enroute to the lake several good schools of red salmon were noted ascending the river. Frank Stevens had given bureau men the privilege of using his cabin at the head of the lake, which provided comfortable quarters and facilitated the work in that locality.

All streams in the vicinity were inspected immediately after our arrival; but while good schools were noted at the stream mouths, the fish had not yet begun to ascend in any numbers. Local natives advised that the salmon had not appeared until July 20, which was considerably later than usual. On August 15 large schools were seen around the spawning streams. While returning from a trip of investigation in Chief Creek we noticed a steady stream, averaging 12 feet wide, of red salmon moving along the lake shore about 50 feet from the water's edge, and two hours later, or at dark, the fish were still passing up the lake, presumably headed for Chief Creek. Return to Egegik was started on August 17. Great schools of reds were observed at various points in the lake and in the narrows between Big and Little Becharof Lakes.

While the salmon were late in ascending the lake and covering the spawning grounds, there were sufficient numbers to give every assurance of an adequate escapement.

EXAMINATION OF SPAWNING GROUNDS IN THE WOOD RIVER DISTRICT, 1928

To secure further information regarding the salmon runs of the Nushagak region, Frank H. Waskey was employed to gather material for scientific studies and to make an examination of the spawning grounds of the Wood River Lake system. The following is taken from his report of the investigation:

Wood River was ascended to Aleknagik Lake on August 6, at which time the river was discharging as much water, apparently, as during the break-up flood, and Aleknagik Lake was unusually high. Agulowak River, which connects Lakes Aleknagik and Nerka, also was in flood.

It had been planned to spend only a few days examining the more important spawning areas on Aleknagik Lake and then to proceed to the upper lakes of the system. Ordinarily in August the lakes and connecting rivers have fallen to a stage where it is a simple matter to take a dory or other suitable boat up the several short outlet rivers. Boats are "lined" or "nosed" along the banks, one man furnishing the traction, and another keeping the boat away from the shore and rocks by pole or by wading alongside the boat. Several bad shallow rapids and many rocks in Agulowak River make its ascent by power boat impracticable. During all of August it was impossible to nose boats along the rocky shore of that river, as the water was so deep that there was no footing.

While waiting for better conditions, counts and estimates of salmon on Aleknagik were made, but this work was greatly hampered by the almost continuous heavy weather and by dark water due to cloudy skies.

By August 18 Agulowak River had fallen only slightly, and on August 19 rains started again, continuing for several days and causing a further rise of the water. It was then hoped that if the river did not fall soon it would rise high enough to cover the rapids and bars sufficiently to permit the use of a power boat. Preparations for this undertaking were started, and everything was in readiness for ascent on the 25th. Rain and heavy storms continued throughout August. It was necessary to have a day without wind and with a clear sky so that the water could be "read" and reefs and rocks avoided. No such day occurred until September 2, when the first attempt to ascend was made with an 18-foot dory, powered with a 5½-horsepower outboard motor. Two trials with this rig showed its lack of power and general unsuitability for the unusual conditions. The use of a 28-foot river boat with motors having a total of 12 horsepower was then attempted but was successful only in the lower mile of the river. In the rapids in the second mile it was found there was not depth of water enough for safety, and further ascent with power boat was abandoned.

On return to Aleknagik Lake two kayaks were secured, which with camp outfit were portaged to Lake Nerka on September 12. Provisions were portaged on the following day, and examination of the upper lakes was begun. The work in the district was interrupted on October 19, when snow covered the beaches and stream bars. By November 4 the snow had all melted, and the examination was continued until November 9, when snow again interfered with the work.

EXTENT OF EXAMINATION

Lake Kulik was completely circled and examined. Fourth Lake waters were all examined, but not satisfactorily so on account of poor visibility. All of Lake Beverley was examined, with the exception of one creek at the head of Hard Luck Bay on the north shore of the lake. On Lake Nerka, Lynx Lake and outlet were not visited, and Little Togiak Lake and its outlet were not examined. Ugamumunuk Creek, the large tributary at the northwest end of Aleknagik Lake, was not satisfactorily examined, nor were Stormy or Youth Creek, Ice Creek, and Bear Creek, tributaries on the south side of the lake. All Aleknagik grounds were visited, but in the instances noted times or conditions were such that accurate observations could not be made.

Actual counts of salmon were made when possible; in other instances careful estimates were made. The sex estimates are made with a due sense of the limited number of fish examined as compared with the total fish on grounds or dead fish seen. Nevertheless, it is believed that the percentages as given are trustworthy.

On the accompanying sketch of the several lakes and their important tributaries the names of bays and tributaries as given are, with two exceptions, the local names used by prospectors and natives. Crenelated and Bluff Creeks on Lake Kulik were named by the writer.

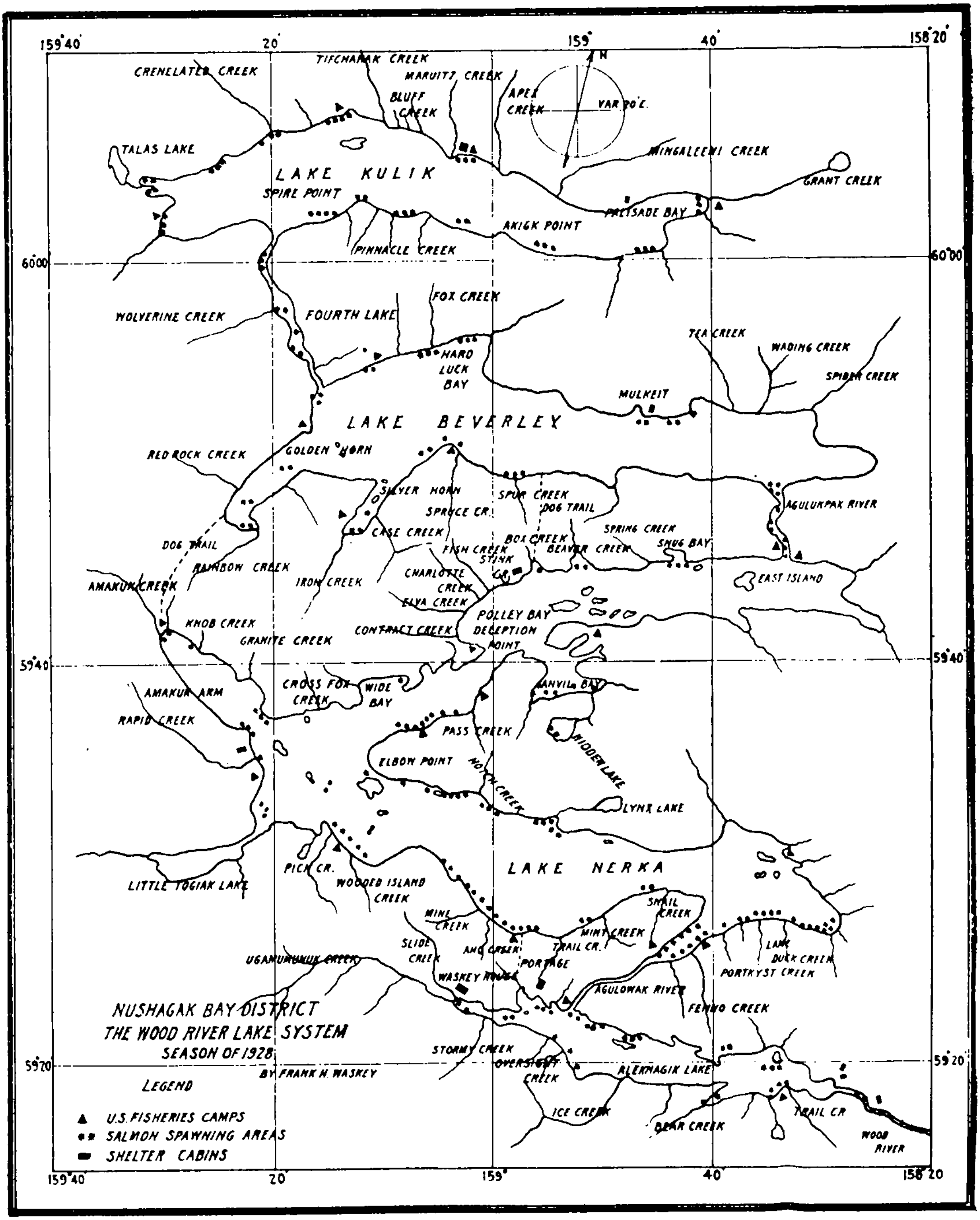

NUSHAGAK BAY DISTRICT
THE WOOD RIVER LAKE SYSTEM
SEASON OF 1928
BY FRANK H. WASKEY
LEGEND
U.S. FISHERIES CAMPS
SALMON SPAWNING AREAS
SHELTER CABINS
LAKE KULIK
LAKE BEVERLEY
LAKE NERKA
ALEKNAGIK LAKE
WOOD RIVER
159°40
20
159°
40
158°20
60°00
59°40
59°20
N

FIGURE 4

CONDITION OF SPAWNING BEDS AND ESTIMATED ESCAPEMENT

A study of the unnamed bay at the northwest end of Lake Kulik makes plain one of the factors that influence the red salmon in their choice of a spawning ground. This bay is bifurcated by a rock peninsula, which at one time was an island. The northerly half of this bay is bounded on the west by a slide of detrital matter, which in time past had filled a portion of the former area of Lake Kulik and dammed off the extreme west end. This severed area now remains as Talas Lake, about 1 mile long and at an elevation above the present Lake Kulik. The overflow waters from Talas Lake have cut a narrow channel around and through the slide to the southerly half of the bay in Lake Kulik; but there is a heavy seepage of water from the upper lake through the slide to the northerly half of the bay, and all along that shore of the bay the beach was swarming with spawning salmon. There were no spawning salmon in the southerly half of the bay, although gravel was available and the tributary from the upper lake enters there.

A notable instance of the salmon refusing an apparently favorable spawning beach is shown at the mouth of Red Rock Creek, a tributary of Golden Horn Bay in Lake Beverley. This creek has deposited a gravel fan extending along the bay for half a mile of sheltered shore line. Conditions, apparently, are ideal for a spawning area, but an examination of the gravel in the creek and the deposit shows that the gravel is very compact, containing a heavy binding sediment, which prevents any seepage of the creek waters through the fan to the lake. The contrary is true of many of the creeks at whose mouths large spawning areas are found—for instance, Tifcharak Creek in Lake Kulik, the creeks on the south side of River Bay in Lake Nerka, and the creeks in Anvil Bay. These creeks carry good heads of water in their central portions but are "blind," or nearly so, at their mouths.

There are also many important spawning areas along the lake shores at points distant from tributary streams. It is known, from winter examinations, that at many of these areas there are springs coming up through the lake bottom. This water is probably of a different temperature than that of the surrounding lake water. It is known to be warmer in winter than the lake water and is probably cooler in summer. This difference in temperature may have its effect in causing the prurient salmon to choose these places. Also, it may be that the ebullition of the rising water has a tendency to keep the gravel in a state of partial suspension and so facilitate nesting. Springs and spring-fed creeks, sometimes quite insignificant in size, are often important spawning grounds.

Porphyry, Pass, and Wooded Island Creeks, entering Lake Nerka, and an unnamed creek on the south side of Lake Kulik have good gravel but are being rapidly aggraded. This may account for their not being salmon streams. Salmon spawn on the beach at their mouths.

Amakuk Creek, Lake Nerka's largest tributary, is also being aggraded in its lower portion. This stream is transporting an immense amount of gravel and other material, most of which is being deposited as a delta in the deep water at its mouth. This delta is of recent origin and forms an extension to the older stream-borne deposits that make up the northwesterly shore line of Amakuk Bay. Along the beach of these older deposits 20,000 red salmon spawned during the season, and 5,000 spawned in a short spring-fed creek one-quarter of a mile east of Amakuk Creek. Only the lower half mile of this creek, above the delta, was examined, in which distance not one live or dead salmon was seen. Conditions along this half mile, as to current, bars, high-level channels, and visibility, were such that had any considerable number of salmon reached the unexamined portion of the creek some evidence to that effect would have been seen along the part of the creek examined. There is reason to believe that this stream is ordinarily a good salmon stream. It may be that on account of the almost constant rains in the past season it was carrying so much sand and mud during the peaks of the runs as to discourage any ascending salmon.

It is probable that some of the many more than 200,000 dead fish seen along the banks of Agulowak River may have come from River Bay, but it is certain that in the river and lower bay more than 500,000 salmon spawned. These are in addition to 45,000 spawners on the south side of upper River Bay, 20,000 on the north side, and more than 23,000 in small creeks entering the north side of the bay. In Agulukpak River, the stream connecting Lakes Nerka and Beverley, the estimated number of spawning salmon was 100,000.

At a casual inspection both Agulowak and Agulukpak Rivers appear too swift and rocky for good spawning grounds, but in the first-named stream the many short eddies along the shores and the numerous bars in the center of the stream afford favorable conditions, and the upper mile of Agulukpak River is made up of wide-spreading shallows with moderate current. There can be no doubt that all the dead and spent fish seen in Agulukpak River spawned in the river or in a very limited area at the point where the current breaks from Lake Beverley into the river. Spawners and nests were seen at this point and throughout the river.

No evidence was seen of salmon having spawned along the south shore of Lake Beverley to the east of the outlet nor for a distance of 16 miles west of it. On the north side of the lake, across from the outlet, the shore is entirely unsuitable for spawning as far west as Mulkeit Point, 5 miles away. Only 100 salmon were seen at that place, and no more for several miles. There were no dead fish at all on the south shore of the lake, either east or west of the outlet. Had any of the dead or spent salmon seen in Agulukpak River spawned in the lake at any distance away from the head of the river, some dead fish would have been seen along the lake shores, as there is no current from the lake except at the entrance to the river.

Of the several thousand dead and spent salmon seen along the river connecting Lake Beverley and Fourth Lake it is thought that most of them spawned in Fourth Lake. This river is very shallow, with little current, but much of the bottom is made up of glacial till, covered in spots with a thin layer of small stream gravel. It is believed that the estimate of spawners for Fourth Lake is considerably below the actual number, as dark and rough water prevented a close estimate. In the delta of the river above Fourth Lake approximately 10,000 salmon spawned, while in the remaining 2½ miles of the stream only 200 spawners were seen.

SUMMARY OF ESTIMATED ESCAPEMENT

The following summary shows the total estimated escapement of red salmon in the several large lakes and the more important rivers:

Wood River below Aleknagik Lake	2, 600
Aleknagik Lake (30 per cent females)	95, 170
Agulowak River	200, 000
Lake Nerka (40 per cent females)	785, 720
Agulukpak River	100, 000
Lake Beverley (over 40 per cent females)	304, 600
Fourth Lake and river below	30, 411
River below Lake Kulik	9, 900
Lake Kulik (50 per cent females)	262, 000
Total	1, 790, 401

INDICATIONS OF TWO RUNS

On all the lakes evidence was seen of an early and a later run, each much larger than the scattering fish between the two runs. In Anvil Bay and in Lakes Beverley and Kulik the peaks of these two runs were at least four weeks apart, and perhaps the runs up Rainbow and Mingaleeni Creeks may have been six weeks before the date when the maximum amount of fish were on the lake-shore areas near by. Ascending Agulowak River, the earlier of these runs coincides with the peak of the run early in July on the commercial fishing ground in salt water. During this run the salmon ascending Agulowak River are nearly all ocean bright and have probably come directly from tidewater.

So far as known there was no run in Nushagak estuary during August of the present year to account for the very large schools of fish that appeared along the north shores of Lake Aleknagik about August 17. These fish were all in deep red coloration. From August 17 to 23 there was a steady stream of salmon ascending the east bank of Agulowak River and a lesser line going up the west bank. These fish were vigorous but highly colored. On September 14 about 80 salmon were seen ascending Elva Creek on the north shore of Lake Nerka that were only in moderate stage of red color. On September 16 there were more than 50,000 dead and spent fish along the banks of Agulukpak River, and most of the fish there that had not spawned were noticeably weak. On the contrary, many of the salmon seen on September 24 and 25 in Fourth Lake and Silver Horn and Golden Horn Bays in Lake Beverley were in remarkable flesh and vigor.

Do many of these late spawning fish remain for a while in comparative quiescence in the deeper parts of the lakes? The natives claim this is the fact with reference to Aleknagik. If this is so, it would appear that the males come into the lake spawning areas first. Of approximately 4,000 red salmon taken in set nets on the north shore of Aleknagik to the west of Agulowak River between July 10 and August 13 only about 10 per cent were females. Between August 15 and September 4 about 12,000 salmon were taken on the same grounds, and of these 30 per cent, or slightly more, were females. On August 10, of 10,000 spawning and spent fish in Portage Creek, in the northeast corner of Aleknagik, approximately one-third were females. The ratio of males to females increased progressively toward the head of the lake system in favor of the females, until in Lake Kulik there was an estimated 50 per cent of females.

Evidence of overseeding of areas was seen in several places, notably in Silver Horn Bay in Lake Beverley and Anvil Bay in Lake Nerka. In both these instances this was due to fish of the later run working on grounds seeded in advance of their arrival. Exceptional as was the run this year, however, it is thought that some lakeshore areas and favorable creeks were only partially seeded.

PREDATORY ENEMIES OF SALMON

Trout were unusually plentiful at the mouth of Agulowak River at times during July and August. The best protectors that the young salmon of the Wood River lake system have at present are the many otter that frequent the several lakes. These otter travel in companies, usually from a pair to five or more. They feed, no doubt, on all kinds of fish, but from the many heads and bodies left at the scene of their kills it is known that they prefer trout; and they are particular as to the trout, eating only the best portions of the firm-fleshed ones. When an emaciated fish or one that is soft-meated from spawning or other cause is taken, the fish is killed, pawed over, and left for the ravens and other carrion-eaters. It is confidently believed that an otter will destroy more than 1,000 trout each year. What this means in the way of young salmon saved is well known. The number of mature salmon that are killed by otter on the lakes is negligible.

Gulls were very plentiful on all the lakes throughout the season, and the number of terns was about as usual. Many of the islands in the district afford nesting grounds for these birds as well as for mergansers and other ducks. During September many ducks were killed for food, all of which had been feeding on salmon eggs. The mergansers take many salmon fingerlings. Large flocks of Amercan golden eyes were seen feeding on salmon eggs in Anvil Bay.

KUSKOKWIM RIVER

Operations on the Kuskokwim River, which are confined to fishing for local requirements and not for export, were again under the inspection of Stream Guard Charles McGonagall, who was stationed there for about three months during the summer and patrolled 1,605 miles with a chartered launch. The runs of kings, reds, and chums were unusually heavy, and the natives were out to catch all they could, as they had experienced a severe shortage of dried salmon the previous winter. Weather conditions were not favorable for curing, as there were continual rains from June until September, and the grade of dried fish was poor. A great deal of the catch from the lower river was shipped by steamer to the upper river posts, as very little fishing is done above Hoffmans.

The use of commercial airplanes in Alaska has lessened travel by dog team in this region. During the winter virtually all the fur is shipped by plane either to Fairbanks or Anchorage, thence over the Government railroad to Seward, where connections are made with boats bound for Seattle, a saving of from 30 to 40 days over the old way of shipping by dog team. This development, of course, affects the demand for dried fish for dog feed.

Two white fishermen and 354 natives were engaged in the fishery in 1928, using 350 gill nets of 4,800 fathoms and 22 fish wheels. The products consisted of 20 barrels of pickled kings and 312 tons of dried salmon for dog feed, of which 310 tons were chums and 2 tons red salmon.

YUKON RIVER

Commercial fishing in Yukon River waters for export from Alaska is prohibited, but the usual operations were carried on to supply local needs and the market for dried salmon for dog feed throughout the interior of Alaska. Inspector C. F. Townsend and one stream guard were on duty at the fishing grounds during the season.

The run of king salmon was especially good, entering the Yukon one week earlier than usual and following the left side of the river. Prior to 1927 the main run entered by the Kwiguk Slough. On investigation of conditions there this year it was noted that various channels at the mouth of the slough were filled with silt and sand, which undoubtedly prevented the fish from taking that course. The run of chum salmon started early in June and continued through July and August with very little abatement. More pinks were caught in the river than in any recent year. It was observed that beluga whales were very scarce during the entire season. Severe storms in June, July, and the first part of August wrecked many fish wheels all along the river. Although the season was extremely rainy, very few fish spoiled on the drying racks, as there was always a wind. Moreover, the natives are building better smoke houses and are covering their drying racks. As a whole, the catch of salmon was above the average, and it is believed many tons of dried fish will be carried over at the end of the winter.

Products of the Yukon and Tanana fisheries were as follows: 82 cases of kings canned, 37 barrels of king salmon and 19 barrels of chums pickled, 2,880 pounds of beleke from kings, 1,400 pounds of kippered kings, 1,800 pounds of kings frozen, and 872,000 pounds of dried chums. Apparatus consisted of 212 wheels, 74 gill nets of 911 fathoms, 1 launch, 3 power dories, 1 scow, and a number of small boats. There were 21 whites and 270 natives engaged in the fishery.

KARLUK SALMON COUNT

The weir for counting the escapement of spawning salmon in Karluk River was erected on the same site as in previous years, being completed on May 10. The first salmon passed through on May 19, but it was not until May 31 that the run attained any appreciable size. Counting was continued through October 13, when 1,093,817 red salmon, 6,002 kings, 4,720 pinks, and 18,428 cohos had ascended.

The last heavy run of the season through the weir on October 11 was the result of an accumulation of salmon that had remained in the lagoon until a slight rise of water started them upstream. After that date natives fishing for local food requirements in the river below the weir caught very few red salmon but large numbers of steelheads.

Departmental regulations prohibited commercial fishing for salmon in Karluk waters prior to 6 o'clock a. m. June 1 and after 6 o'clock p. m. October 1. However, as the salmon were late in entering the river in the spring, commercial fishing was not permitted until June 11. When it became evident, on August 4, that the commercial catch by seines outside the river would prevent the escapement of 1,000,000 red salmon by September 1, the 36-hour weekly closed period was extended 24 hours, the extension being applicable to Karluk beach seines only and continuing for two weeks. This restriction, though effective, was not adequate to meet the situation, and all commercial fishing for salmon in the Karluk district was prohibited from August 19 to August 26, inclusive, with the result that an adequate escapement was assured. Commercial operations for the season were discontinued on September 24. The commercial take of red salmon from the Karluk run was 959,731, or about 47 per cent of the total.

Instead of building traps above the weir for taking trout, as in former years, small seines were used with good results until salmon fingerlings migrating downstream became numerous and it was necessary to discontinue seining in order to avoid injuring them. Some 29,000 Dolly Varden trout were destroyed. As compared with former years, the run of migrating salmon was fair, and 50,000 reds were marked.

Ray S. Wood was in charge of counting operations at the Karluk weir under the direction of Warden Howard H. Hungerford.

ALITAK SALMON COUNT

Weirs for counting the salmon escapement at two streams tributary to Olga Bay were maintained as in previous seasons, the cannery-station weir being completed and ready for operation on May 18 and the upper-station weir on May 22. Red salmon began to appear at the cannery-station weir on May 23 and at the upper-station weir on May 28, although very few in number. Larger runs occurred in Olga Bay about June 6. Counting was continued through September 28, when the escapement of red salmon at the upper station was 420,808 and at the cannery station 72,550, a total of 493,358. In addition, 19,930 cohos and 425 pinks were counted through the weirs. It was estimated that the number of red salmon that entered Horse Marine Lagoon was at least 30,000, which brings the total escapement of reds in Alitak Bay waters to approximately 525,000. Several visits were made to Silver Salmon Lake, but very few fish were noted there at any time.

Commercial fishing for salmon in Alitak waters was prohibited prior to June 15 under departmental regulations, but the Moser Bay traps were not operated until after the middle of July, pending increased escapement at the weirs. Seining began early in July, was stopped August 15, and was not resumed. All traps except the two at the entrance of Moser Bay were closed August 15 and resumed operations September 1. Commercial fishing ceased about September 18. The total reported catch of red salmon in the district was 212,239.

Henry B. Looff, under the supervision of H. H. Hungerford, was in charge of operations for the bureau.

UGANIK SALMON COUNT

The counting of salmon ascending the Uganik River to the spawning grounds was initiated in 1928 by the installation of a weir above the flats about 2 miles upriver from Mush Bay, where the stream is confined to one channel approximately 220 feet wide. The depth of water at this site on June 4 was about 3 feet at the south bank and 5½ feet at the north bank. Construction was begun on June 12 and completed by July 1, the work having been retarded considerably because of heavy rains. Counting began on July 2 and continued through August 22, during which time 15,732 red salmon, as well as 4,205 chums, 1,001 cohos, and 765 pinks, passed through the weir. Early on the morning of August 23 the river had risen 2 feet higher than the weir structure, which was jammed with drift. In a short time the weir was laid flat, two sections being washed away. Most of the remaining material was salvaged and piled on shore for future use, the lack of available replacement material preventing any attempt to restore the weir this season. It was estimated that 15,000 red salmon passed up the river before the weir was in place and some 5,000 after it went out, which, with those counted, would make the escapement for 1928 about 35,000 reds.

Harley W. Barton, under the direction of H. H. Hungerford, was in charge of operations at this weir from June 17 to the end of the season.

CHIGNIK SALMON COUNT

Erection of the counting weir in Chignik River was begun on April 26 and completed on May 17. Approximately the same site was used as in the preceeding year, and the weir was again built on the tripod plan, permitting the use of all the old material that was in good condition. Although there was considerable snow on the mountains in the spring, the cool weather caused it to melt gradually, and there were no freshets. This condition greatly facilitated the work of installing the weir.

The migration of salmon fingerlings downstream appeared to be the heaviest since the counting experiment has been in progress. Small schools were seen on June 2, and the migration increased daily to June 25, when the heaviest migration for any one day of the season was observed. A good migration continued until July 11, then gradually became lighter, and only occasional small schools were seen after July 27. Large numbers of Dolly Varden trout were seen going downstream, chiefly before the migration of young salmon began, although they were not as plentiful as in the previous year. During the month of May 8,348 of these predatory fish were caught, which number was augmented to 10,635 before the end of the season.

The first red salmon appeared below the weir on June 3 and passed upstream on June 4. Counting was continued through October 20, when the total escapement of red salmon numbered 1,490,600. During the first part of June the run was light and the salmon were smaller than the early fish usually are. While the run was not heavy at any one time, it was fair and steady the greater part of the season. In addition to the red salmon 52,749 cohos and 3,354 kings were counted through the weir. No count was made of pinks, inasmuch as some of this species swim back and forth through the counting gates, thus preventing any accurate enumeration. It was noted that the run of pinks was lighter than in any recent year, although a good return had been anticipated from the large escapement in 1926.

Under departmental regulations no commercial fishing for salmon is permitted in the Chignik area prior to June 1 and after October 1 in each year. In view of the forecast of a light run of red salmon a further restriction was placed upon fishing, whereby the traps in Chignik Bay were limited to a catch of 50,000 red salmon before the minimum escapement of 1,000,000 was secured at the weir. As it was believed there might be a possibility of obtaining this limited catch of reds early in the season, thus preventing operation of the traps during the height of the pink-salmon run, none of the six traps in Chignik Bay and Lagoon was set for fishing before July 9. All commercial fishing stopped on September 22. The total reported catch of red salmon from the Chignik run was 735,760. The work at Chignik was under the supervision of Warden Charles Petry.

MORZHOVOI SALMON COUNT

Work on the weir at Morzhovoi Bay was begun on May 23, and by the end of the following day the center section, which had been removed the previous fall, was placed and the weir was in readiness for operation. At the time of an inspection trip on July 1 no fish were seen below the rack nor in the lake stream and lagoon. A watchman was stationed at the weir on July 8, and the first salmon passed upstream on July 9. Counting was continued through September 15, and on the 16th the weir was removed. The total count of red salmon was 8,904, and in addition 530 cohos and 1 pink salmon were tallied. Assistant Agent L. G. Wingard directed operations at this weir.

THIN POINT LAGOON SALMON COUNT

A weir for counting the salmon escapement at Thin Point Lagoon was again established at approximately the same site as in previous years, although the structure was extended farther into the lake and at a greater angle to the current in order that it might be as far as possible above the shifting sands of the outlet. During the first part of July 49 red salmon passed through, and from August 14 to 18 there was an escapement of 892, a total of 941 for the season. The weir was removed on August 20.

In former years Thin Point Lake harbored a large run of red salmon, but the various channels of the lagoon appear to be gradually filling with sand from the glacier stream, and this summer it was seldom possible for the fish to reach the lake because of low water in these channels. Thousands of salmon spawned and died in the shallow pools and gutters of the lagoon. It is said that the cohos, of which 32 were counted through the weir in August, reach the lake in fair numbers in the fall, when higher tides and continual rains raise the streams in this locality. The work at this place was under the supervision of Assistant Agent L. G. Wingard.

CHINIK CREEK SALMON COUNT

The counting weir at Chinik Creek, Kamishak Bay, was completed and ready for operation on June 23. At that time fair numbers of salmon were observed near the mouth of the stream, although no fish were going up. Counting was started on July 2 and continued through August 7, when the total escapement numbered 31,097 red salmon. E. N. Pond was in charge of the work at this place.

ENGLISH BAY SALMON COUNT

In 1928 a weir for the counting of salmon ascending the stream at the head of English Bay was again installed, the structure being completed on May 28. The first salmon passed through on May 30, and counting continued through July 28, at the close of which date the weir was removed. The total count for the season was 24,025 red salmon. Operations at this place were carried on by Jack Tansy.

UGASHIK SALMON COUNT

Work on the installation of the Ugashik weir was begun on June 1 and, with the exception of the main channel, was completed on June 16. Unfavorable weather conditions delayed operations, and the weir was not fully completed until June 26.

Salmon first appeared at the weir on June 27, on which date 3 were counted through. Very few salmon ascended until July 14, when larger schools were noticed, the weir count for that day totaling 3,930. Fair numbers ascended each day until July 26, after which there was a steady decline until the weir was destroyed by storm on the night of August 4. The total number of red salmon counted through the weir was 202,966, and it was estimated that there was an additional escapement of 25,000 after counting operations ceased. Henry McFadden was in charge of operations at this weir during the season.

ANAN SALMON COUNT

The work of putting the weir at Anan Creek in readiness for operation was started on May 16. Owing to heavy rains and extremely high water considerable difficulty was encountered in placing the horses and stringers. The weir was completed on May 31, and the first salmon of the season were counted through on June 18. It was not until June 26 that the fish appeared in any numbers. From then on until early in August a good run occurred, the numbers holding fairly steady throughout this period, with a decided increase on July 17, which reached its peak the following day, when 15,696 pink salmon were counted. During the first week in August the run diminished rapidly, after which it slackened gradually until September 19, when only a few fish were in evidence. The last count was made on September 25, the total escapement for the season being 195,578 pink salmon. In addition, 2,911 cohos, 64 chums, 77 reds, 40 kings, and 60 steelheads were counted through the weir. Walter J. Larson was in charge of construction and of counting operations at this weir.

OLIVE COVE SALMON COUNT

The counting of salmon ascending the creek at the head of Olive Cove to spawn was begun in 1928 by the erection of a new weir at a site about 100 yards above the rapids at the head of the falls, where the stream is approximately 70 feet wide and normally about 15 inches deep. The work of construction was started on June 16 and completed about July 1. The first fish were counted through on July 16, a fairly steady run continuing from then on until August 4, after which only small schools appeared. The final count was on September 22, when the total escapement for the season numbered 49,156 pinks and 385 cohos. Counting operatons at the weir were carried on by Walter Campen.

EAGLE CREEK SALMON COUNT

A new weir for the counting of ascending spawning salmon was established in Eagle Creek, east coast of Prince of Wales Island, the rack being completed and ready for operation on June 10. The first salmon counted through were 16 reds on June 27, but it was not until August 9 that pinks appeared. Counting was continued through

September 29. The total escapement of pink salmon for the season numbered 405,723, which includes an estimated escapement of 200,000 during the period from September 12 to 15, inclusive. At that time heavy rains after a prolonged drought caused the fish to ascend the stream in such numbers that they were crowding each other out of the water. As there was danger that many of them might suffocate, the three counting gates of the weir were thrown open and counts were made for 30-minute periods at each of the gates as a basis for estimating the escapement. In addition to the pink salmon, 2,726 reds, 523 cohos, and 1,985 chums were counted through the weir. Counting operations were in charge of J. A. Kelly.

SITUK RIVER SALMON COUNT

A new counting weir was established on the Situk River about a mile above the locality where the sloughs connect it with Ahrnklin and

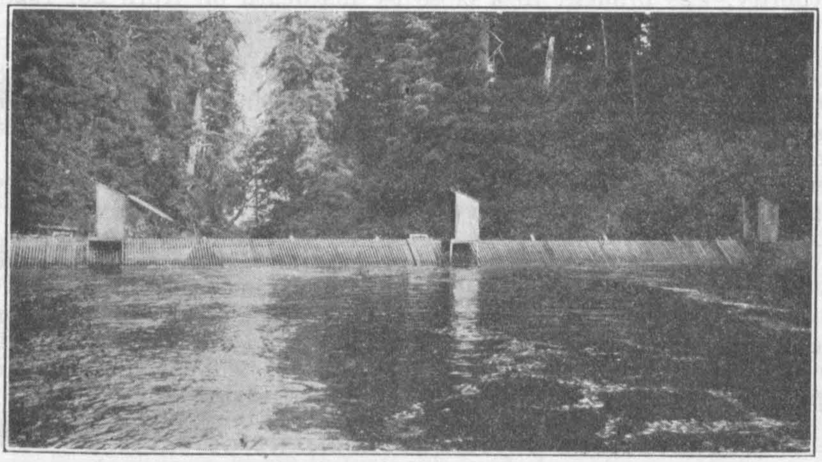


FIGURE 5.—Salmon-counting weir, Eagle Creek, Southeast Alaska

Lost Rivers at high tide. The work of construction was begun the second week of May and was finished on June 5, having been hindered somewhat on account of high water in the river.

The first red salmon were seen below the weir on June 8 and counted through on June 10. Counting was continued to July 20, when the weir was put out of commission by floods. Continued high water prevented further operation of the weir this season, and it was removed on August 15. The total count of red salmon was 97,738, and in addition 4,851 pinks and 1,224 kings passed through.

Commercial fishing operations began on June 14. As the reported catch of salmon for June exceeded the escapement at the weir, one weekly closed period was extended 40 hours, or until midnight of July 3. During this time a good escapement occurred. Operations at this weir were under the supervision of Warden Harry A. Pryde.

SALMON TAGGING

The tagging of salmon as a means of securing information upon the migration routes of individual runs was conducted in only one locality in Alaska in 1928 and involved but one species, red salmon, the fish being captured in a trap of the Pacific American Fisheries at Nicholaski Spit on the Alaska Peninsula. It had been planned to tag 1,000 fish, but a scarcity of red salmon at the time the work was undertaken, together with the hampering of operations by the presence of large quantities of silver hake, resulted in the affixing of only 463 tags. Reports indicate that there were 30 recaptures, a few of which were from rather distant and widely separated waters, one being taken in Bristol Bay, one near the head of Cook Inlet, and one at Uganik Bay on Kodiak Island. Full details of the tagging experiment will be included in a separate document.

SALMON LIFE-HISTORY STUDIES

Dr. C. H. Gilbert's valuable work, conducted over a long period of years in connection with studies of the life history of the Pacific salmons, a subject on which he was regarded as the outstanding authority, was brought to a close by his death on April 20, 1928. Almost up to that day he was engaged in the analysis of data previously collected in Alaska to further the knowledge of the important salmon runs there. Studies along this line are being continued by Dr. Willis H. Rich, chief investigator of salmon fisheries and an associate with Doctor Gilbert in the work for many years. In 1928 Doctor Rich was assisted by Seymour P. Smith, whose investigations were carried on in the Karluk region, and by Harlan B. Holmes, who engaged in similar work in the Chignik district.

Extensive collections of scales of salmon were made in various parts of Alaska for scientific study in relation to life-history problems, and approximately 50,000 young red salmon migrating from Karluk Lake to the sea were marked. Some 1,400 marked adults were taken in the commercial catch, most of which came from the marking experiment of 1926. Reports of the investigations will be published in separate documents.

OBSERVATIONS ON THE ESCAPEMENT OF SALMON

As in previous years, an examination of the important spawning grounds in all districts of Alaska was made by bureau employees to note escapement conditions. Reports of observations during the 1928 season indicate the adequate seeding of many localities but a serious shortage in certain areas, necessitating some further limitations on fishing to prevent depletion.

Southeastern Alaska.—In most sections of southeastern Alaska the 1928 run of pinks was about on a par with that of 1926, and stream surveys have shown ample seeding of the spawning grounds in all but a few localities. Along the northwestern shore of Cleveland Peninsula, from Lemesurier Point to Watkins Point, the run was light, and streams in this region, with the exception of Black Bear Creek in Union Bay, had a poor escapement. In Behm Canal between Unuk River and Point Nelson, including Rudyerd Bay, Smeaton Bay, and Eddystone Creek, the escapement was comparatively light. On the east coast of Prince of Wales Island the escapement of pinks and chums into all streams north of Kendrick Bay was larger than in any recent year; most of the streams to the south of that bay are not suitable for spawning purposes and are said never to have had runs of any importance. On the west coast of

Prince of Wales Island many streams were inadequately seeded, although a few localities had an excellent escapement of pinks. Duncan Canal and Fools Inlet in the Wrangell district also had poor escapements.

As a whole, there was a generally heavy run and adequate escapement of pinks, a normal run with good escapement of chums, and a shortage of kings and cohos. Regulatory measures prohibiting commercial fishing, except by trolling, prior to certain specified dates in various districts of southeastern Alaska were effective in securing the escapement of a large proportion of the early runs of red salmon to the spawning grounds.

Copper and Bering Rivers.—There was a satisfactory escapement of salmon in Copper River, where very good runs of king and red salmon appeared, the season being considered the best since 1924. Bering River also had a very good run of fish and a large escapement.

Prince William Sound and Resurrection Bay region.—Good runs of salmon in the Prince William Sound district were irregular and spasmodic, and the escapement as a whole was slightly under that of the preceding year and not as well distributed, the larger streams generally having a better escapement but the smaller streams showing a slight decrease. Areas in the eastern portion of the Sound, including Port Gravina, Long Bay, Wells Bay, and Unakwik Inlet, were better supplied this year than in 1927, but the west side, where there are many small streams, had a smaller escapement. The run of salmon in Resurrection Bay was considerably larger than in the preceding year, and it was estimated that at least 70 per cent of the fish escaped to the spawning grounds, due partly to the closed periods and partly to stormy weather that prevailed during the best part of the fishing season.

Cook Inlet.—A large increase in the amount of fishing gear used in the Cook Inlet area in 1928 took a heavy toll from the runs of salmon, and investigation of certain spawning grounds toward the end of July showed a very poor escapement. This condition was overcome to some extent by the lengthened closed season in August, commercial operations being prohibited for 3 weeks, or approximately one week longer than in former years.

Chignik district.—At the beginning of the season the run of red salmon in the Chignik district was light, but later the fish appeared in much larger numbers than had been anticipated, and a satisfactory escapement occurred. The run of pink salmon was very light. Warden Charles Petry, who has charge of the district, submitted the following report of examination of the spawning conditions in various streams:

A trip was made to Bear Creek on July 16 to see if there were any salmon spawning there, but none were seen at that time. On August 8 another trip was made to this creek and about 25 pink and 150 chum salmon were seen spawning. Bear Creek is about 15 feet wide and from 1 to 3 feet in depth, emptying into Chignik River about 1 mile above the weir. It has very good spawning beds, and in seasons when there is a good run of pink salmon thousands of them spawn in this stream.

On August 10 a trip was made up a small creek that empties into Chignik River about one-fourth mile below the weir. Six chum salmon were seen spawning at that time. Another survey of this creek was made 12 days later, when 3 chum salmon and 54 pinks were seen spawning. This creek is about 8 feet wide and from 2 to 3 feet deep and has very good spawning beds, which are well seeded whenever there is a good run of pink salmon.

A trip to Black Lake and vicinity was started on the morning of August 14, camp being made that night about 3 miles from the lake. Progress from the head of Chignik Lake to West Fork River, locally known as Sand River, is very difficult and slow because sand is being carried down continually and deposited in the river at the head of the lake. This made the water so shallow for a distance of about 1½ miles at the head of the lake that it was necessary to drag our skiff the entire distance, as there was no channel. Red salmon were seen splashing through the shallow places with their backs out of water. On August 15 we proceeded to Black Lake and followed the eastern shore to Alee River, which we ascended about 1½ miles until we came to Milk Creek, the first tributary. About 6 miles of the creek were inspected, and it was estimated that 3,000 red salmon were spawning there.

On August 16 a trip was made up Chiaktuk Creek, locally called Red Salmon Creek, in which there are very good spawning beds. The creek is from 20 to 30 feet wide and from 2 to 3 feet deep, and it empties into Chignik River about 3 miles below Black Lake. Approximately 8 miles of this stream were inspected, and some 5,000 red salmon were seen spawning. A large school of red salmon was observed milling around in the river at the mouth of the creek.

On August 23 we proceeded to Chignik Lake. About 1,230 red salmon and 7 pinks were seen spawning in the 2 miles of Hatchery Creek that were inspected.

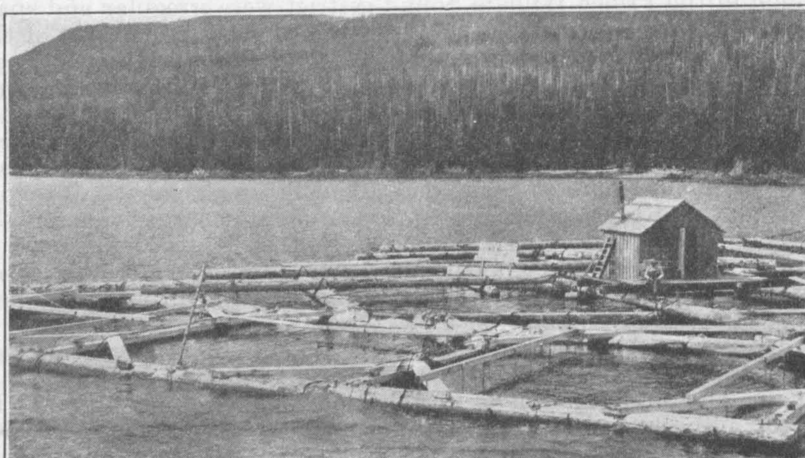


FIGURE 6.—Floating fish trap, Southeast Alaska

Lagoon Creek and Spring Creek also were visited. There were but 3 red salmon seen in Lagoon Creek. This creek was too low at the time for any salmon to ascend farther than a few rods from the mouth. Spring Creek was inspected throughout its entire length, but no salmon were seen and there were no indications of any salmon having spawned there this season. Red salmon were seen spawning in the lake all along the southwest shore between Lagoon Creek and Spring Creek. More male than female salmon were observed in all the streams visited this season.

Kodiak-Afognak district.—Pink salmon, except in a few of the streams on Afognak Island, were very scarce throughout the district, but the runs and escapement of other species were normal. The runs of red salmon at Karluk and Alitak were fair and as large as anticipated in view of the escapements at the beginning of the cycle. Chums were unusually abundant in many streams on the islands, although only light runs occurred on the mainland shore. The closed season from August 15 to September 1 in certain parts of the district was regarded as of especial importance in securing an adequate escapement.

Alaska Peninsula district.—An unusually heavy run of chum salmon occurred in the Alaska Peninsula region, and the spawning beds of this species in general were well seeded. Pink salmon, which ordinarily are abundant in an even year, were scarce, but a large percentage of the run escaped to the spawning grounds, both as a result of closed seasons and due to the fact that the seine operators found it more profitable to fish in other localities where chum salmon were plentiful. While there were some exceptions, such as at Middle Lagoon in Morzhovoi Bay, Thin Point Lagoon, and Wosnesenski Creek, the red-salmon streams of the district as a whole had fairly good runs and escapements. The runs of reds at Port Moller and vicinity were the largest in several years. After a careful survey of Bear River Lake and its tributary streams, Assistant Agent L. G. Wingard estimated the escapement there at 1,000,000 red salmon. Approximately 100,000 red salmon reached the spawning beds of Sandy River Lake, which can accommodate many more salmon than ordinarily are received.

Bristol Bay district.—The escapement of salmon in the Bristol Bay district as a whole was satisfactory. There was an unusually good run in the Nushagak area, and an examination of the spawning beds of the Wood River Lakes region in the fall indicated a heavy escapement. A good run occurred also in the Kvichak–Naknek area, although it was observed that most of the fish passed by the mouth of the Naknek River and ascended the Kvichak, the escapement in the former stream being fair but not heavy. The only locality which had an inadequate escapement was Ugashik, where there has been a serious decline in the last three years.

An examination of the Iliamna–Lake Clark area was again made by Agent Dennis Winn in August, and conditions in the Becharof Lake district were observed by Clarence Olsen, who was in charge of the patrol in the Egegik region. Reports of their observations are printed elsewhere in this document.

HATCHERIES

EXTENT OF OPERATIONS

Salmon propagation in Alaska was carried on at two Government-owned hatcheries (at Afognak and McDonald Lake) and at one privately owned hatchery—that of the Northwestern Fisheries Co. at Hugh Smith Lake.

Operations of Federal and private hatcheries in Alaska in 1928

Location of hatchery	Red or sockeye salmon		
	Eggs taken in 1927	Salmon liberated in 1927–28	Eggs taken in 1928
Afognak	4,225,408	3,675,000	[1] 20,442,925
McDonald Lake	20,240,000	18,784,715	[2] 24,036,000
Hugh Smith Lake (Quadra)	20,240,000	19,360,000	20,310,000
Total	44,705,408	41,819,715	64,788,925

[1] Also 2,300,800 pink-salmon eggs were collected, from which 1,851,650 eyed eggs were shipped to the Washington State Fish Commission, Seattle, Wash., in October.

[2] Also 2,128,200 pink-salmon eggs were collected. Shipments of 2,037,000 eyed pink-salmon eggs and 2,493,000 eyed red-salmon eggs were forwarded to Seattle in October.

AFOGNAK

The Federal salmon hatchery at Afognak produced and liberated in Litnik Lake and its tributaries 3,675,000 red-salmon fry from the collection of 4,225,408 eggs made in 1927, the loss on the take being approximately 13 per cent.

The collection of red-salmon eggs began August 1, 1928, and ended August 24 with a total take of 20,442,925. Pink-salmon eggs were collected between August 27 and September 5, in which period 2,300,800 eggs were secured, and in October 1,851,550 eyed eggs of this species were shipped to the Washington State Fish Commission at Seattle, Wash.

Few Dolly Varden trout were seen in Afognak Lake during the spring and summer, but they appeared in larger numbers in the fall, and throughout the season some 20,000 were destroyed.

M'DONALD LAKE

Of the fry hatched from 20,240,000 red-salmon eggs taken at the Federal salmon hatchery on McDonald Lake in 1927, 2,500,000 fingerlings No. 1 were released in that lake in June, 1928, and 16,284,715 in July, a total of 18,784,715. The net loss on the take, therefore, was 7.2 per cent.

A shipment of 54,288 eastern brook-trout eggs was received from Seattle for incubation in December, 1927, and 41,600 No. 1 fingerlings were released in May, 1928, of which 14,400 were shipped to Juneau for planting in Auk Lake and 13,600 each to Petersburg and Sitka for stocking waters in those vicinities.

There were 24,036,000 red-salmon eggs collected at this station from September 3 to October 1, 1928, and 2,128,200 pink-salmon eggs from August 20 to September 12. Shipments of 2,493,000 eyed red-salmon eggs and 2,037,000 eyed pink-salmon eggs were forwarded to Seattle, Wash., in October. During the year 1,518 predatory fish, chiefly Dolly Varden trout, were destroyed.

HUGH SMITH LAKE (QUADRA)

The Northwestern Fisheries Co. liberated 19,360,000 red-salmon fry from its hatchery near Boca de Quadra in 1928, hatched from 20,240,000 eggs taken in 1927, a loss of 4.3 per cent. In 1928 the take of red-salmon eggs was 20,310,000.

HATCHERY REBATES

The owners of private salmon hatcheries in Alaska who are also packers of canned salmon receive a rebate on license fees and taxes of every nature on their catch and pack of salmon at the rate of 40 cents per 1,000 king or red salmon fry liberated by them in Alaskan waters. In the fiscal year ended June 30, 1928, only one such private salmon hatchery was operated—that of the Northwestern Fisheries Co. at Hugh Smith Lake—and the rebate due on the 19,360,000 red-salmon fry liberated there during the year amounted to $7,744.

GENERAL STATISTICS OF THE FISHERIES

The total number of persons engaged in the fisheries of Alaska in 1928 was 31,086, or 2,214 more than in 1927. Fishery products were valued at $54,545,588, an increase of $14,382,288, or about 35.8 per cent, over the preceding year. Of the total amount, 87 per cent represented the value of salmon products; 5.7 per cent, herring; 5.7 per cent, halibut; and 1.6 per cent, the value of all other fishery products.

Summary of persons engaged and products of the Alaska fishery in 1928

Item	Southeast Alaska		Central Alaska		Western Alaska		Total	
	Number	Value	Number	Value	Number	Value	Number	Value
PERSONS ENGAGED								
Whites	8, 195		4, 526		4, 605		17, 326	
Natives	3, 578		1, 022		1, 014		5, 614	
Chinese	365		283		428		1, 076	
Japanese	653		532		305		1, 490	
Filipinos	1, 807		1, 413		731		3, 951	
Mexicans	73		100		1, 110		1, 283	
Kanakas	40		2		24		66	
Porto Ricans	3		10		31		44	
Negroes	5		31		172		208	
Miscellaneous	10		5		13		28	
Total	14, 729		7, 924		8, 433		31, 086	
PRODUCTS								
Salmon:								
Canned ... cases	2, 971, 147	$19, 584, 085	1, 639, 155	$12, 482, 057	1, 473, 601	$13, 317, 743	6, 083, 903	$45, 383, 885
Mild-cured ... pounds	4, 403, 200	1, 063, 747	276, 800	38, 124			4, 680, 000	1, 101, 871
Pickled ... do	27, 800	2, 585	92, 600	5, 927	736, 700	100, 125	857, 100	108, 637
Fresh ... do	1, 646, 581	146, 146					1, 646, 581	146, 146
Frozen ... do	6, 126, 064	553, 858	20, 879	905	5, 800	545	6, 152, 743	555, 308
Dry-salted, dried, and smoked ... do	17, 800	1, 680	4, 790	284	1, 500, 280	120, 782	1, 522, 870	122, 746
Smoked and packed in olive oil ... cases	400	7, 200					400	7, 200
Pudding ... do			17	85			17	85
Eggs for caviar ... pounds	50, 580	1, 284	3, 600	72			54, 180	1, 356
Fertilizer ... do	1, 054, 000	32, 597	367, 644	11, 512			1, 421, 644	44, 109
Oil ... gallons	26, 900	9, 760	15, 490	6, 660			42, 390	16, 420
Halibut:								
Fresh ... pounds	23, 322, 414	2, 483, 887	8, 000	800			23, 330, 414	2, 484, 687
Frozen ... do	7, 012, 773	542, 201	1, 222, 949	67, 040			8, 235, 722	609, 241
Pudding ... cases			18	72			18	72
Herring:								
Fresh, for bait ... pounds	2, 640, 325	27, 428					2, 640, 325	27, 428
Frozen, for bait ... do	3, 572, 901	32, 678	340, 000	3, 400			3, 912, 901	36, 078
Fresh, for food ... do	518, 000	7, 770					518, 000	7, 770
Frozen, for food ... do					24, 000	480	24, 000	480
Pickled, for food—								
Scotch cure ... do	4, 420, 100	342, 255	4, 912, 170	396, 592	6, 724, 325	557, 596	16, 056, 595	1, 296, 443
Norwegian cure ... do	262, 400	24, 171	55, 950	3, 070	27, 500	2, 400	345, 850	29, 641
Roused, for food ... do					87. 100	4, 773	87, 100	4, 773
Kippered ... do	104, 368	10. 437					104, 368	10, 437
Spiced ... do	2, 600	520					2, 600	520
Dry-salted ... do			215, 750	9, 732			215, 750	9, 732
Bloaters ... do			59, 000	2, 120			59, 000	2, 120

Summary of persons engaged and products of the Alaska fishery in 1928—Continued

Item	Southeast Alaska		Central Alaska		Western Alaska		Total	
	Number	Value	Number	Value	Number	Value	Number	Value
PRODUCTS—continued								
Herring—Continued.								
Meal......pounds..	18,425,424	$608,903	1,578,740	$48,577			20,004,164	$657,480
Oil......gallons..	2,303,374	920,703	240,226	94,852			2,543,600	1,015,555
Cod:								
Dry-salted......pounds..			518,053	23,465			518,053	23,465
Stockfish......do....			43,800	4,680			43,800	4,680
Tongues......do....			400	40			400	40
Frozen......do....			15,920	794			15,920	794
Whale:								
Oil......gallons..			406,350	190,334	324,300	$153,452	730,650	343,786
Sperm oil......do....			32,100	12,088	61,650	24,660	93,750	36,748
Fertilizer......pounds..			1,370,000	38,350	1,282,000	35,390	2,652,000	73,740
Clams......cases..			15,170	107,046			15,170	107,046
Crabs:								
Meat......pounds..	63,790	22,010	77,530	27,852			141,320	49,862
Whole in shell......dozen..	504	1,083	266	532			770	1,615
Shrimp......pounds..	504,271	202,165					504,271	202,165
Trout:								
Canned......cases..			35	210			35	210
Fresh......pounds..	29,529	3,863	800	100			30,329	3,963
Frozen......do....	15,117	1,331	8,770	901			23,887	2,232
Sablefish:								
Fresh......do....	16,071	421					16,071	421
Frozen......do....	228,217	10,511					228,217	10,511
Pickled......do....	18,600	1,395					18,600	1,395
Rockfishes, fresh......do....	2,332	70					2,332	70
Smelt:								
Fresh......do....	11,323	1,246					11,323	1,246
Frozen......do....	10,080	1,109					10,080	1,109
"Lingcod":								
Fresh......do....	482	14					482	14
Frozen......do....	7,879	236					7,879	236
Flounders:								
Fresh......do....	100	2					100	2
Frozen......do....	901	18					901	18
Total....		26,649,369		13,578,273		14,317,946		[1] 54,545,588

[1] These figures represent the value of the manufactured product. It is estimated that the value of the catch, exclusive of whales, to the fishermen was approximately $17,343,000. The round weight of the salmon catch landed by the fishermen was approximately 517,069,403 pounds, and the corresponding figures for herring were approximately 134,020,216 pounds. The cod figures given above do not include the offshore catch from waters adjacent to Alaska, which amounted to 5,481,470 pounds of dry-salted cod and 22,000 pounds of tongues, having a total value of $293,624, landed at ports of the Pacific Coast States.

SALMON

The salmon industry of Alaska in 1928 showed a very marked improvement over the preceding year, the value of the products increasing from $32,361,767 to $47,487,763, a gain of almost 47 per cent. The total catch of salmon increased approximately 86 per cent. In each of the three districts there was an increase in the number of cohos and chums taken and a decrease in the number of kings. The run of pink salmon in southeastern Alaska showed a gratifying recovery from the serious shortage of the previous year, the catch being more than four times as large as in 1927, while the number of red salmon taken was the smallest for many years, due largely to further restrictions on fishing during the early runs. In the central district, where a heavy run of pink salmon was anticipated in view of the large runs in previous alternate years, the catch of pinks was less than that of 1927, which, however, was an unusually productive season for an off year although considerably under the last two even years. The catch of red salmon in central Alaska was normal, exceeding that of 1927 by about 29 per cent. In the western district the catch of red salmon was the best since 1922, although only slightly in excess of that of 1926, while the catch of pinks was comparatively light. By districts, the increase in the catch over the preceding year was 227 per cent in southeastern Alaska, 6 per cent in central, and 66 per cent in western Alaska.

There was an increase of 14 per cent for the whole of Alaska in the number of fathoms of seines used and a slight increase in the number of fathoms of gill nets, while the number of traps decreased about 9 per cent. In the southeastern district the decrease in the number of traps operated was 21 per cent, but in the central district there was an increase of 24 per cent, most of the additional traps being in the Cook Inlet and Kodiak areas.

CATCH AND APPARATUS

The total number of seines used in the salmon industry of Alaska in 1928 was 718, of which 141 were beach seines and 577 purse seines. The beach seines aggregated 17,888 fathoms of webbing and the purse seines 91,394 fathoms. The number of gill nets used was 3,631, having a total length of 302,018 fathoms. There were 305 driven traps and 425 floating traps, a total of 730.

Southeastern Alaska was accredited with 473 seines, or a total of 80,559 fathoms of webbing, an increase of 77 seines, or 8,101 fathoms of webbing, over the number in 1927; also with 351 gill nets, aggregating 22,667 fathoms, an increase of 152 nets, but a decrease of 3,312 fathoms; and with 71 driven and 382 floating traps, a decrease of 30 driven and 92 floating traps from the number operated in 1927.

Corresponding figures for central Alaska show 230 seines, or 25,923 fathoms, as compared with 185 seines or 20,175 fathoms in 1927; 1,290 gill nets or 77,065 fathoms, as compared with 1,065 gill nets or 55,223 fathoms in 1927; and 232 driven and 43 floating traps, as compared with 178 and 43, respectively, in 1927.

In western Alaska 15 seines, or 2,800 fathoms of webbing, were used, an increase over 1927 of 3 seines or 200 fathoms of webbing. There were 1,990 gill nets used, of an aggregate length of 202,286 fathoms, an increase of 217 nets but a decrease of 18,275 fathoms in quantity of webbing. Two driven traps were operated, one less than in 1927.

Seines caught 21 per cent of the salmon taken in 1928, gill nets 26 per cent, and traps 51 per cent, while lines and wheels took the remaining 2 per cent.

Percentage of salmon caught in each Alaska district, by principal forms of apparatus

Apparatus	Southeast Alaska		Central Alaska		Western Alaska	
	1927	1928	1927	1928	1927	1928
Seines	16	25	29	29	4	4
Gill nets	6	1	8	7	92	93
Traps	70	71	63	64	1	1
Lines	8	3				
Wheels					3	2

Salmon taken in 1928, by apparatus and species, in each geographic section of Alaska

Apparatus and species	Southeast Alaska	Central Alaska	Western Alaska	Total
Seines:				
Coho, or silver	203, 626	135, 070	504	339, 200
Chum, or keta	2, 320, 741	1, 375, 079	72, 157	3, 767, 977
Pink, or humpback	8, 610, 410	4, 062, 920	16, 789	12, 690, 119
King, or spring	1, 440	1, 926	7, 646	11, 012
Red, or sockeye	245, 034	885, 116	883, 752	2, 013, 902
Total	11, 381, 251	6, 460, 111	980, 848	18, 822, 210
Gill nets:				
Coho, or silver	206, 895	475, 949	2, 559	685, 403
Chum, or keta	23, 643	58, 100	896, 588	978, 331
Pink, or humpback	131, 219	139, 494	4, 917	275, 630
King, or spring	24, 522	72, 377	87, 815	184, 714
Red, or sockeye	244, 534	947, 700	19, 743, 454	20, 935, 688
Total	630, 813	1, 693, 620	20, 735, 333	23, 059, 766
Traps:				
Coho, or silver	957, 766	955, 062		1, 912, 828
Chum, or keta	2, 524, 476	2, 398, 696	23, 561	4, 946, 733
Pink, or humpback	27, 295, 811	7, 243, 542		34, 539, 353
King, or spring	11, 270	67, 770	2, 432	81, 472
Red, or sockeye	859, 853	3, 613, 837	119, 746	4, 593, 436
Total	31, 649, 176	14, 278, 907	145, 739	46, 073, 822
Lines:				
Coho, or silver	791, 122	2, 904		794, 026
Chum, or keta	2, 486			2, 486
Pink, or humpback	13, 756			13, 756
King, or spring	347, 349			347, 349
Red, or sockeye	1, 450			1, 450
Total	1, 156, 163	2, 904		1, 159, 067
Wheels:				
Chum, or keta			437, 650	437, 650
King, or spring			32, 020	32, 020
Red, or sockeye			150	150
Total			469, 820	469, 820
Total:				
Coho, or silver	2, 159, 409	1, 568, 985	3, 063	3, 731, 457
Chum, or keta	4, 871, 346	3, 831, 875	1, 429, 956	10, 133, 177
Pink, or humpback	36, 051, 196	11, 445, 956	21, 706	47, 518, 858
King, or spring	384, 581	142, 073	129, 913	656, 567
Red, or sockeye	1, 350, 871	5, 446, 653	20, 747, 102	27, 544, 626
Grand total	44, 817, 403	22, 435, 542	22, 331, 740	89, 584, 685

The total catch of salmon in 1928 was 89,584,685, an increase of 41,362,014, or 85.8 per cent, over the number taken in 1927. Southeastern Alaska showed a gain of 31,121,290, while central Alaska gained 1,324,682 and western Alaska 8,916,042. The catch by species shows that cohos increased 1,063,695, chums 4,373,501, pinks 26,267,235, and reds 9,968,305, while kings decreased 310,722.

CANNING

CHANGES IN CANNERIES

The Heceta Island plant of Swift-Arthur-Crosby Co. and the Ketchikan plant of the Pure Food Fish Co. were again operated under lease by the Nakat Packing Corporation, which purchased the latter cannery before the close of the year. Libby, McNeill & Libby purchased the cannery of the George Inlet Packing Co., which it had leased the previous year, and Whitworth Fisheries (Inc.)

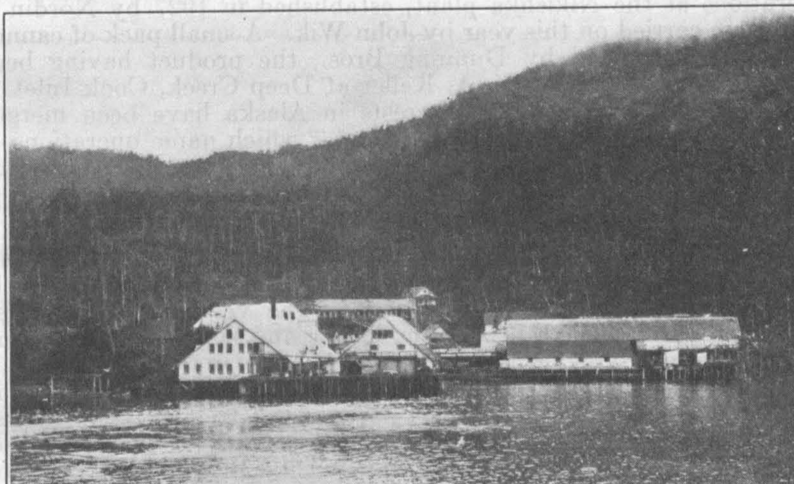


FIGURE 7.—Typical salmon cannery, Prince William Sound, Alaska

continued its lease and operation of the Point Warde Fisheries plant at Point Warde, with ultimate purchase in view. The plant of F. C. Barnes Co. at Lake Bay was leased in the spring of 1928 to a new corporation, the Lake Bay Packing Co. Pacific American Fisheries purchased properties of the Wilson Fisheries Co., including the 4-line cannery of J. L. Smiley & Co. at Ketchikan and the Port Walter cannery of Alaska Herring & Sardine Co., although it did not reopen the latter plant, which was last operated in 1925. The floating cannery, of the barge type, belonging to Far North Fisheries (Inc.), was raised on the beach near the company's warehouse at Hydaburg and now constitutes a shore plant.

The Hemrich Packing Co. operated its salmon and clam cannery at Kukak Bay, which had been leased to the Seashore Packing Co. for the three preceding years. The plant of the Kadiak Fisheries Co. at Shearwater Bay, having been completely rebuilt since being wrecked by windstorm in 1926, was in operation during the season. Activities of the New England Fish Co. in central Alaska were extended by the acquisition and operation of the Prince Packing Co.'s cannery on Knight Island, formerly operated under lease by Gorman & Co. but idle in 1927. A new shore plant erected by the Robinson Packing Corporation on Zachar Bay was in use during the season, replacing the company's floating cannery *Azalea*, which was sold late in the year to the Robinson Fisheries Co. of Anacortes to be employed in the cod industry. The Northwestern Fisheries Co. again operated its cannery at Uyak, which was closed the preceding year, and also the Orca plant, which had been idle since 1918.

Canneries in central Alaska reopened and operated by the Pacific American Fisheries after being closed in 1927 were the Unakwik Inlet plant, leased from Unakwik Inlet Packing Co., and the Bering River plant of the Hoonah Packing Co. In conjunction with its herring operations, the Franklin Packing Co. put up a pack of canned salmon at its Port Ashton plant on Evans Bay, where an output of canned salmon had been prepared once before in the season of 1919. Operations at the Nikishka plant, established in 1927 by Nordin & Wik, were carried on this year by John Wik. A small pack of canned salmon was reported by Dunning Bros., the product having been prepared at the plant of W. A. Keller at Deep Creek, Cook Inlet.

The Naknek Packing Co. interests in Alaska have been merged with the Red Salmon Canning Co., under which name operations of the former company's plant on Naknek River were carried on during the 1928 season.

NEW CANNERIES

The Everett Packing Co. equipped its steamer *Mazama* as a floating cannery and used it to prepare a pack of canned salmon in southeastern Alaska during the fall season. The vessel had been used earlier in the year to transport employees and supplies to the company's plant at Herendeen Bay.

Eleven new canneries, of which nine were on Cook Inlet and two in the Kodiak area, were operated in the central district in 1928. These include three hand canneries operated, respectively, by W. G. Culver at Point McManus, George Valaer at Nikishka Bay, and Jake Young at Portlock. H. J. Emard, who operated a cannery at Moose Point in 1924 and later became associated with Gorman & Co., which took over the machinery of that plant, established a new 1-line cannery at Anchorage and again operated independently. Edward Gustan put up a pack of canned salmon at his plant at Point Possession. San Juan Fishing & Packing Co. installed machinery for a 1-line cannery in its saltery buildings at Tutka Bay, and 1-line canneries were established also by Sunset Packing Co. at Otter Creek, by J. F. Toman at Anchorage, and by Nordin & Sandvik at Swansons Creek. The Trinity Packing Co., a new firm, purchased buildings from Caw Packing Co. and established a cannery at Three Saints Bay. The schooner *Esther*, which had previously been used as a herring plant, was fitted up with 1-line canning equipment and operated in Uyak Bay by the newly organized company—North Pacific Fisheries (Inc.). In addition to these plants, the Anchorage Sanitary Hand Packers put up a small pack by hand at Anchorage.

The International Packing Co. equipped its recently acquired steamer *International* as a floating salmon cannery and operated it on the Ugashik River and at Dutch Harbor in western Alaska and at Dolgoi Harbor in the central district.

CANNERIES NOT OPERATED

Very few of the Alaska salmon canneries operated in the preceding year were closed during the 1928 season. In southeastern Alaska the Wrangell plant of the Alaska Packers Association, which was operated under lease by the Alaska Sanitary Packing Co. in 1927, was idle, and no operations were carried on at the Mountain Point Packing Co. cannery on Wrangell Narrows. The following canneries were closed during the year but may be reopened:

Southeastern Alaska:

Alaska Packers Association	Wrangell.
Alaska Sanitary Packing Co	Cape Fanshaw.
Hoonah Packing Co	Hoonah. Gambier Bay.
Mountain Point Packing Co	Wrangell Narrows.
Northwestern Fisheries Co	Roe Point. Santa Ana.
Pacific American Fisheries	Port Walter.
Tongass Packing Co	Nakat Inlet.

FIGURE 8.—Canned salmon in cooling trays, western Alaska

Central Alaska:

Alaska Packers Association	Kasilof.
Kodiak Island Fishing & Packing Co	Seward.
Northwestern Fisheries Co	Seldovia.

Western Alaska: Alaska Salmon Co .... Kvichak Bay.

TOTAL CANNERIES OPERATED

There were 153 canneries operated in Alaska in 1928—61 in southeastern, 62 in central, and 30 in western, which is 1 less in southeastern, 18 more in central, and 1 more in the western district than in 1927, a net gain of 18 plants. The International Packing Co. operated its floating cannery *International* in both the central and western districts, but it is included in the total of western Alaska only.

Companies that canned salmon in Alaska, number and location of canneries operated, and number of traps owned by each, 1928

[New canneries indicated by (*)]

Company	Canneries: Number	Canneries: Location	Traps: Driven	Traps: Floating	Traps: Total
Southeast Alaska:					
Alaska Consolidated Canneries	6	Boca de Quadra	1	3	4
		Chomly	4	4	8
		Pybus Bay	1	6	7
		Rose Inlet		3	3
		Tenakee	1	8	9
		Yes Bay	1	6	7
Alaska Packers Association	1	Loring	3	4	7
Annette Island Packing Co	1	Metlakatla	5	1	6
Astoria & Puget Sound Canning Co	1	Excursion Inlet	2	6	8
Bayview Packing Co	1	Klawak			
Beegle Packing Co	1	Ketchikan	1	3	4
Burnett Inlet Packing Co	1	Burnett Inlet		3	3
Deep Sea Salmon Co	1	Port Althorp		14	14
C. W. Demmert Packing Co	1	Klawak		5	5
Diamond K Packing Co	1	Wrangell (floating)		6	6
Douglas Island Packing Co	1	Douglas			
Everett Packing Co	1	Bay of Pillars (floating)*			
Far North Fisheries (Inc.)	1	Hydaburg		1	1
Fidalgo Island Packing Co	2	Bay of Pillars	7		7
		Ketchikan	4	2	6
Haines Packing Co	1	Letnikof Cove			
P. E. Harris & Co	1	Hawk Inlet	1	6	7
Hetta Packing Co	1	Coppermount			
Hood Bay Canning Co	1	Hood Bay		6	6
Independent Salmon Canneries	1	Ketchikan			
Karheen Packing Co	1	Karheen	2	2	4
Lake Bay Packing Co	1	Lake Bay	1	3	4
Libby, McNeill & Libby	3	George Inlet		6	6
		Taku Harbor	9	3	12
		Yakutat			
Geo. T. Myers & Co	1	Chatham	3	3	6
Nakat Packing Corporation, The	5	Heceta Island		9	9
		Hidden Inlet		7	7
		Ketchikan		4	4
		Union Bay		11	11
		Waterfall		9	9
New England Fish Co	2	Ketchikan		7	7
		Noyes Island		7	7
North Pacific Trading & Packing Co	1	Klawak		5	5
Northwestern Fisheries Co	5	Boca de Quadra	2	8	10
		Dundas Bay		4	4
		Hunter Bay		8	8
		Kasaan	3	3	6
		Shakan		9	9
Pacific American Fisheries	2	Excursion Inlet	5	5	10
		Ketchikan	2	3	5
Peril Straits Packing Co	1	Todd		6	6
Petersburg Packing Co	1	Petersburg	3	6	9
Pyramid Packing Co	1	Sitka		6	6
Red Salmon Packers Association	1	Dry Bay and Yakutat (floating)			
Sea-Coast Packing Co	1	Craig		9	9
Sebastian-Stuart Fish Co	1	Tyee		8	8
Starr-Collinson Packing Co	1	Moira Sound		2	2
Straits Packing Co	1	Skowl Arm			
Stuart Corporation, The	1	Ketchikan		7	7
Sunny Point Packing Co	3	Funter Bay		13	13
		Kake		11	11
		Ketchikan	3	6	9
Superior Packing Co	1	Tenakee	1	3	4
Ward's Cove Packing Co	1	Ward Cove		2	2
Whitworth Fisheries (Inc.)	1	Point Warde		1	1
Central Alaska:					
Alaska General Fisheries	1	Anchorage	6		6
Alaska Packers Association	3	Alitak	4		4
		Chignik	3		3
		Karluk	2		2
Alaska Year Round Canneries Co	1	Seldovia	8		8
Alitak Packing Co	1	Lazy Bay	9		9
Arctic Packing Co	1	Port Graham	1		1
Columbia River Packers Association	1	Chignik	6		6
Cook Inlet Packing Co	1	Seldovia	9		9
Copper River Packing Co	1	McClure Bay	1	6	7
Cordova Packing Co	1	Cordova			
Crosby Fisheries (Inc.)	1	Kodiak Island (floating)	3		3
Walter G. Culver	1	Point McManus *	1		1
H. J. Emard	1	Anchorage*	5		5

Companies that canned salmon in Alaska, number and location of canneries operated, and number of traps owned by each, 1928—Continued

[New canneries indicated by (*)]

Company	Canneries		Traps		
	Number	Location	Driven	Floating	Total
Central Alaska—Continued.					
Emel Packing Co.	1	Valdez	4		4
Fidalgo Island Packing Co.	1	Port Graham	10		10
Franklin Packing Co.	1	Port Ashton		10	10
Gorman & Co.	1	Anchorage	6		6
Gorman Packing Corporation	1	Drier Bay		3	3
Grimes Packing Co.	1	Uzinki			
Edward Gustan	1	Point Possession*	1		1
P. E. Harris & Co.	1	Isanotski Strait	9		9
Hemrich Packing Co.	1	Kukak Bay			
International Packing Co.	1	Dolgoi Harbor			
Kadiak Fisheries Co.	2	Kodiak	5		5
		Shearwater Bay	1		1
Katmai Packing Co.	1	Uzinki	1		1
W. A. Keller	1	Deep Creek	3		3
Kenai River Packing Co.	1	Kenai	7		7
Kodiak Island Fishing & Packing Co.	1	Uganik Bay	5		5
Libby, McNeill & Libby	1	Kenai	17		17
New England Fish Co.	2	Cordova	4	4	8
		Drier Bay			
Nordin & Sandvik	1	Swansons Creek*			
North Coast Packing Co.	1	Ninilchik	8		8
North Pacific Fisheries (Inc.)	1	Uyak Bay (floating)*			
Northern Light Packing Co.	1	Mountain Slough			
Northwestern Fisheries Co.	4	Chignik	2		2
		Kenai	9		9
		Orca		6	6
		Uyak	1		1
Orca Packing Co.	1	Cordova (floating)			
Pacific American Fisheries	4	Bering River			
		Ikatan	6		6
		King Cove	15		15
		Unakwik Inlet		1	1
Pajoman & Trout	1	Iron Creek	1		1
Pioneer Packing Co.	1	Cordova		3	3
Pioneer Sea Foods Co.	1	do		2	2
Premier Salmon Co.	1	Orca Bay	2	1	3
Robinson Packing Corporation	1	Zachar Bay	2		2
San Juan Fishing & Packing Co.	3	Evans Bay	4	1	5
		Tutka Bay*	3		3
		Uganik Bay	6		6
Shepard Point Packing Co.	1	Shepard Point		4	4
Shumagin Packing Co.	1	Squaw Harbor	4		4
Snug Harbor Packing Co.	1	Snug Harbor	8		8
Sunset Packing Co.	1	Otter Creek*	3		3
J. F. Toman	1	Anchorage*			
Trinity Packing Co.	1	Three Saints Bay*			
George Valaer	1	Nikishka Bay*			
John Wik	1	do	1		1
Jake Young	1	Portlock *			
Western Alaska:					
Alaska Packers Association	9	Egegik River			
		Kvichak Bay (2)			
		Naknek River (3)			
		Nushagak Bay (2)			
		Ugashik River			
Alaska-Portland Packers Association	2	Naknek River			
		Nushagak Bay			
Alaska Salmon Co.	1	Wood River			
Bristol Bay Packing Co.	1	Kvichak Bay			
Columbia River Packers Association	1	Nushagak Bay			
Everett Packing Co.	1	Herendeen Bay			
International Packing Co.	2	Makushin Bay (floating)			
		Ugashik River and Dutch Harbor (floating).*			
Libby, McNeill & Libby	6	Egegik River			
		Ekuk			
		Koggiung			
		Libbyville			
		Lockanok			
		Nushagak			
Nakat Packing Corporation, The	1	Nakeen			
Northwestern Fisheries Co.	2	Naknek River			
		Nushagak			
Pacific American Fisheries	1	Port Moller	2		2
Red Salmon Canning Co.	3	Naknek River (2)			
		Ugashik River			

LOSSES AND DISASTERS

Property losses in the salmon-canning industry in 1928 aggregated $180,425, consisting of boats, buildings, fishing gear, and fishery products. The largest single item was the Alaska Packers Association's sailing ship *Star of Falkland* (1,866 tons), which was wrecked near Akun Head on May 23, the loss of the vessel and cargo amounting to $61,362. The gas boat *Kuiu*, valued at $4,500, and various small boats, equipment, fishing gear, and salmon products, valued at $40,187, were lost in southeast Alaska, in addition to several mess houses and bunk houses having a total value of $23,900, which were destroyed by fire. Central Alaska reported a loss in gear, boats, and small structures of $25,550, the most important items of which were the cannery tenders *Blue Sea*, valued at $6,000, and the *Ikaros*, valued at $4,500. In western Alaska, exclusive of the loss of the ship *Star of Falkland* and cargo, the loss of gear and small boats amounted to $24,926.

Forty lives were lost—13 in southeast Alaska, 8 in central, and 19 in western Alaska. In the southeastern district 1 transporter was drowned and 1 died of disease; 2 shoresmen were drowned, 2 died of disease, and 3 were killed in accidents; 1 fisherman was drowned, 1 died of disease, 1 was killed by accident, and 1 committed suicide. Two fishermen and 3 shoresmen died of disease in the central district; 1 shorseman was drowned and 2 died of accidents. In western Alaska 4 fishermen were drowned and 3 died of disease; 3 shoresmen were drowned, 8 died of disease, and 1 met death by accident.

STATISTICS

In 1928, 153 canneries were operated in Alaska, 18 more than in 1927, the expansion of operations being chiefly in the central district. Employment was given to 24,428 persons, as compared with 22,131 in 1927, an increase of 2,297. White employees increased 660, natives 537, Japanese 139, Filipinos 1,070, Kanakas 22, Porto Ricans 27, and miscellaneous (including Koreans) 7, while Mexicans decreased 92, Chinese 27, and Negroes 46.

The total pack of canned salmon was 6,083,903 cases, valued at $45,383,885. This was an increase of 2,511,775 cases, or 70 per cent, over the 1927 pack, and an increase in value of $15,367,621, or 51 per cent. The output in southeastern Alaska increased from 1,052,193 cases to 2,971,147 cases, or 182 per cent; in central Alaska from 1,571,103 cases to 1,639,155, or 4 per cent; and in western Alaska from 948,832 cases to 1,473,601, or 55 per cent. In Alaska as a whole the pack of cohos increased from 253,044 cases to 298,623 cases, or 18 per cent; chums increased from 507,723 cases to 995,785, or 96 per cent; pinks from 1,420,775 cases to 2,787,242, or 96 per cent; and reds from 1,320,195 cases to 1,948,094 cases, or about 48 per cent. The only decrease was in the pack of kings, of which 54,159 cases were packed, as compared with 70,391 cases in 1927, a decrease of 16,232 cases, or 23 per cent.

Data are included in the following tables to show comparison of the 1928 pack with the average for the five preceding years, 1923 to 1927, by cases of each species and by districts. It is interesting to note that while there was an increased pack of not more than three out of the five species in any one district, the total pack for each district in 1928 showed a net gain over the average for the 5-year period, and the pack of each species for Alaska as a whole likewise showed a net gain.

Persons engaged, wages paid, and operating units of Alaska salmon canning industry, 1928

Item	Southeast Alaska	Central Alaska	Western Alaska	Total
PERSONS ENGAGED				
Fishermen:				
Whites	1,124	1,301	2,076	4,501
Natives	1,638	456	95	2,189
Chinese	1			1
Japanese	3		1	4
Filipinos	16			16
Mexicans	6			6
Kanakas	5			5
Total	2,793	1,757	2,172	6,722
Shoresmen:				
Whites	2,249	1,823	1,899	5,971
Natives	1,422	450	155	2,027
Chinese	354	283	428	1,065
Japanese	614	527	304	1,445
Filipinos	1,775	1,410	731	3,916
Mexicans	59	100	1,110	1,269
Kanakas	35	2	24	61
Porto Ricans	3	10	31	44
Negroes	2	31	162	195
Miscellaneous [1]	6	5	13	24
Total	6,519	4,641	4,857	16,017
Transporters:				
Whites	883	550	134	1,567
Natives	46	36		82
Chinese	8			8
Japanese	8	5		13
Filipinos	6	1		7
Negroes	1		10	11
Miscellaneous [1]	1			1
Total	953	592	144	1,689
Total:				
Whites	4,256	3,674	4,109	12,039
Natives	3,106	942	250	4,298
Chinese	363	283	428	1,074
Japanese	625	532	305	1,462
Filipinos	1,797	1,411	731	3,939
Mexicans	65	100	1,110	1,275
Kanakas	40	2	24	66
Porto Ricans	3	10	31	44
Negroes	3	31	172	206
Miscellaneous [1]	7	5	13	25
Grand total	10,265	6,990	7,173	24,428
Wages paid shoresmen	$2,581,764	$2,075,616	$2,076,288	$6,733,668
Wages paid transporters	$447,301	$357,309	$75,420	$880,030
OPERATING UNITS				
Plants:				
Shore canneries	58	60	28	146
Floating canneries—				
Power vessels	2	1	2	5
Net tonnage	1,745	768	3,124	5,637
Sailing vessel		1		1
Net tonnage		287		287
Barge	1			1
Net tonnage	488			488
Total plants operated	61	62	30	153
Vessels:				
Power, over 5 tons	455	164	97	716
Net tonnage	9,824	7,940	28,975	46,739
Sailing		2	3	5
Net tonnage		3,396	6,818	10,214
Barge	1			1
Net tonnage	225			225
Launches	167	235	30	432
Power dories	22	26	2	50
Gill net boats	89	86	1,053	1,228
Seine skiffs	184	186	17	387

[1] Koreans, Arabians, etc.

Persons engaged, wages paid, and operating units of Alaska salmon canning industry, 1928—Continued

Item	Southeast Alaska	Central Alaska	Western Alaska	Total
OPERATING UNITS—continued				
Vessels—Continued.				
Other rowboats and skiffs	1,053	740	142	1,935
Lighters and scows	308	275	158	741
Houseboats	24	4	35	63
Pile drivers	46	40	22	108
Pile pullers	10	2		12
Rigging scows	28	8		36
Apparatus:				
Purse seines	464	103	10	577
Fathoms	79,684	9,460	2,250	91,394
Beach seines	9	121	5	135
Fathoms	875	15,933	550	17,358
Gill nets	348	1,286	1,493	3,127
Fathoms	22,367	76,795	190,700	289,862
Traps, driven	71	232	2	305
Traps, floating	382	43		425

Output and value of canned salmon in Alaska in 1928 [1]

Product	Southeast Alaska		Central Alaska		Western Alaska		Total	
	Cases	Value	Cases	Value	Cases	Value	Cases	Value
Coho, or silver:								
½-pound flat	9,681	$93,095	3,817	$40,172			13,498	$133,267
1-pound flat	5,840	44,864					5,840	44,864
1-pound tall	130,249	918,275	148,543	1,025,447	493	$3,436	279,285	1,947,158
Total	145,770	1,056,234	152,360	1,065,619	493	3,436	298,623	2,125,289
Chum, or keta:								
½-pound flat	4,963	38,834	94	776			5,057	39,610
1-pound flat	4	20					4	20
1-pound tall	565,252	3,261,527	377,763	2,445,373	47,709	289,936	990,724	5,996,836
Total	570,219	3,300,381	377,857	2,446,149	47,709	289,936	995,785	6,036,466
Pink, or humpback:								
½-pound flat	36,965	312,561	3,508	30,871			40,473	343,432
1-pound flat	6,189	43,051					6,189	43,051
1-pound tall	2,099,684	13,681,839	639,822	4,210,523	1,074	6,685	2,740,580	17,899,047
Total	2,142,838	14,037,451	643,330	4,241,394	1,074	6,685	2,787,242	18,285,530
King, or spring:								
½-pound flat	756	10,636	11,026	177,383			11,782	188,019
1-pound flat	2,465	25,074	11,807	163,026	582	7,756	14,854	195,856
1-pound tall	2,301	17,895	12,203	97,976	13,019	103,062	27,523	218,933
Total	5,522	53,605	35,036	438,385	13,601	110,818	54,159	602,808
Red, or sockeye:								
½-pound flat	26,401	361,576	40,828	592,858	21,834	308,075	89,063	1,262,509
1-pound flat	15,071	168,300	58,661	664,864	13,368	129,986	87,100	963,150
1-pound tall	65,326	606,538	331,083	3,032,788	1,375,522	12,468,807	1,771,931	16,108,133
Total	106,798	1,136,414	430,572	4,290,510	1,410,724	12,906,868	1,948,094	18,333,792
Grand total	2,971,147	19,584,085	1,639,155	12,482,057	1,473,601	13,317,743	6,083,903	45,383,885

[1] Cases containing ½-pound cans have been reduced one-half in number, and thus, for the purpose of affording fair comparison, all are put upon the basis of forty-eight 1-pound cans to the case.

Output of canned salmon in Alaska, in cases, by species, 1923 to 1928 [1]

Product	1923	1924	1925	1926	1927	Average for 5-year period, 1923–1927	1928	Percentage of increase or decrease in 1928, as compared with 5-year average
Coho, or silver:								
½-pound flat	13,866	8,059	7,145	10,354	10,105	9,906	13,498	+36.26
1-pound flat	10,151	5,403	7,223	16,625	15,047	10,890	5,840	−46.37
1-pound tall	140,090	170,139	146,642	175,548	227,892	172,062	279,285	+62.32
Total	164,107	183,601	161,010	202,527	253,044	192,858	298,623	+54.84
Chum, or keta:								
½-pound flat	6,356	346	3,051	1,367	9,414	4,107	5,057	+23.13
1-pound flat	16	630	....	48,982	1,449	10,215	4	−99.96
1-pound tall	519,250	1,027,512	1,075,629	852,094	496,860	794,269	990,724	+24.73
Total	525,622	1,028,488	1,078,680	902,443	507,723	808,591	995,785	+23.15
Pink, or humpback:								
½-pound flat	29,363	21,365	34,005	59,835	50,455	39,005	40,473	+3.76
1-pound flat	9,428	13,095	185	82,161	14,662	23,906	6,189	−74.11
1-pound tall	2,409,338	2,566,823	2,076,403	3,196,353	1,355,658	2,320,915	2,740,580	+18.08
Total	2,448,129	2,601,283	2,110,593	3,338,349	1,420,775	2,383,826	2,787,242	+16.92
King, or spring:								
½-pound flat	5,466	1,501	2,755	3,324	10,528	4,715	11,782	+149.88
1-pound flat	7,281	9,500	8,828	11,125	11,371	9,621	14,854	+54.39
1-pound tall	25,596	22,647	38,395	38,027	48,492	34,631	27,523	−20.52
Total	38,343	33,648	49,978	52,476	70,391	48,967	54,159	+10.60
Red, or sockeye:								
½-pound flat	121,775	31,947	68,901	82,181	88,874	78,736	89,063	+13.12
1-pound flat	159,271	110,352	28,757	104,329	57,771	92,096	87,100	−5.42
1-pound tall	1,578,450	1,305,596	962,018	1,970,577	1,173,550	1,398,038	1,771,931	+26.74
Total	1,859,496	1,447,895	1,059,676	2,157,087	1,320,195	1,568,870	1,948,094	+24.17
Grand total	5,035,697	5,294,915	4,459,937	6,652,882	3,572,128	5,003,112	6,083,903	+21.60

[1] The number of cases shown has been put upon the common basis of forty-eight 1-pound cans per case.

Output of canned salmon in Alaska, in cases, by districts and species, 1923 to 1928[1]

District	1923	1924	1925	1926	1927	Average for 5-year period, 1923–1927	1928	Percentage of increase or decrease in 1928 as compared with 5-year average
Southeast Alaska:								
Coho, or silver	130, 351	109, 989	91, 352	96, 389	114, 970	108, 610	145, 770	+34. 21
Chum, or keta	433, 376	799, 557	847, 913	618, 397	224, 433	584, 735	570, 219	−2. 48
Pink, or humpback	2, 252, 019	1, 677, 454	1, 707, 456	2, 158, 699	588, 291	1, 676, 784	2, 142, 838	+27. 79
King, or spring	13, 048	8, 282	12, 005	10, 679	8, 031	10, 409	5, 522	−46. 95
Red, or sockeye	178, 325	192, 507	143, 688	173, 891	116, 468	160, 976	106, 798	−33. 66
Total	3, 007, 119	2, 787, 789	2, 802, 414	3, 058, 055	1, 052, 193	2, 541, 514	2, 971, 147	+16. 90
Central Alaska:								
Coho, or silver	32, 931	69, 180	68, 289	104, 309	138, 034	82, 549	152, 360	+84. 57
Chum, or keta	72, 564	192, 934	200, 274	243, 808	253, 197	192, 555	377, 857	+96. 23
Pink, or humpback	196, 110	892, 413	402, 992	1, 144, 180	817, 538	690, 647	643, 330	−6. 85
King, or spring	10, 703	10, 531	19, 300	23, 683	43, 470	21, 537	35, 036	+62. 68
Red, or sockeye	431, 332	440, 049	361, 738	630, 505	318, 864	436, 498	430, 572	−1. 36
Total	743, 640	1, 605, 107	1, 052, 593	2, 146, 485	1, 571, 103	1, 423, 786	1, 639, 155	+15. 13
Western Alaska:								
Coho, or silver	825	4, 432	1, 369	1, 829	40	1, 699	493	−70. 98
Chum, or keta	19, 682	35, 997	30, 493	40, 238	30, 093	31, 301	47, 709	+52. 42
Pink, or humpback		31, 416	145	35, 470	14, 946	16, 395	1, 074	−93. 45
King, or spring	14, 592	14, 835	18, 673	18, 114	18, 890	17, 021	13, 601	−20. 09
Red, or sockeye	1, 249, 839	815, 339	554, 250	1, 352, 691	884, 863	971, 396	1, 410, 724	+45. 23
Total	1, 284, 938	902, 019	604, 930	1, 448, 342	948, 832	1, 037, 812	1, 473, 601	+41. 99
Grand total	5, 035, 697	5, 294, 915	4, 459, 937	6, 652, 882	3, 572, 128	5, 003, 112	6, 083, 903	+21. 60

[1] The number of cases shown has been put upon the common basis of forty-eight 1-pound cans per case.

Relative importance of each species of canned salmon within each district in 1928

District	Coho	Chum	Pink	King	Red	Total, all species
	Per cent	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*
Southeast Alaska	4. 9	19. 2	72. 1	0. 2	3. 6	100
Central Alaska	9. 3	23. 1	39. 2	2. 1	26. 3	100
Western Alaska	. 0	3. 3	. 1	. 9	95. 7	100
All Alaska	4. 9	16. 4	45. 8	. 9	32. 0	100

Relative importance of each district in the production of each species of salmon canned in 1928

District	Coho	Chum	Pink	King	Red	Total, all species
	Per cent	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*
Southeast Alaska	48. 8	57. 3	76. 9	10. 2	5. 5	48. 8
Central Alaska	51. 0	37. 9	23. 1	64. 7	22. 1	27. 0
Western Alaska	. 2	4. 8	. 0	25. 1	72. 4	24. 2
Total	100. 0	100. 0	100. 0	100. 0	100. 0	100. 0

Average annual price per case of forty-eight 1-pound cans of salmon, 1918 to 1928

Product	1918	1919	1920	1921	1922	1923	1924	1925	1926	1927	1928
Coho, or silver	$9.15	$11.27	$9.13	$5.63	$5.47	$5.74	$6.83	$9.72	$8.40	$8.51	$7.12
Chum, or keta	6.27	6.82	4.19	3.68	3.98	4.65	4.68	4.44	5.01	5.47	6.06
Pink, or humpback	6.58	8.35	5.47	4.21	4.34	4.86	4.93	5.28	5.39	5.87	6.56
King, or spring	9.85	13.13	10.97	10.22	8.08	8.56	8.89	11.91	10.37	11.25	11.13
Red, or sockeye	9.44	12.98	13.05	8.96	9.24	9.27	9.53	13.12	9.89	12.08	9.41

PACK IN CERTAIN DISTRICTS

Statistics of the salmon pack are again presented for subdivisions of the three main districts of Alaska, and comparison is made with similar statistics for 1927. These districts are described as follows:

Bristol Bay.—The Bering Sea shore, east and north of the Ugashik River.

Port Moller and Herendeen Bay.—Port Moller, Herendeen Bay, and Nelson Lagoon.

Ikatan-Shumagin Islands.—False Pass, Ikatan Bay, King Cove, and the Shumagin Islands.

Chignik.—Canneries located at Chignik.

Kodiak-Afognak Islands.—Kodiak, Spruce, and Raspberry Islands.

Cook Inlet.—The shores of Cook Inlet.

Prince William Sound.—Extends from Resurrection Bay to Point Whitshed, except that the pack of fish taken in the Copper River district by canneries at and near Cordova is omitted.

Copper and Bering Rivers.—Extends from Point Whitshed to Bering River and includes the pack by canneries at Cordova from fish not credited to Prince William Sound.

Yakutat and Dry Bay.—Extends from Yakutat Bay to and including Dry Bay.

Icy Strait-Lynn Canal.—West coast of Baranof and Chichagof Islands, the shores of Cross Sound, Icy Strait, Lynn Canal, and Stephens Passage, south to Taku Harbor. Only part of the pack at Taku Harbor is credited to this district, as some of it originated elsewhere.

Chatham Strait-Frederick Sound.—Includes part of the Taku cannery pack and the Petersburg Packing Co.'s pack, in addition to the packs of all canneries on both shores of Chatham Strait and its bays from Point Augusta to Cape Ommaney, and through Frederick Sound and its bays northward to Taku Harbor, including Kake.

Sumner Strait-Dixon Entrance.—Extends southward from Petersburg and eastward from Port Beauclerc to Cape Chacon and Dixon Entrance, and includes all canneries on the mainland and intervening islands from the Stikine River to Portland Canal.

West coast, Prince of Wales Island.—Territory west and south of a line from Cape Chacon to Point Baker and Cape Ommaney. A part of the Petersburg Packing Co.'s pack is credited to this district.

Pack of canned salmon in Alaska in 1928, by districts [1]

District	Coho	Chum	Pink	King	Red	Total	Percentage of increase or decrease from 1927
	Cases	*Cases*	*Cases*	*Cases*	*Cases*	*Cases*	
Bristol Bay	484	38, 503	339	12, 467	1, 341, 208	1, 393, 001	+53. 65
Port Moller and Herendeen Bay		8, 239		1, 134	67, 636	77, 009	+193. 91
Ikatan-Shumagin Islands	9, 378	238, 298	50, 643	1, 902	76, 800	377, 021	+29. 43
Chignik	7, 091	12, 086	2, 578	98	76, 750	98, 603	+22. 44
Kodiak-Afognak Islands	28, 218	71, 645	86, 302	627	125, 850	312, 642	−29. 85
Cook Inlet	50, 729	9, 969	31, 931	17, 213	92, 724	202, 566	+9. 87
Prince William Sound	21, 150	46, 826	472, 611	1, 148	15, 262	556, 997	+11. 23
Copper and Bering Rivers	35, 803			14, 048	45, 067	94, 918	+12. 53
Yakutat and Dry Bay	23, 712	362	16, 327	2, 465	16, 589	59, 455	−8. 86
Icy Strait-Lynn Canal	39, 177	102, 807	500, 911	896	41, 222	685, 013	+85. 88
Chatham Strait-Frederick Sound	21, 631	135, 598	551, 699	72	13, 088	722, 088	+192. 83
Sumner Strait-Dixon Entrance	44, 470	230, 837	885, 217	1, 707	31, 340	1, 193, 571	+299. 45
West coast, Prince of Wales Island	16, 780	100, 615	188, 684	382	4, 558	311, 019	+325. 87
Total	298, 623	995, 785	2, 787, 242	54, 159	1, 948, 094	6, 083, 903	+70. 32

[1] Pack reduced to the basis of forty-eight 1-pound cans per case.

FIGURE 9.—Sorting and weighing troll-caught salmon, Southeast Alaska

MILD CURING

While there was an increase in the number of plants operated and persons engaged in the salmon mild-curing industry in 1928, production showed a sharp decline from the record output of the preceding year. A scarcity of king salmon during the early part of the season, followed by a trollers' strike at the time of the best run, made the pack of kings very short. Brisk market demands stimulated operations during the closing weeks of the season, and the production of mild-cured cohos lessened the shortage to some extent. Although the pack was considerably below that of 1927, it was on about the same level as in other recent years. Employment was given to 1,970 persons (1,584 whites and 386 natives), or 201 more than the number employed in 1927.

Property losses in the industry amounted to $8,100, the chief item of which was the gas boat *Pelican*, valued at $6,000. One shoresman died of disease.

The total output of mild-cured salmon was 4,680,000 pounds, valued at $1,101,871, a decrease of 2,363,200 pounds in quantity and $468,970 in value. The pack consisted of 1,320,000 pounds of cohos, 5,600 pounds of chums, and 3,354,400 pounds of kings. In units of 800-pound tierces, the pack consisted of 1,650 tierces of cohos, 7 tierces of chums, and 4,193 tierces of kings.

Persons engaged, wages paid, and operating units, Alaska salmon mild-curing industry, 1928

Item	Southeast Alaska	Central Alaska	Total
PERSONS ENGAGED			
Fishermen:			
Whites	1,456	2	1,458
Natives	352	1	353
Total	1,808	3	1,811
Shoresmen:			
Whites	107	3	110
Natives	20	8	28
Total	127	11	138
Transporters:			
Whites	16		16
Natives	5		5
Total	21		21
Grand total	1,956	14	1,970
Wages paid shoresmen	$85,367	$2,009	$87,376
Wages paid transporters	$16,787		$16,787
OPERATING UNITS			
Plants:			
Shore	10	2	12
Floating—			
Power vessels	2		2
Net tonnage	48		48
Barges	3		3
Net tonnage	632		632
Scows	2	1	3
Total plants operated	17	3	20
Vessels:			
Power, over 5 tons	21	1	22
Net tonnage	337	14	351
Launches	956	1	957
Power dory	1		1
Rowboats and skiffs	328		328
Lighters and scows	5		5
Houseboat	1		1
Apparatus:			
Gill nets	3	3	6
Fathoms	300	250	550
Lines	7,800	6	7,806

Products of Alaska salmon mild-curing industry in 1928

Products	Southeast Alaska		Central Alaska		Total	
	Pounds	Value	Pounds	Value	Pounds	Value
Coho, or silver	[1] 1,103,200	$158,495	[2] 216,800	$26,562	[3] 1,320,000	$185,057
Chum, or keta	5,600	350			[4] 5,600	350
King, or spring	[5] 3,294,400	904,902	[6] 60,000	11,562	[7] 3,354,400	916,464
Total	4,403,200	1,063,747	276,800	38,124	4,680,000	1,101,871

[1] 1,379 tierces.
[2] 271 tierces.
[3] 1,650 tierces.
[4] 7 tierces.
[5] 4,118 tierces.
[6] 75 tierces.
[7] 4,193 tierces.

PICKLING

There was little expansion over the preceding year in the production of pickled salmon in Alaska, the tendency being to utilize as much of the catch as possible in canning. In western Alaska, where the heavy runs of red salmon contributed to the success of operations, the output increased considerably, but in the central and southeastern districts it showed a sharp decline.

The number of persons reported engaged in the industry was 140, or 32 more than in 1927. Eight plants were operated, the same number as in the previous season, of which 4 were in central and 4 in western Alaska. Products in southeastern Alaska decreased from 33,000 pounds in 1927 to 27,800 pounds in 1928, and in central Alaska from 193,400 pounds to 92,600 pounds. In western Alaska the production increased from 540,000 pounds in 1927 to 736,700 pounds in 1928. The total output in 1928 was 857,100 pounds, valued at $108,637, as compared with 766,400 pounds in 1927, valued at $92,712, an increase of approximately 12 per cent in quantity and 17 per cent in value.

Persons engaged, wages paid, and operating units, Alaska salmon-pickling industry, 1928

Item	Central Alaska	Western Alaska	Total
PERSONS ENGAGED			
Fishermen:			
Whites	10	32	42
Natives	9	43	52
Total	19	75	49
Shoresmen:			
Whites		13	13
Natives		33	33
Total		46	46
Grand total	19	121	140
Wages paid shoresmen		$8,302	$8,302
OPERATING UNITS			
Plants (shore)	4	4	8
Vessels:			
Power, over 5 tons		1	1
Net tonnage		40	40
Launches	2	2	4
Power dories	1	1	2
Gill-net boats		18	18
Seine skiffs	5		5
Rowboats	4	8	12
Scow		1	1
Apparatus:			
Beach seines	6		6
Fathoms	530		530
Gill nets	1	79	80
Fathoms	20	6,175	6,195

Products of Alaska salmon-pickling industry in 1928

Species	Southeast Alaska		Central Alaska		Western Alaska		Total	
	Pounds	Value	Pounds	Value	Pounds	Value	Pounds	Value
Coho, or silver	21, 200	$2, 092	38, 400	$3, 403	9, 800	$735	69, 400	$6, 230
Chum, or keta					15, 300	1, 458	15, 300	1, 458
Pink, or humpback	5, 000	258	200	15	3, 400	229	8, 600	502
King, or spring	200	40	300	43	29, 200	4, 091	29, 700	4, 174
Red, or sockeye	1, 400	195	53, 700	2, 466	679, 000	93, 612	734, 100	96, 273
Total	27, 800	2, 585	92, 600	5, 927	736, 700	100, 125	857, 100	108, 637

FRESH SALMON

Operations in the fresh-salmon business in 1928 were carried on only in southeastern Alaska and were incidental to other branches of the fishery industry. The total production was 1,646,581 pounds of all species, valued at $146,146, a decrease of 25.7 per cent in quantity and 31.7 per cent in value from 1927, when fresh-salmon products amounted to 2,217,335 pounds, valued at $213,995.

Products of the Alaska fresh-salmon industry in 1928

Species	Pounds	Value
Coho, or silver	777, 074	$59, 845
Chum, or keta	41, 871	1, 280
Pink, or humpback	9, 187	258
King, or spring	815, 491	84, 622
Red, or sockeye	2, 958	141
Total	1, 646, 581	146, 146

FREEZING

The freezing of salmon in Alaska, which is largely incidental to other lines of the fishery industry, was on a much larger scale in 1928 than ever before. Three concerns in southeastern Alaska whose chief product was frozen salmon gave employment to 37 white shoresmen. There was an increased production of every species except kings, while the output of cohos alone exceeded the total quantity frozen in 1927. The total output in 1928 was 6,152,743 pounds, valued at $555,308, an increase of approximately 93 per cent in quantity and 80 per cent in value over the preceding year, when 3,194,034 pounds, valued at $308,393, were prepared.

Products of the Alaska frozen-salmon industry in 1928

Species	Southeast Alaska		Central Alaska		Western Alaska		Total	
	Pounds	Value	Pounds	Value	Pounds	Value	Pounds	Value
Coho, or silver	3, 845, 428	$323, 867	4, 130	$305	4, 000	$295	3, 853, 558	$324, 467
Chum, or keta	808, 787	36, 923					808, 787	36, 923
Pink, or humpback	155, 571	24, 250	16, 749	600			172, 320	24, 850
King, or spring	1, 311, 738	168, 445			1, 800	250	1, 313, 538	168, 695
Red, or sockeye	4, 540	373					4, 540	373
Total	6, 126, 064	553, 858	20, 879	905	5, 800	545	6, 152, 743	555, 308

DRY-SALTED, DRIED, SMOKED, AND OTHER MISCELLANEOUS SALMON PRODUCTS

Two companies prepared dry-salted salmon in southeastern and one in central Alaska in 1928, such production being subordinate to other fishery operations. In the fishery of the Yukon and Kuskokwim Rivers, which is carried on principally by natives, 1,496,000 pounds of salmon were dried, valued at $119,730; and, in addition, 1,400 pounds of kippered kings, valued at $230, and 2,880 pounds of beleke from kings, valued at $822, were prepared. In this western district 23 whites and 617 natives were engaged, and the apparatus used consisted of 234 wheels, 418 gill nets of 5,411 fathoms, 24 rowboats and skiffs, 4 gill-net boats, 2 power dories, and 1 launch.

A new development in the Alaska salmon industry in 1928 was the experimental production of sliced smoked salmon packed in olive

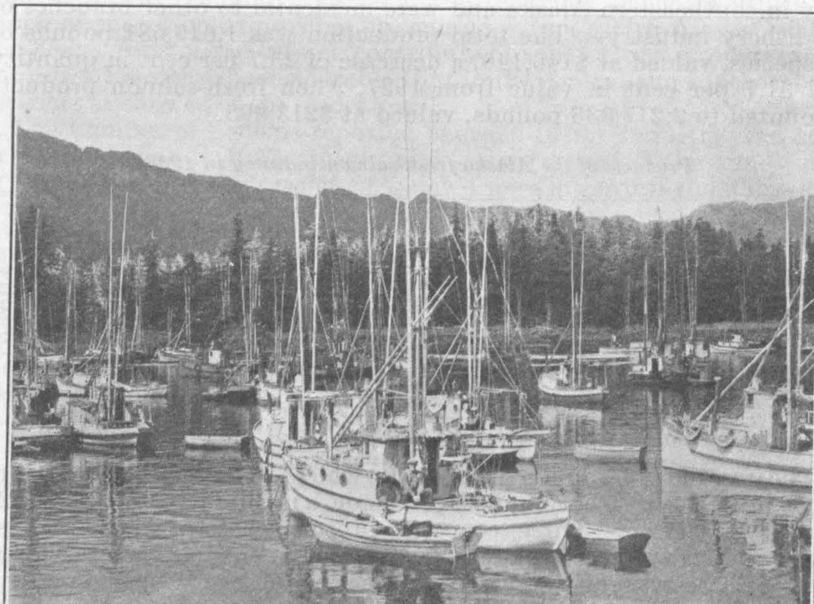


FIGURE 10.—Salmon trolling boats at Port Alexander, Southeast Alaska

oil, which was undertaken by a firm in the herring saltery business in the southeastern district. The quantity thus prepared consisted of 400 cases of cohos put up in ¼-pound flat tins (100 to the case), valued at $7,200.

In the central district one of the salmon canneries produced 17 cases of fish pudding from chum salmon, packed in 1-pound flat tins, valued at $85.

Some further commercial utilization was made of salmon eggs for caviar, such operations being carried on at two salmon canneries in southeastern Alaska and one in the central district. The total output consisted of 54,180 pounds of eggs valued at $1,356.

Production of dry-salted, dried, smoked, and other miscellaneous salmon products in Alaska in 1928

Product	Southeast Alaska		Central Alaska		Western Alaska		Total	
	Pounds	Value	Pounds	Value	Pounds	Value	Pounds	Value
Dry-salted:								
Coho, or silver	4,000	$370	4,000	$220			8,000	$590
Red, or sockeye	13,800	1,310					13,800	1,310
Total	17,800	1,680	4,000	220			21,800	1,900
Dried:								
Chum, or keta			340	34	1,492,000	$119,410	1,492,340	119,444
Pink, or humpback			300	15			300	15
Red, or sockeye					4,000	320	4,000	320
Total			640	49	1,496,000	119,730	1,496,640	119,779
Kippered:								
Pink, or humpback			150	15			150	15
King, or spring					1,400	230	1,400	230
Total			150	15	1,400	230	1,550	245
Beleke: King, or spring					2,880	822	2,880	822
Smoked and packed in olive oil: Coho, or silver	10,000	7,200					10,000	7,200
Pudding: Chum, or keta			816	85			816	85
Salmon eggs:								
Chum, or keta	45,580	1,084					45,580	1,084
King, or spring	5,000	200	3,600	72			8,600	272
Total	50,580	1,284	3,600	72			54,180	1,356
Grand total	78,380	10,164	9,206	441	1,500,280	120,782	1,587,866	131,387

BY-PRODUCTS

The same number of plants engaged in the manufacture of salmon by-products as in the preceding year, two companies in southeastern Alaska giving employment to 18 white shoresmen and 3 white transporters. Operations incidental to other branches of the fishery industry were carried on at a herring-reduction plant in the southeastern district and at four salmon canneries in central Alaska. The total production was 1,421,644 pounds of fertilizer, valued at $44,109, and 42,390 gallons of oil, valued at $16,420, as compared with 932,834 pounds of fertilizer, valued at $26,935, and 32,374 gallons of oil, valued at $13,650, in 1927, or an increase of approximately 52 per cent in amount of fertilizer and 31 per cent in quantity of oil.

Production of salmon oil and fertilizer in Alaska in 1928

District	Oil		Fertilizer	
	Gallons	Value	Pounds	Value
Southeast Alaska	26,900	$9,760	1,054,000	$32,597
Central Alaska	15,490	6,660	367,644	11,512
Total	42,390	16,420	1,421,644	44,109

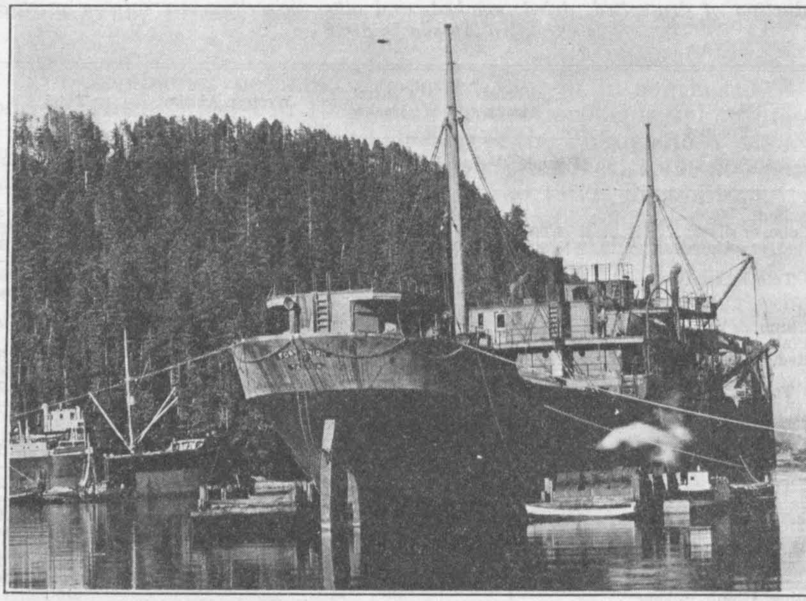


FIGURE 11.—Floating fish-reduction plant, Port Armstrong, Alaska

FIGURE 12.—Herring purse-seine boats returning to plant at Big Port Walter, Southeast Alaska

HERRING

An outstanding feature of the herring industry in Alaska in 1928 was the development of operations in the eastern part of the Aleutian Islands region, Dutch Harbor for the first time becoming an important producing center. A tremendous run of herring occurred there in August, and a number of operators who had previously confined their activities to the central district, where they had little success this season, rushed their outfits to the westward to take advantage of the abundance of fish. Although the run in that district was over by the end of August, the quantities of herring held in pounds permitted packing to continue for several weeks thereafter.

In central Alaska the producton of Scotch-cured herring was the smallest in many years, the shortage occuring throughout the district, although Prince William Sound showed the greatest decrease from the preceding season. It was reported that herring were very numerous in many bays of the Kodiak-Afognak district, but they were too small to be utilized for curing or for bait. A very good run appeared on the south side of Kodiak Island about the first of October. In the Cook Inlet district the only catches of any appreciable size were made the latter part of October, when a good run entered Port Graham and Halibut Cove.

In the southeastern district the run of herring was irregular, and at times stormy weather interferred with operations, but the total output was larger than in the preceding year. An unusually good run occurred in Lynn Canal. At Ketchikan there was a temporary shortage of bait herring early in March, and shipments were brought in from Tee Harbor and from British Columbia, the latter under special arrangement with government authorities.

Two floating plants used in the preceding year were withdrawn from the industry—the S. S. *Lake Miraflores* was not returned to Alaska, and the schooner *Esther*, owned by Ottar Hofstad, was converted into a floating salmon cannery. A refrigeration plant was installed on the floating herring saltery *Donna Lane*, belonging to the Utopian Fisheries, chiefly for the purpose of supplying frozen herring for bait to halibut vessels. Some frozen halibut and salmon also were prepared. The vessel was operated at Prince William Sound, Cook Inlet, and Dutch Harbor, the principal saltery operations being at the last place. Other floating plants engaged mainly in the western district were the *Alice Cooke*, of the Aurora Fish Co., and the *La Merced*, of the Nassau Fish Co. The schooners *Rosamond*, of the North American Fisheries, and *Salvator*, belonging to Libby, McNeill & Libby, were operated in Cook Inlet; and the barges *Peralta* and *Fort Union*, operated by the Ocean Industries (Inc.) and the Puget Sound Reduction Co., respectively, were again employed in southeastern Alaska. Several small floating plants were also in use in various localities.

In southeastern Alaska, where the production of oil and meal is chiefly centered, only two operators did not pack Scotch-cured herring in connection with the manufacture of by-products. Of these, the Killisnoo Fisheries (Inc.) had contracted with Henry Klapisch for the handling of that portion of their catch suitable for curing, thus leaving but one plant engaged exclusively in reduction operations.

The output of Scotch-cured herring in southeastern Alaska in 1928 was 4,420,100 pounds, as compared with 3,353,000 pounds in 1927; and the production of by-products increased from 13,883,590 pounds of meal and 1,948,145 gallons of oil in 1927 to 18,425,424 pounds of meal and 2,303,374 gallons of oil in 1928.

Of the Scotch-cured herring prepared in central Alaska, 2,804,620 pounds were from Cook Inlet, 1,166,125 pounds from the Kodiak-Afognak district, and 911,925 pounds from Prince William Sound. This was a marked decrease in all localities from the output in 1927, when Cook Inlet produced 4,320,390 pounds, the Kodiak-Afognak district 3,245,500 pounds, and Prince William Sound 3,484,500 pounds.

The pack of more than 6,500,000 pounds of Scotch-cured herring in Dutch Harbor served to offset the shortage in central Alaska and, with the increased production in the southeastern district, brought the total output to somewhat more than that of the preceding year. There was a decline in value, however, resulting partly from the effects of large imports of Scottish herring.

In southeastern Alaska 30 establishments handled herring. Among the larger operators were the following:

Reduction plant: Puget Sound Reduction Co. (floating plant)	Port Armstrong.
Saltery: Ness Fish Co. (floating plant)	Petersburg and Washington Bay.
Saltery and reduction plants:	
Arentsen & Co	Big Port Walter.
Atlas Packing Corporation	Deep Cove.
Baranof Packing Co	Red Bluff Bay.
Buchan & Heinen Packing Co	Port Armstrong.
Chatham Strait Fish Co	New Port Walter.
Fidalgo Island Packing Co	Bay of Pillars.
Killisnoo Fisheries (Inc.)	Killisnoo.
Marine Packing & Reduction Co	Washington Bay.
Northwestern Herring Co	Port Conclusion.
Ocean Industries (Inc.) (floating plant)	Port Armstrong.
Pacific Herring Co	Hood Bay.
Port Walter Herring & Packing Co	Saginaw Bay.
Storfold & Grondahl Packing Co	Washington Bay.
United States-Alaska Packing Co	Port Herbert and Warm Springs Bay.

Six cold-storage plants froze herring for bait and three outfits were engaged solely in the production of herring for bait.

In central Alaska operations were carried on mainly in three localities namely, Prince William Sound, with 11 operators; Cook Inlet, with 34 operators; and the Kodiak-Afognak district, with 7 operators. In the Prince William Sound district the following companies operated:

Salteries:	
Aurora Fish Co	Floating plant.
Crescent Herring Co	Do.
Enterprise Packing Co	Sawmill Bay
Johnson & Peterson Packing Co	Floating plant.
Latouche Packing Co	Latouche.
Nassau Fish Co	Floating plant.
Utopian Fisheries (Inc.)	Do.
Saltery and reduction plants:	
Everett Pacific Fisheries	Thumb Bay.
Franklin Packing Co	Evans Bay.
San Juan Fishing & Packing Co	Do.
S. Sklaroff & Sons	Crab Bay.

The more important operators in Cook Inlet were the following, all of whom prepared Scotch-cured herring:

E. Akeson Co	Halibut Cove.
David Buvick	Do.
Crescent Herring Co	Floating plant.
Drier Bay Packing Co	Halibut Cove.
Enterprise Packing Co	Do.
S. Feinson	Seldovia.
Fidalgo Island Packing Co	Port Graham.
Jack Gjoen	Halibut Cove.
Hanson & Strand	Do.
Ted Iverson	Do.
Bert Jacobsen	Do.
Ed Jacobsen	Do.
Johnson & Peterson	Floating plant.
B. Knutsen & Co	Halibut Cove.
Kodiak Herring Co	Floating plant.
John Loken	Halibut Cove.
Tony Martin	Do.
Nassau Fish Co	Floating plant.
North American Fisheries	Do.
North Coast Packing Co	Halibut Cove.
Ray Olsen & Co	Do.
E. Sandvik	Do.
Chas. H. Sharp	Do.
Shuyak Packing Co	Do.
E. Sivertson	Do.
S. Sklaroff & Sons	Seldovia.
H. Sunsby & Co	Halibut Cove.
Utopian Fisheries (Inc.)	Floating plant.

The chief operators in the Kodiak-Afognak district were the following, all of whom prepared Scotch-cured herring:

Caw Packing Co	Iron Creek and Three Saints Bay.
Kadiak Fisheries Co	Shearwater Bay.
Nassau Fish Co	Floating plant.
S. Sklaroff & Sons	Shearwater Bay.

Of the following operators in the western district, all but two were engaged in the fishery at Dutch Harbor, and all produced pickled herring, chiefly Scotch-cured:

Edward Anderson	Golovin Bay.
Aurora Fish Co	Floating plant.
John Bow	Unalaska.
Crescent Herring Co	Floating plant.
Enterprise Packing Co	Unalaska.
Franklin Packing Co	Do.
Golovin Bay Packing Co	Golovin Bay.
Johnson & Peterson	Floating plant.
Nassau Fish Co	Do.
S. Sklaroff & Sons	Unalaska.
Utopian Fisheries (Inc.)	Floating plant.
Fritz Waage	Unalaska.

Property losses in the herring industry in 1928 totaled $47,942. In southeastern Alaska 182 tons of meal, valued at $12,275, were destroyed by fire; loss of seines and other fishing gear amounted to $18,168; and damage to the plant of the Killisnoo Fisheries (Inc.) by fire amounted to $2,799. Two gas boats operated in the central district were lost—the *Maryland*, valued at $5,000, was driven ashore by a heavy gale and wrecked on Ocean Cape near Yakutat Bay, and the *Northern King*, valued at $3,000, was destroyed by fire. Other losses in the central district consisted of seines, gill nets, and supplies valued at $5,100. In western Alaska one scow, valued at $800, and

40 barrels of herring, valued at $800, were lost. Two fishermen in central Alaska were killed in accidents, and one in southeastern Alaska died of disease.

George A. Rounsefell continued the investigation of the Alaska herring, which has been in progress since 1925, and spent a number of weeks studying conditions in the principal herring districts of central Alaska and at Unalaska. A report of his investigations is being prepared and will be published as a separate document.

STATISTICAL SUMMARY

The herring industry in Alaska employed 1,992 persons in 1928, as compared with 2,110 in 1927, and the number of plants in operation decreased from 68 to 65. Products were valued at $3,098,457 in 1928, as compared with $2,850,823 in the preceding year, an increase of $247,634, or about 9 per cent. Scotch-cured herring increased from 14,542,390 pounds in 1927 to 16,056,595 pounds, a gain of about 10 per cent, although the value of the 1928 product was only $1,296,443, as against $1,449,527 for the smaller output of the preceding year. Herring for bait decreased from 8,041,905 pounds in 1927 to 6,553,226 pounds in 1928, which amount does not include 2,303,235 pounds frozen at Ketchikan from shipments of fresh herring imported from British Columbia. Meal increased 38 per cent in quantity and 50 per cent in value and oil increased 25 per cent in quantity and about 18 per cent in value from the production in 1927.

Persons engaged, wages paid, and operating units of Alaska herring industry, 1928

Item	Southeast Alaska	Central Alaska	Western Alaska	Total
PERSONS ENGAGED				
Fishermen:				
Whites	446	206	74	726
Natives	11	25	48	84
Japanese	1			1
Total	458	231	122	811
Shoresmen:				
Whites	595	272	217	1,084
Natives	17	27	12	56
Japanese	1			1
Total	613	299	229	1,141
Transporters:				
Whites	12	7	20	39
Native			1	1
Total	12	7	21	40
Grand total	1,083	537	372	1,992
Wages paid shoresmen	$329,019	$101,929	$95,330	$526,278
Wages paid transporters	8,936	2,800	13,749	25,485
Plants:				
Shore	15	31	6	52
Floating—				
Power vessels		2	2	4
Net tonnage		43	3,535	3,578
Sailing vessels		2	1	3
Net tonnage		1,370	774	2,144
Barges	2			2
Net tonnage	10,800			10,800
Scows	1	2	1	4
Total plants operated	18	37	10	65

Persons engaged, wages paid, and operating units of Alaska herring industry, 1928—Continued

Item	Southeast Alaska	Central Alaska	Western Alaska	Total
OPERATING UNITS				
Vessels:				
Power, over 5 tons	80	38	17	135
Net tonnage	2,345	779	359	3,483
Launches	6	12	1	19
Power dories		8		8
Gill net boats	3	9	9	21
Seine skiffs	43	21	12	76
Other rowboats and skiffs	30	24	10	64
Lighters and scows	7	6	2	15
Pile drivers	3	1		4
Apparatus:				
Purse seines	70	26	11	107
Fathoms	12,745	4,205	1,807	18,757
Beach seines		1	3	4
Fathoms		40	180	220
Gill nets	7	145	94	246
Fathoms	440	5,407	2,550	8,397
Pound seines	11	13	3	27
Pounds	2	15	20	37

Products of Alaska herring industry in 1928

Item	Southeast Alaska		Central Alaska		Western Alaska		Total	
	Pounds	Value	Pounds	Value	Pounds	Value	Pounds	Value
Fresh, for bait	2,640,325	$27,428					2,640,325	$27,428
Frozen, for bait	3,572,901	32,678	340,000	$3,400			3,912,901	36,078
Fresh, for food	518,000	7,770					518,000	7,770
Frozen, for food					24,000	$480	24,000	480
Pickled, for food:								
Scotch cure	4,420,100	342,255	4,912,170	396,592	6,724,325	557,596	16,056,595	1,296,443
Norwegian cure	262,400	24,171	55,950	3,070	27,500	2,400	345,850	29,641
Roused, for food					87,100	4,773	87,100	4,773
Kippered	104,368	10,437					104,368	10,437
Spiced	2,600	520					2,600	520
Dry-salted			215,750	9,732			215,750	9,732
Bloaters			59,000	2,120			59,000	2,120
Meal	18,425,424	608,903	1,578,740	48,577			20,004,164	657,480
Oil	[1] 17,275,305	920,703	[2] 1,801,695	94,852			[3] 19,077,000	1,015,555
Total	47,221,423	1,974,865	8,963,305	558,343	6,862,925	565,249	63,047,653	3,098,457

[1] 2,303,374 gallons. [2] 240,226 gallons. [3] 2,543,600 gallons.

HALIBUT

The first official report of investigations of the halibut fishery conducted by the International Fisheries Commission under the direction of Will F. Thompson during the last few years was submitted to the United States and Canadian Governments in May, 1928, with recommendations for further conservation measures. The chief features of the proposed additional restrictions are a specified percentage reduction in catch in certain areas until the fishery therein shall reach a state of stability of yield, the establishment of closed areas in which all commercial fishing shall be prohibited, limitations on fishing gear, lengthening the closed season, and the licensing of vessels fishing for halibut in treaty waters.

The investigations indicate that the fishery is in a very serious condition and the banks can not stand the intensity of fishing to which they are subjected. While the three months' closed season, from November 16 to February 15, which first became effective in the fall of 1924 under the North Pacific halibut treaty, has been beneficial from an economic standpoint, inasmuch as operations carried on during the winter months are particularly hazardous and expensive on account of stormy weather, it has resulted in little protection to the halibut. Fish protected during that period have merely been caught in greater numbers during the open season, and the closure, therefore, can not be regarded as adequate for the rehabilitation of the banks.

Further investigations were carried on by the commission in 1928, the field work consisting primarily of the collection of eggs and larvæ and the study of ocean currents, temperature, and salinity at various depths. A trip was made in January on the chartered schooner *Dorothy*, which visited halibut banks in the vicinity of Yakutat, Kodiak Island, and intermediate waters. The vessel was chartered again in the fall for further studies along this line and sailed from Seattle about the end of October, returning in December from the Gulf of Alaska. Heavy storms limited operations, and several days were spent in a search for two lost halibut vessels, but considerable material of value was obtained.

The loss of the schooners *Imperial* and *Brunvoll* with all persons on board during a terrific gale in the Gulf of Alaska at the close of the fishing season was the worst disaster that has occurred in the halibut industry in recent years. Other losses during the year were the *Alaska*, which was wrecked on February 23 near Port Hobron on Kodiak Island, and the *Mildred II*, which was burned on April 30 off Prince of Wales Island. The *McKinley* struck a rock and sank near Spanish Island off Cape Ommaney about the 1st of March, but was raised and towed to Ketchikan and repaired by midsummer. Fifteen lives were lost—12 on the two schooners mentioned above, 2 others by drowning, and 1 as a result of poisoning from a fishhook.

A decline in production and low price levels marked the 1928 season in the halibut fishery. These conditions were due in some measure to the large stock of frozen halibut carried over from the preceding year. There was a strengthening of the market toward the latter part of the season, but intermittent storms hampered fishing operations. Unsatisfactory market conditions no doubt were a deterrent to any extensive operations in the regions to the westward; some prospecting west of Kodiak Island was done in the first half of the season, but the catches as a rule were disappointing and in view of the high cost of voyages to those distant banks there was no inducement to continue the effort.

Bait supplies in Alaska generally were ample throughout the season. Large stocks of frozen bait were put up by the Juneau Cold Storage Co. and at cold-storage plants in Ketchikan, the latter importing approximately 2,500,000 pounds of herring from British Columbia early in the spring, as the winter catch in the vicinity of Ketchikan was small. Some frozen bait was available also in central Alaska from the motorship *Donna Lane*, of the Utopian Fisheries, which had been fitted up as a floating freezer early in the year and was operated during part of the season in Prince William Sound.

STATISTICAL SUMMARY

There were 1,241 persons engaged in the halibut industry in 1928, a decrease of 124 from the number reported for the preceding year, and the products totaled 31,567,000 pounds, valued at $3,094,000. This output represents the total fares of the Alaska halibut fleet, which comprises all American vessels landing more than one-half of their catch in Alaska or British Columbia ports rather than in the States. Landings of halibut in Alaska totaled 9,805,000 pounds, valued at $757,000, which include 70,000 pounds valued at $4,000 landed by four Canadian vessels. In 1927 the landings of the Alaska fleet were 34,491,283 pounds of halibut, valued at $3,805,088, while landings in Alaska totaled 15,052,404 pounds, valued at $1,533,528. Thus, the decrease in fares of the Alaska fleet was 2,924,283 pounds, or approximately 8 per cent in quantity and 19 per cent in value; while landings at Alaska ports declined 5,247,404 pounds, or about 35 per cent in quantity and 51 per cent in value from the preceding year.

Persons engaged, wages paid, and operating units, Alaska halibut industry, 1928

Item	Southeast Alaska	Central Alaska	Total
PERSONS ENGAGED			
Fishermen: Whites	1,176		1,176
Shoresmen:			
Whites	40	15	55
Natives	10		10
Total	50	15	65
Grand total	1,226	15	1,241
Wages paid shoresmen	$58,549	$19,323	$77,872
OPERATING UNITS			
Vessels:			
Power, over 5 tons	144	1	145
Net tonnage	3,707	28	3,735
Launches	30		30
Dories	144	1	145
Skates of lines	6,412	48	6,460

Products of the Alaska halibut fishery in 1928

Products	Southeast Alaska		Central Alaska		Total	
	Pounds	*Value*	*Pounds*	*Value*	*Pounds*	*Value*
Fresh, (including local)	23,322,414	$2,483,887	8,000	$800	23,330,414	$2,484,687
Frozen	7,012,773	542,201	1,222,949	67,040	8,235,722	609,241
Pudding			864	72	[1] 864	72
Total	30,335,187	3,026,088	1,231,813	67,912	31,567,000	3,094,000

[1] 18 cases.

COD

Operations in the cod industry carried on from shore stations in Alaska were marked by a further decline in 1928, the plant of the Alaska Codfish Co. at Unga being closed and its schooner *City of Papeete* used in the offshore fishery, products of which are not included in the following table inasmuch as the vessels operate from and land their fares in ports of the Pacific Coast States.

The offshore fleet, which is listed elsewhere, comprised eight vessels in all—one belonging to the Pacific Coast Codfish Co., one to Capt. J. A. Matheson, and two each to the Alaska Codfish Co., Robinson Fisheries Co., and Union Fish Co. The *Charles R. Wilson*, formerly operated by the Pacific Coast Codfish Co., and the *Beulah*, of the Union Fish Co., which had been withdrawn from the fleet in 1927, were again operated, while the *Galilee* and *Louise*, belonging to the latter company, were transferred to operations in the tuna fishery in Lower California. More fishing dories than formerly were equipped with outboard motors, and the season started very favorably with many good catches. However, bad weather hampered operations later, and the products of the offshore fleet were only slightly larger than in 1927. The increase would have been considerably greater but for the loss of the cargo of the schooner *Maweema*, which was wrecked on the south coast of St. George Island on August 19. Losses of small boats and gear in the shore-station industry amounted to $290, and one fisherman was drowned.

STATISTICAL SUMMARY

The cod industry gave employment to 53 persons in 1928, 59 less than in the preceding year. All operations were carried on in central Alaska, chiefly in the Shumagin Islands region. Dry-salted and pickled cod, stockfish, and tongues aggregating 578,173 pounds, valued at $28,979, were the products of the cod industry. Comparable figures for 1927 are 1,292,289 pounds, valued at $57,780. The products of the offshore fishery were reported to be 5,503,470 pounds of dry-salted cod and tongues, valued at $293,624. These figures do not include 400 tons of salt codfish, valued at $40,000, which were lost on the *Maweema*. The offshore fishery employed 292 persons.

Persons engaged, wages paid, and operating units, Alaska cod industry, 1928

Item	Number	Item	Number
PERSONS ENGAGED		OPERATING UNITS	
Fishermen:		Shore stations	20
Whites	40	Vessels:	
Natives	5	Motor	1
		Net tonnage	26
Total	45	Power dories	46
		Rowboats	20
Shoresmen:		Apparatus:	
Whites	7	Trawl lines	34
Native	1	Hooks	12,464
		Hand lines	72
Total	8		
Grand total	53		
Wages paid shoresmen	$3,250		

Products of Alaska cod industry in 1928

Item	Pounds	Value
Dry-salted cod	518,053	$23,465
Stockfish	43,800	4,680
Tongues	400	40
Pickled	15,920	794
Total	578,173	28,979

Offshore cod fleet in 1928

Name	Rig	Net tonnage	Operator
City of Papeete	Schooner	370	Alaska Codfish Co., San Francisco, Calif.
Maweema	do	392	Do.
Fanny Dutard	do	252	J. A. Matheson, Anacortes, Wash.
C. A. Thayer	do	390	Pacific Coast Codfish Co., Seattle, Wash.
Wawona	do	413	Robinson Fisheries Co., Anacortes, Wash.
Charles R. Wilson	do	328	Do.
Beulah	do	339	Union Fish Co., San Francisco, Calif.
William H. Smith	do	496	Do.

WHALES

The only firm engaged in the whaling industry in Alaska in 1928 was the American Pacific Whaling Co., which again operated its plants at Akutan and Port Hobron. Employment was given to 220 whites and 10 natives, a total of 230 and a decrease of 96 from the number reported employed in the industry in 1927. One fisherman met death by accident. There were 402 whales taken, consisting of 98 finbacks, 220 humpbacks, 51 sulphur bottoms, 24 sperm, 6 right, 1 sei, and 2 California gray whales. This is a decrease of 316 from the number caught in Alaskan waters in the preceding year, when, in addition to the operation of the above-named plants, the California Sea Products Co. was engaged in the industry with its floating plant *Lansing*. The latter company confined its whaling operations this season to California waters.

The products of the whale fishery were as follows: 730,650 gallons of whale oil, valued at $343,786; 93,750 gallons of sperm oil, valued at $36,748; 849 tons of fertilizer from meat, valued at $59,430; and 477 tons of bone fertilizer, valued at $14,310; a total value of products of $454,274 and a decrease of 27 per cent from 1927, when products were valued at $622,412.

CLAMS

No field work was carried on in Alaska during the season in connection with scientific investigations of the clam resources, but Dr. F. W. Weymouth, of Stanford University, assisted by H. C. McMillin, devoted attention to the analysis of data previously collected and the preparation of a report thereon, which will be published in a separate document.

The clam industry in Alaska in 1928 was on a greatly diminished scale from that of the preceding year. The smaller production, however, was attributed to unfavorable market conditions rather than to any marked decrease in abundance of clams on the beaches. Six companies had prepared clam products in 1927, but in 1928 only three were engaged in the business, one of which handled clams exclusively and two canned both salmon and clams. One of the two firms operating in the Cordova district more than doubled its output, but the curtailment or discontinuance of operations by other producers resulted in a marked decrease in the Territory's total production. Reports indicate that the stormy weather in the Kukak Bay district this season in all probability would have interfered with securing a large pack, even if more extensive operations had been attempted.

Employment was given to 132 whites, and the output in 1928 was 15,170 cases, containing 367,494 pounds, valued at $107,046, a decrease of 42 per cent in quantity and 27 per cent in value from the production in 1927, when 23,865 cases, totaling 634,752 pounds, valued at $146,735, were packed.

Products of the Alaska clam industry in 1928

Item	Cases	Pounds	Value
Minced:			
½-pound cans (48 to case)	14,808	355,392	$103,518
10-ounce cans (48 to case)	293	8,790	2,637
Whole: 1-pound cans (48 to case)	69	3,312	891
Total	15,170	367,494	107,046

SHRIMP

Operations in the shrimp industry in Alaska continued on about the same scale as in the last few years, being confined to the vicinity of Petersburg and Wrangell. Although fewer persons were engaged in the business and the number of plants operated was one less than in 1927, there was an increased output, which undoubtedly would have been considerably greater had not the light demand early in the season slowed down production to some extent. Two plants were operated, one by the Alaskan Glacier Sea Food Co. at Petersburg and one by the Reliance Shrimp Co. at Wrangell.

Employment was given to 127 persons, of whom 19 were whites, 57 natives, 2 Chinese, 26 Japanese, 10 Filipinos, 8 Mexicans, 3 Koreans, and 2 Negroes. Products for the 1928 season consisted of 504,271 pounds of shrimp meat valued at $202,165, an increase of 12,446 pounds in quantity and $5,433 in value over the preceding year, when 491,825 pounds valued at $196,732 were prepared.

CRABS

In southeastern Alaska crab products were prepared by two companies—the Reliance Shrimp Co. at Wrangell, which handled chiefly shrimp, and the Northern Sea Food Co. at Petersburg. The latter company extended its operations during the season to Cordova in central Alaska, where the Cordova Shellfish Co. also engaged again in the crab industry. Employment was given to 69 whites, 4 natives, and 2 Filipinos. Products consisted of 141,320 pounds of cold-packed meat, valued at $49,862, and 770 dozen crabs in the shell, valued at $1,615. Of the crabs in shell, 620 dozen were cooked and 150 dozen were shipped fresh. The total value of products in 1928 was $51,477, as compared with $39,929 in 1927, an increase of 29 per cent.

TROUT

Production of trout in Alaska in 1928 was wholly incidental to other fishery operations. The products were as follows: Dolly Vardens, 25,822 pounds fresh, valued at $3,456; 8,770 pounds frozen, valued at $901; and 1,680 pounds canned, valued at $210; steelheads, 4,507 pounds fresh, valued at $507; and 15,117 pounds frozen, valued at $1,331. The total production of both species was 55,896 pounds, valued at $6,405, as compared with 57,946 pounds valued at $6,596 in 1927, a decrease of 3.5 per cent in quantity and 2.9 per cent in value.

MISCELLANEOUS FISHERY PRODUCTS

Several species of fish of minor commercial importance are taken in small quantities, chiefly in connection with the halibut fishery, and are landed at ports of Alaska and British Columbia and at Seattle. Such products landed in Alaska in 1928 were as follows: Sablefish, 16,071 pounds fresh, valued at $421, 288,217 pounds frozen, valued at $10,511, and 18,600 pounds pickled, valued at $1,395; rockfishes, 2,332 pounds fresh, valued at $70; flounders, 100 pounds fresh, valued at $2, and 901 pounds frozen, valued at $18; "lingcod," 482 pounds fresh, valued at $14, and 7,879 pounds frozen, valued at $236; smelt, 11,323 pounds fresh, valued at $1,246, and 10,080 pounds frozen, valued at $1,109. All of these products were from southeastern Alaska.

FUR-SEAL INDUSTRY

PRIBILOF ISLANDS

GENERAL ADMINISTRATIVE WORK

In the calendar year 1928, 31,099 fur-seal skins were taken on the Pribilof Islands, of which 23,003 were from St. Paul Island and 8,096 from St. George Island. The take from both islands was 6,157 greater than the take in 1927. On St. Paul Island 14,584 sealskins were blubbered in the course of curing operations. The killing of seals was confined as far as possible to 3-year-old males, and in order to insure the preservation of a suitable number of these animals for the future breeding stock, 8,852 of them were marked and released. Special attention was given to the blue-fox herds.

The work of replacing buildings no longer possible of repair was continued, and further extension was made of the roads on the islands.

Through the courtesy of the Navy Department the U. S. S. *Vega* transported from Seattle the general annual shipment of supplies required at the Pribilofs and on the bureau's power schooner *Eider*.

The United States Coast Guard detailed a number of vessels for patrolling the waters frequented by the fur-seal herd and afforded many courtesies in connection with the bureau's administrative work at the Pribilofs.

As in former years, the Canadian and Japanese Governments' shares of fur-seal skins taken at the Pribilof Islands were sold by the United States and the net proceeds remitted to the respective Governments. This Government's share of fur-seal skins taken on the Japanese islands is delivered to the United States, the skins for 1928 being received in January, 1929.

PURCHASE AND TRANSPORTATION OF SUPPLIES

The U. S. S. *Vega* transported the general supplies required for the Pribilof Islands and for the power schooner *Eider*. The *Vega* left Seattle with the cargo on July 24 and arrived at the Pribilofs on July 31. En route the vessel discharged at Dutch Harbor 32 tons of supplies and 25 tons of coal for the *Eider*. The cargo for the Pribilofs consisted of approximately 877 tons of general supplies, 957 tons of coal, and 380,000 feet of lumber. The vessel left the islands on

August 16 with the season's shipment of fur-seal and fox skins, some miscellaneous freight, and a number of passengers, arriving at Seattle August 24.

Minor shipments of supplies were made from Seattle from time to time. Some were taken by the *Eider* on its departure from Seattle in March. A shipment amounting to approximately 30 tons, consisting chiefly of perishable foodstuffs for the Pribilofs and the *Eider*, was forwarded from Seattle on the steamship *Victoria* on May 15 for delivery to the *Eider* at Akutan. Another small shipment was made from Seattle on the *Victoria* on June 7, delivery being made to the *Eider* at Unalaska. The usual fall shipment of perishable foodstuffs and miscellaneous emergency supplies for the Pribilof Islands and the *Eider*, approximately 30 tons, was forwarded to Unalaska from Seattle on October 10 on the *Victoria*.

POWER SCHOONER "EIDER"

From the beginning of the year until in March the vessel was at the Lake Washington Shipyard, Seattle, where a general overhauling

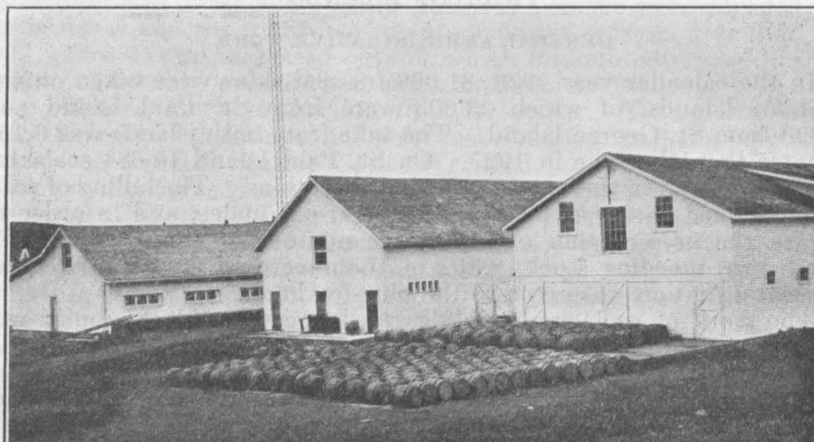


FIGURE 13.—Barreled fur-seal skins ready for shipment, St. Paul Island

was given the engine, hull, and equipment. It left Seattle March 22, arriving at Seward April 1 and at Unalaska April 7. The time from April 10 to 19 was occupied with a trip to the Pribilof Islands, transporting mail, freight, and passengers to those islands. While on this trip considerable difficulty was experienced with ice and heavy weather.

On April 24 the *Eider* left Unalaska for King Cove, where passengers and freight for the Pribilof Islands were taken aboard. Direct passage was made to the islands, and the *Eider* returned to Unalaska on April 29. In May three trips were made between Unalaska and the Pribilofs, and, in addition, calls were made at all villages between Belkofski and Nikolski seeking natives for temporary work at the Pribilofs.

On July 15 the *Eider* took aboard a shipment of supplies from the steamship *Victoria* at Akutan and proceeded to the Pribilof Islands. While there, assistance was given to those engaged in the annual seal computation. In the latter part of the month the vessel proceeded to Unalaska, thence to Akutan, and back to the Pribilofs. In August it was engaged on miscellaneous work at the Pribilofs and between the Pribilofs and Unalaska, and on August 22 left the Pribilofs for St. Michael, arriving there August 30.

Returning to the Pribilof Islands, some interisland work was done, and the vessel then proceeded to Unalaska with native workmen who had been temporarily employed at the Pribilofs, arriving at Unalaska on September 7. On September 18 the vessel left Unalaska for the Pribilofs with mail and freight received from the steamers *Victoria* and *Starr*, and after the transaction of business at the islands returned to Unalaska on September 22 with a number of workmen aboard.

In October the *Eider* made two trips to the Pribilofs, delivering mail and fall supplies to the islands and returning temporary workmen to Unalaska. The vessel left Unalaska November 8 for Seattle, arriving there November 25. During December the *Eider* remained at the Lake Union Dry Dock for overhauling. During the year the *Eider* traveled 13,958 nautical miles.

The appropriations for the Bureau of Fisheries for the fiscal year 1930 provide $125,000 for the purchase or construction of a power vessel to act as local tender for the Pribilof Islands and to assist in the protection and conservation of the fur seals and fisheries of Alaska. The money was made immediately available and plans were begun promptly for the construction of the vessel, which will be named *Penguin*. It is expected that the vessel will be placed in commission early in 1930. It will replace the *Eider*, which on account of its age and the severe service in which it has been used must be assigned to work in less exposed waters.

ROADS

St. Paul Island.—On account of the late spring the roads at the Pribilof Islands were covered with snow and in many places were impassable until the end of May, and the ground remained frozen until much later. It was, therefore, impossible to undertake road work until after the end of the sealing season and the departure of the supply vessel.

Work was confined to the roadway from the village to Northeast Point. A power shovel and five trucks were used in the work. The road was extended for a distance of 1½ miles, and a considerable portion of that already made was resurfaced. There are now 5 miles of scoria-surfaced road between the village and Northeast Point.

Lumber for building approximately 1 mile of road across the Northeast Point sand dunes was forwarded to St. Paul Island during the year. It was all hauled to the dunes, and it is planned to lay it in place in 1929. Lumber will be required for approximately 4 miles of road across the dunes.

St. George Island.—On account of the necessity of using most of the available native labor in the construction of new buildings, it was impossible to start any road work until in October. About 1 mile of new road toward East Reef rookery was graded and fills were made. About a quarter of a mile of this road was surfaced with scoria. The remaining three-quarters of a mile is ready for surfacing.

NEW BUILDINGS

St. Paul Island.—One 4-room and one 3-room house for the use of resident natives and a building to serve as quarters for native workmen brought to the island for temporary employment were erected. A jail and a store were also built to replace similar structures no longer in condition for economic repair. The two houses for resident natives are of concrete, the other three are of frame construction with concrete foundations.

St. George Island.—Ten 4-room houses for the use of resident natives were constructed, and a medical building to be completed in 1929 was begun also. All of these buildings are of frame construction with concrete foundations.

BY-PRODUCTS PLANT

The by-products plant on St. Paul Island was operated for a brief period in order to provide materials for use in the feeding of foxes.

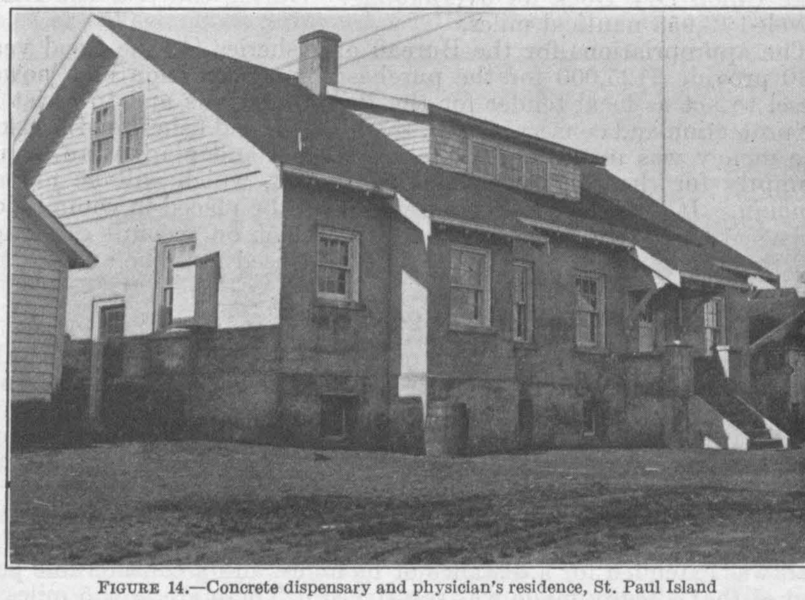


FIGURE 14.—Concrete dispensary and physician's residence, St. Paul Island

The products consisted of 2,354 gallons of oil, 125 gallons of foots, and 4,215 pounds of seal meal.

NATIVES

CENSUS

The annual census, taken as of December 31, 1928, showed 205 native residents on St. Paul Island. In addition, 4 St. Paul Island natives were in the States enrolled at the Salem Indian School, Chemawa, Oreg., and 12 elsewhere, making a total of 221 accredited to the island. One native was recorded as having permanently left the island and one, from St. George Island, as having become a permanent resident of St. Paul Island. During the year there were 12 births and 6 deaths among the natives.

On St. George Island there were 149 resident natives on December 31, 1928, 2 of whom were temporary (having their permanent residence on St. Paul Island), leaving 147 accredited to the island. During the year there were 7 births and 2 deaths. One native left the island, taking up permanent residence on St. Paul Island.

The total number accredited to both islands on December 31, 1928, was 368, a net increase of 10 during the year.

MEDICAL SERVICES

Physicians are detailed to St. Paul and St. George Islands for the benefit of the native population and of the Government employees and their families. The isolation of the islands insures in large measure freedom from infectious and contagious diseases, and the problems to be dealt with are to a large extent those of accidents, hygiene, and sanitation. In general, conditions on both islands were satisfactory throughout the year.

SCHOOLS

Schools for the native children are maintained by the bureau on both St. Paul and St. George Islands. Two teachers are employed on each island.

St. Paul Island.—The 1927–28 school year began September 12, 1927, and continued until May 18, 1928. There were 29 children enrolled in the junior and 28 in the senior school. The following information also has been obtained from the report submitted by the teachers:

All children between the ages of 6 and 16 years were required to attend. Sickness or other legitimate reason outside a pupil's control were the only excuses accepted for absences. Each week the resident physician inspected the school.

Since the children when entering the school have no real knowledge of English, the teaching of this language was given first importance with the first-year children. The teaching of the beginners was done by means of pictures, charts, games, and songs. Phonics, which was made the subject of more intensive drill with the more advanced pupils, was not given a major place in the teaching of reading to the beginners, since it was found that reading without comprehension was encouraged.

Manual training was given to all boys of 12 years of age or older. They were given work in which they would be interested, making household articles, furniture, and toys. Quantity of production was not emphasized, but a good grade of workmanship was insisted upon at all times. An understanding of the correct use of tools, the care of them, right methods, and careful measurements were made matters of most importance.

A class in sewing was conducted for all girls 12 years or more of age. All of the girls made underclothing, and the older girls made dresses also. They were given practice on the sewing machine whenever possible and taught to draft and use patterns and to obtain properly fitting garments.

St. George Island.—The 1927–28 school year began September 19, 1927, and continued to May 11, 1928. Twenty-two pupils were enrolled in the junior school and 25 in the senior. The junior school was housed in a well lighted, airy, and pleasant room recently built. The following has also been obtained from the teachers' report:

Emphasis was laid on cleanliness, care of the teeth, and general hygiene. The children responded well. When these children are compared to other native children who are not living under Government care and supervision, the physical and mental superiority of the St. George Island children is at once very evident. Since the Government took charge in 1910, the number of pupils of school age has increased steadily until it is now more than double the number 18 years ago.

In the junior school the larger part of the time was given to language work, since the children when they enter the school are scarcely able to speak any English at all.

The subjects taught in the senior school were reading, spelling, arithmetic, penmanship, geography, history, hygiene, and music. Two sets of readers dealing with seals and reindeer were used and proved very useful, inasmuch as they dealt with things of which the children had a personal knowledge.

The moving pictures used for the community were also a great help in giving the children a concept of the things read about in books.

Attendance at Salem Indian School, Chemawa, Oreg.

No children from the Pribilof Islands entered the Salem Indian School in 1928. The four (Mariamna Merculieff, Kleopatra Krukoff, Tatiana Krukoff, and Abraham S. Merculieff) who were in attendance at the beginning of the year were still enrolled at its close. In January, 1929, the district superintendent in charge advised that the two Krukoff girls were under the outing system, in residence in Portland, Oreg., and attending public school. Mariamna Merculieff was also in Portland under the outing system for a part of 1928. The children were reported as being all well and getting along nicely.

SAVINGS ACCOUNTS

Certain of the Pribilof Islands natives and the St. Paul Island native church have funds in the custody of the United States Commissioner of Fisheries. Throughout 1928 these funds were kept on deposit with the Washington Loan & Trust Co., Washington, D. C., and interest was paid at the rate of 3 per cent per annum, calculated on monthly balances. Three new accounts for natives were opened and four closed during the year. These include an account that was opened and closed during the year. A summary of the accounts as a whole for the year 1928 is shown in the statement that follows:

On hand, Jan. 1, 1928	$11,636.20
Deposited in 1928	100.00
Interest earned from Jan. 1 to Dec. 31, 1928	338.31
	12,074.51
Withdrawn by natives in 1928	1,132.01
On hand Dec. 31, 1928	10,942.50

An itemized statement of the funds, showing the individual accounts, follows:

Funds of the Pribilof Islands natives and the St. Paul Island church in custody of United States Commissioner of Fisheries, as trustee, December 31, 1928

Bourdukofsky, Martha	$114.53	Merculief, Nicolai G	$150.49
Bourdukofsky, Peter	.90	Merculief, Tatiana	613.23
Fratis, Martha [3]	117.73	Pankoff, Agrippina	166.26
Fratis, Iuliania [3]	117.73	Pankoff, Maria M [elovidov]	9.20
Gromoff, Iuliania	322.88	St. Paul Island native church	1,600.00
Kochutin, Alexandra	4,322.76	Sedick, Lavrenty	60.70
Kozloff, Raisa	101.75	Sedick, Leonty [4]	60.70
Krukoff, Ekaterina	58.95	Sedick, Marina	.38
Lekanof, Sophia M	261.03	Shane, Michael [4]	108.45
Lestenkof, Michael	343.14	Swetzof, Eleazar [4]	149.66
Mandregan, Alexandra M	12.86	Tetoff, Vikenty M [elovidov]	136.03
Melovidov, Anton	4.59	Zacharof, Emanuel [4]	.45
Merculieff, Mariamna [3]	81.58		
Merculief, Alexandra	310.30	Total	10,942.50
Merculief, Daniel	613.23		
Merculief, Erena	613.23		
Merculief, George	291.46		
Merculief, jr., George	198.30		

[3] Not living on island in 1928.

[4] Deceased.

PAYMENTS FOR TAKING FUR-SEAL SKINS

The resident natives of the Pribilof Islands were paid in cash for their work in taking sealskins. A flat rate of 75 cents was allowed for each sealskin taken, and bonuses were allowed for special work. As the work of taking sealskins is collective in character, the amount earned on each island, on the basis of 75 cents per skin, was divided among the resident native sealers in accordance with ratings based on skill and ability. The men were divided into classes, each man in a given class receiving an equal amount. Payments were made as shown below:

St. Paul Island.—For the 23,003 sealskins taken on St. Paul Island, $17,252.25 was paid, and, in addition, $100 was allowed two foremen for special services and $50 for a cook. A statement of the earnings follows:

Payments to St. Paul Island natives for taking fur-seal skins, calendar year 1928

Classification	Number of men	Share of each	Total
First class	34	$349.50	$11,883.00
Second class	11	279.00	3,069.00
Third class	5	244.50	1,222.50
Fourth class	4	175.50	702.00
Fifth class	3	125.25	375.75
Foreman (additional compensation)			50.00
Do			50.00
Cook			50.00
Total			17,402.25

St. George Island.—For the 8,096 sealskins taken on St. George Island, $6,072 was paid, and, in addition, a total of $100 was allowed two foremen for special services. A statement of the earnings follows:

Payments to St. George Island natives for taking fur-seal skins, calendar year 1928

Classification	Number of men	Share of each	Total
First class	23	$201.00	$4,623.00
Second class	4	160.50	642.00
Third class	4	120.75	483.00
Fourth class	2	81.00	162.00
Fifth class	4	40.50	162.00
Foreman (addtional compensation)			55.00
Do			45.00
Total			6,172.00

PAYMENTS FOR TAKING FOX SKINS

The natives are paid $5 in cash for each fox skin taken on the Pribilof Islands. For the season of 1927–28 these payments amounted to $310 for the 62 skins taken on St. Paul Island and $1,155 for the 231 skins taken on St. George Island, a total of $1,465.

FUR SEALS

QUOTA FOR KILLING

The plans for sealing operations in 1928 provided for reserving for the future breeding stock eight thousand 3-year-old males and the killing of the remaining available males of this age class. The reserved males were to be marked by shearing a patch of fur and were to be divided between St. Paul and St. George Islands in approximately the ratio of four at the former to one at the latter island. Provision was made also for increasing the marked reserve if the actual count of harem and idle bulls made during the season indicated the advisability of such action. The actual number of 3-year-old males reserved in any year is always greater than the number marked, for the reason that not all the individuals are taken up in the reserving and killing drives.

KILLINGS

In 1928, 31,099 seals were killed, of which 23,003 were taken on St. Paul Island and 8,096 on St. George Island. These figures include 801 killed in the fall for food for the natives. Details in regard to the killings are shown in the following tabulations:

Seal killings on Pribilof Islands in 1928

ST. PAUL ISLAND

Date	Serial No. of drive	Hauling ground	Skins secured
May 18	1	Sea Lion Rock (Sivutch)	64
June 15	2	Reef and Gorbatch	287
17	3	Polovina, Polovina Cliffs, and Little Polovina	77
18	4	Vostochni and Morjovi	533
19	5	Tolstoi and Lukanin	246
20	6	Zapadni and Little Zapadni	362
21	7	Reef and Gorbatch	674
22	8	Polovina and Little Polovina	72
23	9	Vostochni and Morjovi	938
24	10	Tolstoi, Lukanin, and Kitovi	254
25	11	Zapadni and Little Zapadni	658
26	12	Reef and Gorbatch	1,496
27	13	Polovina, Polovina Cliffs, and Little Polovina	165
28	14	Vostochni and Morjovi	990
29	15	Tolstoi, Lukanin, and Kitovi	418
30	16	Zapadni and Little Zapadni	417
July 1	17	Reef and Gorbatch	1,353
2	18	Polovina, Polovina Cliffs, and Little Polovina	488
3	19	Vostochni and Morjovi	1,083
5	20	Tolstoi, Lukanin, and Kitovi	728
6	21	Zapadni and Little Zapadni	626
7	22	Reef and Gorbatch	2,308
8	23	Polovina, Polovina Cliffs, and Little Polovina	427
9	24	Vostochni and Morjovi	1,408
10	25	Tolstoi, Lukanin, and Kitovi	552
11	26	Zapadni and Little Zapadni	337
12	27	Reef and Gorbatch	1,070
13	28	Polovina, Polovina Cliffs, and Little Polovina	210
14	29	Vostochni and Morjovi	801
15	30	Tolstoi, Lukanin, and Kitovi	221
16	31	Zapadni and Little Zapadni	311
17	32	Reef and Gorbatch	1,642
18	33	Polovina, Polovina Cliffs, and Little Polovina	311
19	34	Vostochni and Morjovi	568
		Skins from seals that died as a result of reserving operations	25
29	35	Tolstoi, Lukanin, and Kitovi	108
30	36	Gorbatch	274
Oct. 20	37	do	171
Nov. 2	38	do	110
10	39	do	220
		Total	23,003

Seal killings on Pribilof Islands in 1928—Continued

ST. GEORGE ISLAND

Date	Serial No. of drive	Hauling ground	Skins secured	Date	Serial No. of drive	Hauling ground	Skins secured
June 7	1	North	35	July 10	15	North and Staraya Artil	530
9	2	East	61	13	16	East	134
12	3	North and Staraya Artil	44	14	17	North and Staraya Artil	854
16	4	East	112	18	18	East	486
18	5	North and Staraya Artil	187	19	19	North and Staraya Artil	836
21	6	East	134	22	20	East	434
22	7	North and Staraya Artil	214	23	21	North	288
26	8	East	153	23		Skin from seal that died as a result of reserving operations	1
27	9	North and Staraya Artil	324	26	22	East	444
July 1	10	East	237	27	23	North	303
2	11	North and Staraya Artil	476	28	24	Zapadni	20
3		Skins from seals that died as a result of reserving operations	10	30	25	East	350
5	12	East	329	Oct. 20	26	North	191
6	13	North and Staraya Artil	472	23	27	Staraya Artil	69
7		Skins from seals that died as a result of reserving operations	2	24	28	North	40
9	14	East	327			Total	8,096

AGE CLASSES

The age class of a male seal belonging to the Pribilof Islands herd is determined from the length of its body. The classification was derived from measurements of a large number of pups branded in 1912 and killed in subsequent years. The limits of the various age classes are shown in the table following:

Age classes of male seals, Pribilof Islands

Age	Length of summer seals	Length of fall seals	Age	Length of summer seals	Length of fall seals
	Inches	*Inches*		*Inches*	*Inches*
Yearlings	Up to 36.75	Up to 38.75	4-year-olds	46 to 51.75	48 to 53.75
2-year-olds	37 to 40.75	39 to 42.75	5-year-olds	52 to 57.75	54 to 59.75
3-year-olds	41 to 45.75	43 to 47.75	6-year-olds	58 to 63.75	60 to 65.75

Ages of seals killed on Pribilof Islands, calendar year 1928

[On basis of classification shown in preceding table]

Age	Summer (Jan. 1 to Aug. 5)			Fall (Aug. 6 to Dec. 31)			Total for year		
	St. Paul	St. George	Total	St. Paul	St. George	Total	St. Paul	St. George	Total
Yearling males	29	1	30	5		5	34	1	35
2-year-old males	1,072	188	1,260	46	5	51	1,118	193	1,311
3-year-old males	21,036	7,503	28,539	442	295	737	21,478	7,798	29,276
4-year-old males	338	76	414				338	76	414
5-year-old males	2		2				2		2
6-year-old males	1		1				1		1
Cows [1]	24	28	52	8		8	32	28	60
Total	22,502	7,796	30,298	501	300	801	23,003	8,096	31,099

[1] Cows accidentally and unavoidably killed.

It should be stated that some of the seals recorded in the above tabulation as 2-year-olds or 4-year-olds probably were 3-year-olds. Not all the male seals of a given age fall within the length limits assigned for the males of that age. As far as possible the killings in 1928 were confined to 3-year-old males.

RESERVING OPERATIONS

Ample provision was made in 1928 for the maintenance of the male breeding stock of fur seals through the reservation of a large number of 3-year-old males, from which class the seals killed are almost wholly taken. On St. Paul Island 6,900 3-year-old males were marked and released for the reserve and on St. George Island 1,952, making a total of 8,852. The marking was done by shearing a patch of fur, and on St. Paul Island 200 of the animals so marked were also iron-branded for special observation later. The actual reserve of 3-year-old males was, of course, greater than the number marked for the reason that not all the animals of this class appear in the sealing drives.

Marking of 3-year-old male seals for breeding reserve, Pribilof Islands, 1928

ST. PAUL ISLAND

Date	Hauling ground driven	Number of seals marked	Date	Hauling ground driven	Number of seals marked
July 20	Tolstoi, Lukanin, Kitovi, and Zapadni	1,306	July 26	Reef and Gorbatch	920
21	Gorbatch	1,060	27	Polovina, Polovina Cliffs, and Little Polovina	111
22	Reef	593	28	Vostochni and Morjovi	1,091
23	Polovina, Polovina Cliffs, and Little Polovina	306	31	Reef	300
24	Vostochni and Morjovi	882		Total	6,900
25	Tolstoi, Kitovi, Lukanin, and Zapadni	331			

ST. GEORGE ISLAND

Date	Hauling ground driven	Number of seals marked	Date	Hauling ground driven	Number of seals marked
June 11	Zapadni	66	July 23	Zapadni	67
19	do	146	24	Staraya Artil	315
25	do	195	28	Zapadni	39
July 3	do	400	29	Staraya Artil	310
7	do	189			
16	do	225		Total	1,952

COMPUTATION OF FUR-SEAL HERD

As in previous years, a computation was made of the number of animals in the fur-seal herd as of August 10. The total of all classes was 871,513, a numerical increase of 62,643 and a percentage increase of 7.74 over the figures for 1927. The constant and steady increase from year to year is very satisfactory, and the future of the herd is assured so long as pelagic sealing is prohibited. In 1911, the last year in which pelagic sealing was permitted, the Pribilof Islands herd was depleted to a point where it contained only about 124,000 animals. Its growth to nearly 900,000 animals in 17 years, coupled with the fact that in this period, from 1912 to 1928, inclusive, 302,284 skins have been secured for commercial purposes, is a striking example of intelligent conservation.

FIGURE 15.—Group of fur seals, Pribilof Island, Alaska

The computation in 1928 was made by Supt. H. J. Christoffers, assisted by A. Christoffersen and H. L. Oliver. The detailed report will be found on pages 325 to 332 of this document. Following is a comparative statement of the numerical strength of the various elements of the fur-seal herd in the years 1917 to 1928, inclusive:

General comparison of computations of the seal herd on the Pribilof Islands, 1917 to 1928

Class	1917	1918	1919	1920	1921	1922
Harem bulls	4, 850	5, 344	5, 158	4, 066	3, 909	3, 562
Breeding cows	128, 024	142, 915	157, 172	167. 527	176, 655	185, 914
Surplus bulls	8, 977	17, 110	9, 619	6, 115	3, 301	2, 346
Idle bulls	2, 706	2, 444	2, 239	1, 161	747	508
6-year-old males	15, 397	13, 756	8, 991	4, 153	3, 991	3, 771
5-year-old males	14, 813	11, 941	5, 282	5, 007	4, 729	6, 060
4-year-old males	16, 631	7, 114	5, 747	5, 667	6, 780	11, 807
3-year-old males	19, 507	9, 117	13, 596	10, 749	14, 668	7, 459
2-year-old males	26, 815	30, 159	33, 081	39, 111	41, 893	40, 920
Yearling males	38, 013	41, 595	46, 444	51, 074	50, 249	52, 988
2-year-old cows	26, 917	30, 415	33, 287	39, 480	43, 419	46, 280
Yearling cows	38, 018	41, 608	46, 447	51, 081	54, 447	57, 413
Pups	128, 024	142, 915	157, 172	167, 527	176, 655	185, 914
Total	468, 692	496, 432	524, 235	552, 718	581, 443	604, 962

Class	1923	1924	1925	1926	1927	1928
Harem bulls	3, 412	3, 516	3, 526	4, 034	4, 643	6, 050
Breeding cows	197, 659	208, 396	226, 090	244, 114	263, 566	284, 725
Surplus bulls	1, 891	2, 043	3, 558	2, 002	4, 827	5, 285
Idle bulls	312	390	311	423	972	1, 449
6-year-old males	4, 863	8, 489	4, 105	13, 434	13, 450	12, 857
5-year-old males	10, 612	5, 132	16, 792	16, 812	16, 073	13, 001
4-year-old males	5, 710	18, 670	18, 692	17, 872	14, 448	7, 798
3-year-old males	22, 786	21, 551	21, 185	17, 189	9, 730	11, 133
2-year-old males	43, 112	45, 685	43, 515	38, 183	41, 252	49, 087
Yearling males	55, 769	59, 291	52, 091	56, 514	61, 026	65, 861
2-year-old cows	48, 801	51, 359	49, 786	44, 415	48, 186	57, 061
Yearling cows	60, 422	64, 240	57, 309	62, 175	67, 131	72, 481
Pups	197, 659	208, 396	226, 090	244, 114	203, 566	284, 725
Total	653, 008	697, 158	723, 050	761, 281	808, 870	871, 513

FOXES

The care of the fox herds on the Pribilof Islands is incidental to the sealing operations. Fortunately, work in connection with the foxes comes at a time when sealing activities are at a minimum. In the winter season, when there is a scarcity of natural food, the foxes are fed prepared rations. The feeding and trapping of foxes provides work for the natives, in return for which they obtain $5 for each pelt taken. The Government also derives considerable revenue from the sale of fox skins.

TRAPPING SEASON OF 1928–29

During the season of 1928–29, 544 blue and 9 white fox pelts, a total of 553, were taken. Of this number, 79 blue and 8 white pelts were taken on St. Paul Island and 465 blue pelts and 1 white pelt on St. George Island. There were also trapped, marked, and released for breeding purposes 24 foxes on St. Paul Island and 281 on St. George Island. As it is evident that many of the foxes in the herd are not caught in the traps, the breeding reserve on the islands was actually greater than 305 animals.

REINDEER

St. Paul Island.—During the year ended September 30, 1928, 22 reindeer were killed and used for food. A count made of the animals in the herd on September 27 showed a total of 315, of which 42 were the young of the season. The herd was reported to be in excellent condition and plenty of natural food was available.

St. George Island.—No reindeer were killed for food in the year ended September 30, 1928. At the end of that period there were 66 animals in the herd, of which 13 were the young of the season.

WRECK OF SCHOONER "MAWEEMA"

The Alaska Codfish Co.'s schooner *Maweema* left Round Island, in the northern part of Bristol Bay, on August 11 for Unimak Pass. Foggy weather, which made steering by dead reckoning necessary, was encountered every day, and some time in the night of August 18 the vessel struck off the south side of St. George Island about a mile west of Garden Cove. The 31 men, including the master, aboard the vessel took to the schooner's boats. They stood by until daylight and then found that their vessel was hopelessly lost. Not knowing on what shore they were, one boat proceeded westward and the others eastward. All the men, however, reached St. George Island village on the 19th, where they were provided with quarters. On August 20 the U. S. Coast Guard cutter *Haida* took the shipwrecked men from the island.

The scene of the wreck was visited by members of the bureau's staff. The *Maweema* was broadside to the beach and about 40 feet from the shore. The entire bottom of the vessel appeared to be torn out, and it was felt that it would probably go to pieces in the first storm. The holds of the vessel were filled with codfish. A few days later some gear and supplies were salvaged.

The *Maweema* left San Francisco on March 29 and had been fishing, mostly in Bristol Bay, all summer. It was said to have had 400 tons of salted codfish on board when the wreck occurred.

FUR-SEAL SKINS

SHIPMENTS

One shipment of fur-seal skins was made from the Pribilof Islands in the calendar year 1928. This consisted of 31,062 skins, as follows: From St. Paul Island, 501 taken in the calendar year 1927 and 22,502 taken in 1928; from St. George Island, 263 taken in the calendar year 1927 and 7,796 taken in 1928. The shipment was made from the islands in August on the U. S. S. *Vega*, which arrived at Seattle, Wash., on August 24. The skins were forwarded from there by freight on August 25 via Union Pacific System and Wabash Railway Co. and were delivered to the department's selling agents at St. Louis, Mo., on September 5.

SALES

In 1928 a total of 23,442 fur-seal skins taken on the Pribilof Islands were sold at two public auction sales held at St. Louis. There were also sold through special sales 245 fur-seal skins taken on those islands. Along with the following detailed statements of these sales, the sales of other fur-seal skins by the Department of Commerce for the account of the Government are included in order that the records may be complete.

Public auction sale, May 14, 1928.—At this sale 9,982 fur-seal skins taken at the Pribilof Islands were sold for $381,572. Of these skins, 5,995 were dyed black and 3,987 logwood brown (Bois de Campêche). Three confiscated fur-seal skins were also sold for $51.50, making a grand total of $381,623.50 for fur-seal skins at this sale.

Public auction sale, October 15, 1928.—At this sale 13,444 fur-seal skins taken at the Pribilof Islands, dressed, dyed, and machined, sold for $414,101.50, and 14 dressed and 2 raw salted fur-seal skins, also taken at the Pribilof Islands, sold for a total of $1.60. There were also sold 161 Japanese fur-seal skins for $1,686.70 and 5 confiscated skins for $35.80, making a grand total of $415,825.60 for fur-seal skins at this sale. Seven thousand one hundred and seventy-four of the Pribilof Islands sealskins were dyed black, 5,623 logwood brown (Bois de Campêche), and 647 golden chestnut (Châtaigne d'Or). Of the Japanese skins, 144 were dressed, dyed, and machined, 123 being dyed black and 21 logwood brown.

The 161 Japanese fur-seal skins sold on October 15, 1928, were the United States Government's share of such skins taken by the Japanese Government in 1927, delivered pursuant to the provisions of the North Pacific Sealing Convention of July 7, 1911.

Special sales.—In the calendar year 1928, 245 fur-seal skins taken at the Pribilof Islands were sold at special sales for $12,834.87. These skins were dressed, dyed, and machined, logwood-brown dye.

The following tables give further details in regard to all sales of fur-seal skins by the Department of Commerce for the account of the Government in 1928:

Sale of fur-seal skins at St. Louis, Mo., May 14, 1928

5,995 DRESSED, DYED, AND MACHINED PRIBILOF ISLANDS SKINS, DYED BLACK

Lot No.	Number of skins	Trade classification	Price per skin	Total for lot
1	70	Extra large	$42.00	$2,940.00
2	70	....do	42.00	2,940.00
3	40	Extra large; scarred, faulty, etc	23.50	940.00
4	80	Large	37.00	2,960.00
5	80	....do	37.00	2,960.00
6	80	....do	37.50	3,000.00
7	80	....do	37.50	3,000.00
8	80	....do	41.00	3,280.00
9	80	....do	38.00	3,040.00
10	80	....do	37.50	3,000.00
11	80	....do	39.50	3,160.00
12	80	....do	40.00	3,200.00
13	80	....do	41.50	3,320.00
14	80	....do	39.00	3,120.00
15	80	....do	40.00	3,200.00
16	80	....do	40.50	3,240.00
17	80	Large; scarred, faulty, etc	22.50	1,800.00
18	80	....do	22.00	1,760.00
19	80	....do	23.00	1,840.00
20	40	....do	23.50	940.00
21	90	Medium	33.00	2,970.00
22	90	....do	34.50	3,105.00
23	90	....do	34.00	3,060.00
24	90	....do	34.00	3,060.00
25	90	....do	35.00	3,150.00
26	90	....do	34.50	3,105.00
27	90	....do	35.50	3,195.00
28	90	....do	34.00	3,060.00
29	90	....do	34.50	3,105.00
30	90	....do	35.00	3,150.00
31	90	....do	34.50	3,105.00
32	45	....do	37.00	1,665.00
33	90	Medium; scarred, faulty, etc	23.00	2,070.00
34	90	....do	23.00	2,070.00
35	90	....do	24.00	2,160.00

Sale of fur-seal skins at St. Louis, Mo., May 14, 1928—Continued

5,995 DRESSED, DYED, AND MACHINED PRIBILOF ISLANDS SKINS, DYED BLACK—Continued

Lot No.	Number of skins	Trade classification	Price per skin	Total for lot
36	45	29 medium, 16 small medium	$29.00	$1,305.00
37	45	18 medium, 27 small medium	26.50	1,192.50
38	45	25 medium, 20 small medium; scarred, faulty, etc	21.00	945.00
39	90	Small medium	25.00	2,250.00
41	70	10 extra extra large, 60 extra large	42.50	2,975.00
42	30	Extra large	45.00	1,350.00
43	70	25 extra extra large, 45 extra large; scarred, faulty, etc	23.50	1,645.00
44	70	Extra large; scarred, faulty, etc	23.50	1,645.00
45	80	Large	36.00	2,880.00
46	80	....do	36.50	2,920.00
47	80	....do	35.50	2,840.00
48	80	....do	37.00	2,960.00
49	80	....do	36.50	2,920.00
50	80	....do	37.00	2,960.00
51	40	....do	38.00	1,520.00
52	80	Large; scarred, faulty, etc	23.50	1,880.00
53	80	....do	24.00	1,920.00
54	80	....do	24.50	1,960.00
55	80	....do	24.50	1,960.00
56	80	....do	25.00	2,000.00
57	90	Medium	35.00	3,150.00
58	90	....do	36.00	3,240.00
59	90	....do	34.50	3,105.00
60	90	....do	34.50	3,105.00
61	90	....do	35.50	3,195.00
62	90	....do	34.50	3,105.00
63	90	....do	35.00	3,150.00
64	90	....do	35.50	3,195.00
65	90	Medium; scarred, faulty, etc	23.50	2,115.00
66	90	....do	24.00	2,160.00
67	90	....do	24.50	2,205.00
68	90	....do	24.50	2,205.00
69	90	....do	24.00	2,160.00
70	90	....do	25.00	2,250.00
71	90	....do	24.50	2,205.00
72	45	....do	24.50	1,102.50
73	90	Small medium	27.00	2,430.00
74	40	....do	28.00	1,120.00
75	90	Small medium; scarred, faulty, etc	19.00	1,710.00
76	90	....do	20.00	1,800.00
77	30	III; 2 extra extra large, 28 extra large	6.50	195.00
78	35	III; large	6.00	210.00
79	35	III; 28 medium, 7 small medium	7.50	262.50
	5,995			187,072.50

3,987 DRESSED, DYED, AND MACHINED PRIBILOF ISLANDS SKINS, DYED LOGWOOD BROWN (BOIS DE CAMPÊCHE)

Lot No.	Number of skins	Trade classification	Price per skin	Total for lot
81	24	Extra extra large	$58.00	$1,392.00
82	20	2 extra extra large, 18 extra large; scarred, faulty, etc	34.00	680.00
83	70	Extra large	49.00	3,430.00
84	70	....do	53.50	3,745.00
85	70	....do	52.00	3,640.00
86	40	....do	52.00	2,080.00
87	40	....do	52.00	2,080.00
88	35	....do	54.00	1,890.00
89	50	....do	54.00	2,700.00
90	50	5 extra large, 45 large	53.00	2,650.00
91	33	6 extra large, 20 large, 7 medium	45.00	1,485.00
92	80	Large	51.50	4,120.00
93	80	....do	52.00	4,160.00
94	80	....do	51.50	4,120.00
95	80	....do	55.50	4,440.00
96	80	....do	54.50	4,360.00
97	80	....do	53.50	4,280.00
98	80	....do	52.50	4,200.00
99	80	....do	55.50	4,440.00
100	80	....do	54.50	4,360.00
101	80	....do	52.50	4,200.00
102	40	....do	53.00	2,120.00
103	40	....do	54.00	2,160.00
104	40	....do	54.00	2,160.00
105	40	....do	54.50	2,180.00
106	40	....do	55.00	2,200.00
107	40	....do	53.50	2,140.00

Sale of fur-seal skins at St. Louis, Mo., May 14, 1928—Continued

3,987 DRESSED, DYED, AND MACHINED PRIBILOF ISLANDS SKINS, DYED LOGWOOD BROWN (BOIS DECAMPÊCHE)—Continued

Lot No.	Number of skins	Trade classification	Price per skin	Total for lot
108	40	Large	$55.50	$2,220.00
109	40	do	52.00	2,080.00
110	80	do	54.50	4,360.00
111	80	do	54.00	4,320.00
112	40	do	55.50	2,220.00
113	40	do	55.00	2,200.00
114	40	do	54.00	2,160.00
115	36	6 large, 18 medium, 12 small medium	46.00	1,656.00
116	29	10 large, 17 medium, 2 small medium	47.00	1,363.00
117	50	Large; scarred, faulty, etc	41.00	2,050.00
118	45	do	39.00	1,755.00
119	45	25 large, 19 medium, 1 small medium; scarred, faulty, etc	28.50	1,282.50
120	35	4 large, 27 medium, 4 small medium; scarred, faulty, etc	28.50	997.50
121	90	Medium	51.00	4,590.00
122	90	do	52.00	4,680.00
123	90	do	51.00	4,590.00
124	90	do	51.50	4,635.00
125	90	do	52.00	4,680.00
126	90	do	52.00	4,680.00
127	90	do	52.00	4,680.00
128	45	do	51.50	2,317.50
129	45	do	51.00	2,295.00
130	45	do	52.50	2,362.50
131	45	do	53.50	2,407.50
132	35	do	52.00	1,820.00
133	90	do	52.00	4,680.00
134	90	do	51.50	4,635.00
135	90	do	52.00	4,680.00
136	50	do	53.00	2,650.00
137	90	do	51.50	4,635.00
138	60	do	52.50	3,150.00
139	30	11 medium; 19 small medium	42.50	1,275.00
140	50	Medium; scarred, faulty, etc	32.50	1,625.00
141	30	Small medium	37.50	1,125.00
142	30	do	40.50	1,215.00
143	49	12 extra large, 20 large, 16 medium, 1 small medium	54.50	2,670.50
144	13	1 large, 8 medium, 4 small medium	49.00	637.00
145	10	1 large, 3 medium, 6 small medium	48.00	480.00
146	41	4 extra extra large, 11 extra large, 26 large; scarred, faulty, etc	32.50	1,332.50
147	39	21 medium, 18 small medium; scarred, faulty, etc	21.50	838.50
148	28	2 extra large, 11 large, 15 medium; scarred, faulty, etc	30.00	840.00
149	45	Medium; scarred, faulty, etc	25.00	1,125.00
150	58	Small medium; scarred, faulty, etc	23.00	1,334.00
151	54	1 extra large, 4 large, 34 medium, 15 small medium; scarred, faulty, etc	26.50	1,431.00
152	24	III; 2 extra large, 7 large, 7 medium, 8 small medium	7.00	168.00
153	14	III; 6 medium, 8 small medium	5.50	77.00
154	15	III; 3 medium, 12 small medium	5.50	82.50
	3,987			194,499.50

3 CONFISCATED SKINS

Lot No.	Number of skins	Trade classification	Price per skin	Total for lot
155	2	Dressed, dyed, and machined, black	$25.00	$50.00
156	1	Dressed in hair	1.50	1.50
	3			51.50

Sale of fur-seal skins at St. Louis, Mo., October 15, 1928

7,174 DRESSED, DYED, AND MACHINED PRIBILOF ISLANDS SKINS, DYED BLACK

Lot No.	Number of skins	Trade classification	Price per skin	Total for lot
1	70	Extra large	$34.00	$2,380.00
2	70	24 extra large, 46 large	33.00	2,310.00
3	48	Extra large; scarred, faulty, etc	19.00	912.00
4	80	Large	31.50	2,520.00
5	80	do	31.50	2,520.00
6	80	do	31.50	2,520.00
7	80	do	32.00	2,560.00
8	80	do	31.50	2,520.00
9	80	do	40.00	3,200.00
10	80	do	33.50	2,680.00
11	80	do	37.50	3,000.00
12	80	32 large, 48 medium	31.00	2,480.00
13	80	Large; scarred, faulty, etc	20.00	1,600.00
14	80	do	21.00	1,680.00
15	80	do	21.50	1,720.00
16	80	do	21.00	1,680.00
17	90	Medium	30.00	2,700.00
18	90	do	31.00	2,790.00
19	90	do	32.00	2,880.00
20	90	do	32.00	2,880.00
21	90	do	32.00	2,880.00
22	90	do	30.50	2,745.00
23	90	do	31.50	2,835.00
24	90	do	29.00	2,610.00
25	90	do	30.50	2,745.00
26	70	do	27.50	1,925.00
27	90	Medium; scarred, faulty, etc	16.00	1,440.00
28	90	do	18.00	1,620.00
29	90	do	18.00	1,620.00
30	90	do	19.00	1,710.00
31	90	do	17.50	1,575.00
32	80	do	18.00	1,440.00
33	34	3 large, 31 medium; scarred, faulty, etc	17.50	595.00
34	90	Small medium	22.00	1,980.00
35	37	do	24.50	906.50
36	88	Small medium; scarred, faulty, etc	16.00	1,408.00
37	50	11 extra extra large, 39 extra large	31.50	1,575.00
38	46	Extra large	30.50	1,403.00
39	47	20 extra extra large, 27 extra large; scarred, faulty, etc	18.50	869.50
40	70	Extra large; scarred, faulty, etc	16.50	1,155.00
41	70	do	17.50	1,225.00
42	80	Large	29.50	2,360.00
43	80	do	29.50	2,360.00
44	80	do	29.50	2,360.00
45	80	do	32.00	2,560.00
46	80	do	30.50	2,440.00
47	80	do	31.00	2,480.00
48	80	do	30.50	2,440.00
49	80	do	33.50	2,680.00
50	47	Large; scarred, faulty, etc	19.00	893.00
51	80	do	17.50	1,400.00
52	80	do	17.50	1,400.00
53	80	do	17.00	1,360.00
54	80	do	17.00	1,360.00
55	80	do	17.00	1,360.00
56	80	do	16.50	1,320.00
57	80	do	17.00	1,360.00
58	80	do	17.50	1,400.00
59	76	do	17.00	1,292.00
60	90	Medium	25.50	2,295.00
61	90	do	26.50	2,385.00
62	90	do	26.50	2,385.00
63	90	do	26.50	2,385.00
64	90	do	26.50	2,385.00
65	90	do	28.00	2,520.00
66	90	do	27.00	2,430.00
67	90	do	27.00	2,430.00
68	90	do	27.50	2,475.00
69	90	do	27.50	2,475.00
70	90	do	26.50	2,385.00
71	66	47 medium, 19 small medium; scarred, faulty, etc	15.50	1,023.00
72	90	Medium; scarred, faulty, etc	15.00	1,350.00
73	90	do	15.50	1,395.00
74	90	do	15.50	1,395.00
75	90	do	16.00	1,440.00
76	90	do	16.00	1,440.00
77	90	do	16.50	1,485.00
78	90	do	16.50	1,485.00
79	90	do	16.50	1,485.00

Sale of fur-seal skins at St. Louis, Mo., October 15, 1928—Continued

7,174 DRESSED, DYED, AND MACHINED PRIBILOF ISLANDS SKINS, DYED BLACK—Continued

Lot No.	Number of skins	Trade classification	Price per skin	Total for lot
80	90	Medium, scarred, faulty, etc	$16.50	$1,485.00
81	90	do	16.50	1,485.00
82	90	do	17.00	1,530.00
83	90	do	17.00	1,530.00
84	63	20 medium, 43 small medium; scarred, faulty, etc	14.00	882.00
85	90	Small medium	22.50	2,025.00
86	90	Small medium; scarred, faulty, etc	14.00	1,260.00
87	90	do	13.50	1,215.00
88	36	III; 10 extra extra large, 26 extra large	9.00	324.00
89	48	III, large	6.50	312.00
90	48	III; 21 large, 20 medium, 7 small medium	6.50	312.00
	7,174			168,027.00

5,623 DRESSED, DYED, AND MACHINED PRIBILOF ISLANDS SKINS, DYED LOGWOOD BROWN (BOIS DE CAMPÊCHE)

Lot No.	Number of skins	Trade classification	Price per skin	Total for lot
91	40	6 extra extra large, 34 extra large	$58.50	$2,340.00
92	40	5 extra extra large, 35 extra large	57.50	2,300.00
93	45	Extra large	59.50	2,677.50
94	42	do	56.50	2,373.00
95	45	5 extra extra large, 40 extra large; scarred, faulty, etc	32.50	1,462.50
96	45	7 extra extra large, 38 extra large; scarred, faulty, etc	38.00	1,710.00
97	45	Extra large; scarred, faulty, etc	31.00	1,395.00
98	44	do	36.00	1,584.00
99	80	Large	52.50	4,200.00
100	80	do	55.50	4,440.00
101	80	do	53.00	4,240.00
102	80	do	53.00	4,240.00
103	80	do	53.00	4,240.00
104	80	do	56.50	4,520.00
105	80	do	65.50	5,240.00
106	80	do	55.00	4,400.00
107	40	do	56.00	2,240.00
108	40	do	58.50	2,340.00
109	40	do	57.50	2,300.00
110	80	do	53.50	4,280.00
111	80	do	56.00	4,480.00
112	80	do	56.00	4,480.00
113	80	do	56.00	4,480.00
114	80	do	55.00	4,400.00
115	40	do	56.50	2,260.00
116	40	do	54.00	2,160.00
117	40	do	55.00	2,200.00
118	37	do	57.50	2,127.50
119	50	do	57.00	2,850.00
120	80	Large; scarred, faulty, etc	34.50	2,760.00
121	80	do	38.00	3,040.00
122	80	do	35.50	2,840.00
123	80	do	35.00	2,800.00
124	80	do	34.00	2,720.00
125	50	do	35.50	1,775.00
126	50	do	36.50	1,825.00
127	80	do	33.50	2,680.00
128	80	do	30.50	2,440.00
129	80	do	31.00	2,480.00
130	80	do	34.00	2,720.00
131	50	do	34.50	1,725.00
132	50	do	35.50	1,775.00
133	45	do	31.00	1,395.00
134	35	9 extra large, 26 large; scarred, faulty, etc	36.50	1,277.50
135	90	Medium	46.50	4,185.00
136	90	do	45.00	4,050.00
137	90	do	45.00	4,050.00
138	90	do	49.50	4,455.00
139	90	do	46.50	4,185.00
140	90	do	46.50	4,185.00
141	50	do	50.00	2,500.00
142	50	do	48.00	2,400.00
143	50	do	47.50	2,375.00
144	50	do	48.00	2,400.00
145	45	do	48.50	2,182.50
146	90	do	49.00	4,410.00
147	90	do	50.00	4,500.00
148	90	do	47.00	4,230.00

Sale of fur-seal skins at St. Louis, Mo., October 15, 1928—Continued

5,623 DRESSED, DYED, AND MACHINED PRIBILOF ISLANDS SKINS, DYED LOGWOOD BROWN (BOIS DE CAMPÊCHE)—Continued

Lot No.	Number of skins	Trade classification	Price per skin	Total for lot
149	90	Medium	$47.50	$4,275.00
150	45	do	47.00	2,115.00
151	45	do	50.00	2,250.00
152	45	do	50.50	2,272.50
153	75	do	47.50	3,562.50
154	90	Medium; scarred, faulty, etc	29.50	2,655.00
155	90	do	28.50	2,565.00
156	90	do	24.50	2,205.00
157	90	do	23.00	2,070.00
158	50	do	23.50	1,175.00
159	50	do	23.00	1,150.00
160	50	do	25.50	1,275.00
161	50	do	25.00	1,250.00
162	90	do	24.50	2,205.00
163	90	do	23.00	2,070.00
164	90	do	24.00	2,160.00
165	50	do	22.50	1,125.00
166	50	do	22.50	1,125.00
167	50	do	22.00	1,100.00
168	60	do	22.00	1,320.00
169	90	Small medium	36.50	3,285.00
170	45	do	36.00	1,620.00
171	90	Small medium; scarred, faulty, etc	20.00	1,800.00
172	90	do	16.50	1,485.00
173	90	do	19.50	1,755.00
174	35	III; 1 extra extra large, 1 extra large, 15 large, 18 medium	7.00	245.00
175	35	III; 28 medium, 7 small medium	6.00	210.00
176	40	III; small medium	5.00	200.00
	5,623			226,844.50

647 DRESSED, DYED, AND MACHINED PRIBILOF ISLANDS SKINS, DYED GOLDEN CHESTNUT (CHÂTAIGNE D'OR)

Lot No.	Number of skins	Trade classification	Price per skin	Total for lot
181	40	4 extra extra large, 17 extra large, 19 large	$48.50	$1,940.00
182	42	Large	45.50	1,911.00
183	40	do	47.00	1,880.00
184	40	22 extra large, 18 large; scarred, faulty, etc	28.00	1,120.00
185	40	Large; scarred, faulty, etc	24.00	960.00
186	40	do	21.00	840.00
187	40	do	23.50	940.00
188	40	Medium	40.00	1,600.00
189	40	do	38.50	1,540.00
190	24	3 extra large, 16 large, 5 medium	47.50	1,140.00
191	32	1 extra extra large, 3 extra large, 21 large, 7 medium; scarred, faulty, etc.	30.50	976.00
192	40	3 large, 37 medium; scarred, faulty, etc	16.50	660.00
193	40	Medium; scarred, faulty, etc	15.50	620.00
194	40	do	15.00	600.00
195	45	36 medium, 9 small medium	35.00	1,575.00
196	64	12 medium, 52 small medium; scarred, faulty, etc	14.50	928.00
	647			19,230.00

16 MISCELLANEOUS PRIBILOF ISLANDS SKINS

Lot No.	Number of skins	Trade classification	Price per skin	Total for lot
206	14	Dressed	$0.10	$1.40
207	2	Raw salted	.10	.20
	16			1.60

5 CONFISCATED SKINS

Lot No.	Number of skins	Trade classification	Price per skin	Total for lot
198	1	Medium; dressed, dyed, and machined, logwood brown, (Bois de Campêche)	$35.00	$35.00
208	4	Washed and dried	.20	.80
	5			35.80

Sale of fur-seal skins at St. Louis, Mo., October 15, 1928—Continued

161 SKINS RECEIVED FROM JAPANESE GOVERNMENT UNDER TREATY PROVISIONS

Lot No.	Number of skins	Trade classification	Price per skin	Total for lot
200	38	3 extra extra large, 1 extra large, 6 large, 19 medium, 9 small medium, dressed, dyed, and machined, black	$15.00	$570.00
201	40	3 extra extra large, 2 extra large, 15 large, 20 medium; scarred, faulty, etc., dressed, dyed, and machined, black	8.50	340.00
202	45	17 medium, 28 small medium; scarred, faulty, etc., dressed, dyed, and machined, black	7.00	315.00
203	8	1 wig, 6 extra extra large, 1 extra large, dressed, dyed, and machined, logwood brown (Bois de Campêche)	34.50	276.00
204	9	4 wigs, 5 extra extra large; scarred, faulty, etc., dressed, dyed, and machined, logwood brown (Bois de Campêche)	20.00	180.00
205	4	III; 3 wigs, 1 extra large, dressed, dyed, and machined, logwood brown (Bois de Campêche)	1.00	4.00
209	1	Washed and dried	.10	.10
210	16	Raw salted	.10	1.60
	161			1,686.70

Special sales of Pribilof Islands fur-seal skins in 1928

Date	Number of skins	Description	Price per skin	Total
		Dressed, dyed, and machined, logwood brown (Bois de Campêche)		
July 9	9	Extra large	$52.07	$468.63
	24	Large	53.49	1,283.76
	12	Medium	51.59	619.08
16	10	Extra large	52.07	520.70
	74	Large	53.49	3,958.26
	116	Medium	51.59	5,984.44
	245			12,834.87

Comparative values, by sizes and grades, with percentages each size, of Pribilof sealskins sold at public auction in 1928

Classes and sales	Grade	Number	High	Low	Average	Total	Total number	Average price	Total price	Percentage
DYED BLACK										
Extra extra large:										
May 14	I and II	10	$42.50	$42.50	$42.50	$425.00	37	$27.72	$1,025.50	0.62
	Scarred, faulty, etc	25	23.50	23.50	23.50	587.50				
	III	2	6.50	6.50	6.50	13.00				
Oct. 15	I and II	11	31.50	31.50	31.50	346.50	41	19.67	806.50	.57
	Scarred, faulty, etc	20	18.50	18.50	18.50	370.00				
	III	10	9.00	9.00	9.00	90.00				
Extra large:										
May 14	I and II	230	45.00	42.00	42.52	9,780.00	413	32.94	13,604.50	6.89
	Scarred, faulty, etc	155	23.50	23.50	23.50	3,642.50				
	III	28	6.50	6.50	6.50	182.00				
Oct. 15	I and II	179	34.00	30.50	32.42	5,803.50	420	23.40	9,829.00	5.86
	Scarred, faulty, etc	215	19.00	16.50	17.63	3,791.50				
	III	26	9.00	9.00	9.00	234.00				
Large:										
May 14	I and II	1,560	41.50	35.50	38.13	59,480.00	2,275	33.30	75,750.00	37.95
	Scarred, faulty, etc	680	25.00	22.00	23.62	16,060.00				
	III	35	6.00	6.00	6.00	210.00				
Oct. 15	I and II	1,358	40.00	29.50	32.19	43,710.00	2,513	25.48	64,036.00	35.03
	Scarred, faulty, etc	1,086	21.50	16.50	18.30	19,877.50				
	III	69	6.50	6.50	6.50	448.50				
Medium:										
May 14	I and II	1,802	37.00	26.50	34.57	62,293.00	2,800	30.62	85,730.50	46.70
	Scarred, faulty, etc	970	25.00	21.00	23.95	23,227.50				
	III	28	7.50	7.50	7.50	210.00				
Oct. 15	I and II	1,918	32.00	25.50	28.69	55,028.00	3,646	22.93	83,619.00	50.82
	Scarred, faulty, etc	1,708	19.00	14.00	16.66	28,461.00				
	III	20	6.50	6.50	6.50	130.00				
Small medium:										
May 14	I and II	263	29.00	25.00	26.54	6,979.50	470	23.32	10,962.00	7.84
	Scarred, faulty, etc	200	21.00	19.00	19.65	3,930.00				
	III	7	7.50	7.50	7.50	52.50				
Oct. 15	I and II	217	24.50	22.00	22.63	4,911.50	554	17.57	9,736.50	7.72
	Scarred, faulty, etc	330	16.00	13.50	14.48	4,779.50				
	III	7	6.50	6.50	6.50	45.50				
All classes:										
May 14							5,995	31.20	187,072.50	100.00
Oct. 15							7,174	23.42	168,027.00	100.00

Comparative values, by sizes and grades, with percentages each size, of Pribilof sealskins sold at public auction in 1928—Continued

Classes and sales	Grade	Number	High	Low	Average	Total	Total number	Average price	Total price	Percentage
DYED LOGWOOD BROWN (BOIS DE CAMPÊCHE)										
Extra extra large:										
May 14	I and II	24	$58.00	$58.00	$58.00	$1,392.00	30	$53.00	$1,590.00	.75
	Scarred, faulty, etc	6	34.00	32.50	33.00	198.00				
Oct. 15	I and II	11	58.50	57.50	58.05	638.50	24	44.75	1,074.00	.43
	Scarred, faulty, etc	12	38.00	32.50	35.71	428.50				
	III	1	7.00	7.00	7.00	7.00				
Extra large:										
May 14	I and II	398	54.50	45.00	52.15	20,754.00	432	50.52	21,824.00	10.84
	Scarred, faulty, etc	32	34.00	26.50	33.00	1,056.00				
	III	2	7.00	7.00	7.00	14.00				
Oct. 15	I and II	156	59.50	56.50	58.03	9,052.00	333	45.38	15,110.50	5.92
	Scarred, faulty, etc	176	38.00	31.00	34.38	6,051.50				
	III	1	7.00	7.00	7.00	7.00				
Large:										
May 14	I and II	1,503	55.50	45.00	53.50	80,418.00	1,675	51.57	86,379.50	42.01
	Scarred, faulty, etc	165	41.00	26.50	35.83	5,912.50				
	III	7	7.00	7.00	7.00	49.00				
Oct. 15	I and II	1,367	65.50	52.50	55.68	76,117.50	2,373	46.42	110,146.50	42.20
	Scarred, faulty, etc	991	38.00	30.50	34.23	33,924.00				
	III	15	7.00	7.00	7.00	105.00				
Medium:										
May 14	I and II	1,395	54.50	42.50	51.60	71,985.00	1,622	48.06	77,947.00	40.68
	Scarred, faulty, etc	211	32.50	21.50	27.79	5,863.50				
	III	16	7.00	5.50	6.16	98.50				
Oct. 15	I and II	1,355	50.50	45.00	47.66	64,582.50	2,441	37.00	90,326.50	43.41
	Scarred, faulty, etc	1,040	29.50	22.00	24.47	25,450.00				
	III	46	7.00	6.00	6.39	294.00				
Small medium:										
May 14	I and II	104	54.50	37.50	41.65	4,332.00	228	29.64	6,759.00	5.72
	Scarred, faulty, etc	96	28.50	21.50	23.55	2,261.00				
	III	28	7.00	5.50	5.93	166.00				
Oct. 15	I and II	135	36.50	36.00	36.33	4,905.00	452	22.54	10,187.00	8.04
	Scarred, faulty, etc	270	20.00	16.50	18.67	5,040.00				
	III	47	6.00	5.00	5.15	242.00				
All classes:										
May 14							3,987	48.78	194,499.50	100.00
Oct. 15							5,623	40.34	226,844.50	100.00

57118—29——8

DYED GOLDEN CHESTNUT (CHÂTAIGNE D'OR)										
Extra extra large:										
Oct. 15	I and II	4	48.50	48.50	48.50	194.00	5	44.90	224.50	.77
	Scarred, faulty, etc	1	30.50	30.50	30.50	30.50				
Extra large:										
Oct. 15	I and II	20	48.50	47.50	48.35	967.00	45	37.21	1,674.50	6.96
	Scarred, faulty, etc	25	30.50	28.00	28.30	707.50				
Large:										
Oct. 15	I and II	117	48.50	45.50	46.77	5,472.50	279	33.72	9,406.50	43.12
	Scarred, faulty, etc	162	30.50	16.50	24.28	3,934.00				
Medium:										
Oct. 15	I and II	121	47.50	35.00	38.33	4,637.50	257	26.68	6,855.50	39.72
	Scarred, faulty, etc	136	30.50	14.50	16.31	2,218.00				
Small medium:										
Oct. 15	I and II	9	35.00	35.00	35.00	315.00	61	17.52	1,069.00	9.43
	Scarred, faulty, etc	52	14.50	14.50	14.50	754.00				
All classes:										
Oct. 15							647	29.72	19,230.00	100.00
Miscellaneous:										
Oct. 15	Dressed	14	.10	.10	.10	1.40	16	.10	1.60	100.00
	Raw salted	2	.10	.10	.10	.20				

DISPOSITION OF FUR-SEAL SKINS TAKEN AT PRIBILOF ISLANDS

On January 1, 1928, 32,613 fur-seal skins taken at the Pribilof Islands were on hand. Of these, 764 were at the Pribilof Islands, 31,838 at St. Louis, Mo., and 11 at Washington. In 1928, 31,099 Pribilof skins were secured at the islands and 23,687 were disposed of, leaving 40,025 on hand at December 31, 1928. The following tables show further details in regard to fur-seal skins taken on the Pribilof Islands, as well as details in regard to other Government-owned fur-seal skins under the control of the Department of Commerce:

Summary of Government-owned fur-seal skins in the custody of Fouke Fur Co., St. Louis, Mo., calendar year 1928

Source	On hand Jan. 1	Receipts in 1928	Sales in 1928	On hand Dec. 31
Taken on Pribilof Islands:				
Calendar year 1925	1			1
Calendar year 1926	7,659		7,658	1
Calendar year 1927	24,178	764	16,029	8,913
Calendar year 1928		30,298		30,298
United States' share of Japanese fur-seal skins:				
Season of 1927		161	161	
Confiscated fur-seal skins	3	5	8	
Total	31,841	31,228	23,856	39,213

Summary of all fur-seal skins handled on Pribilof Islands, calendar year 1928

Island	On hand Jan. 1	Number taken	Total handled	Number shipped	On hand Dec. 31
St. Paul	501	23,003	23,504	23,003	501
St. George	263	8,096	8,359	8,059	300
Total	764	31,099	31,863	31,062	801

Summary of all Government-owned fur-seal skins under control of Department of Commerce, calendar year 1928

Source	On hand Jan. 1	Receipts in 1928	Sales in 1928	On hand Dec. 31
Taken on Pribilof Islands:				
Calendar year 1918, held for reference purposes	7			7
Calendar year 1923	3			3
Calendar year 1924	1			1
Calendar year 1925	1			1
Calendar year 1926	7,659		7,658	1
Calendar year 1927	24,942		16,029	8,913
Calendar year 1928		31,099		31,099
Miscellaneous skins held for reference purposes	4			4
United States' share of Japanese sealskins, season of 1927		161	161	
Confiscated skins	3	5	8	
Total	32,620	31,265	23,856	[1] 40,029

[1] 801 skins at Pribilof Islands; 39,213 in custody of Fouke Fur Co.; 15 in custody Washington office, Bureau of Fisheries.

SHIPMENT AND SALE OF FOX SKINS

The 47 blue and 15 white fox skins taken on St. Paul Island in the season of 1927–28 and the 231 blue-fox skins taken on St. George Island in the same season were placed aboard the U. S. S. *Vega* for shipment in August. These 293 skins reached Seattle August 24 and were forwarded by express on the same date to the bureau's selling agents at St. Louis, Mo.

The 728 blue and 30 white fox skins taken at the Pribilof Islands in the season of 1926–27 were sold at public auction at St. Louis on May 14, 1928. The blue pelts sold for $44,657, an average of $61.34 per skin; the 30 white pelts for $1,439, an average of $47.97 per skin. These average prices compare with average prices of $55.39 for blues and $47.43 for whites at the last preceding sale of Pribilof Islands fox skins for the Government's account, held at St. Louis on October 3, 1927. At the May sale the maximum price per skin was $134, obtained for a blue pelt sold singly.

The 278 blue and the 15 white fox skins taken on the Pribilof Islands in the season of 1927–28 were sold at public auction at St. Louis on October 15, 1928. The blue pelts sold for $20,598, an average of $74.09 per skin; the 15 white pelts for $692, an average of $46.13 per skin. The maximum price per skin was $162, obtained for a blue pelt sold singly. Further details are given in the following tables:

Sale of 728 blue and 30 white fox skins at St. Louis, Mo., May 14, 1928

Lot No.	Number of skins	Trade classification	Price per skin	Total for lot
		BLUE-FOX SKINS		
301	1	Extra, extra fine	$117.00	$117.00
302	1	do	130.00	130.00
303	1	do	105.00	105.00
304	1	Extra fine	126.00	126.00
305	4	do	92.00	368.00
306	1	Extra fine silvery	130.00	130.00
307	2	Fine silvery	126.00	252.00
308	1	do	118.00	118.00
309	2	do	106.00	212.00
310	4	do	126.00	504.00
311	2	Fine	126.00	252.00
312	2	do	98.00	196.00
313	3	I	88.00	264.00
314	4	I dark	90.00	360.00
315	2	do	92.00	184.00
316	5	I silvery	110.00	550.00
317	4	do	110.00	440.00
318	4	I	84.00	336.00
319	3	I blue	82.00	246.00
320	1	I pale	66.00	66.00
321	7	II dark	64.00	448.00
322	2	III	16.00	32.00
323	5	Fine	88.00	440.00
324	1	Fine silvery	110.00	110.00
325	5	I dark	90.00	450.00
326	5	I	80.00	400.00
327	1	I silvery	116.00	116.00
328	1	do	94.00	94.00
329	6	I	86.00	516.00
330	5	I rusty	52.00	260.00
331	12	II	60.00	720.00
332	6	do	66.00	396.00
333	12	do	58.00	696.00
334	6	do	58.00	348.00
335	7	II silvery	66.00	462.00
336	5	II	58.00	290.00
337	7	II pale rusty	42.00	294.00
338	2	II	58.00	116.00
339	12	II low	48.00	576.00
340	6	do	50.00	300.00
341	12	do	40.00	480.00
342	10	II low small	50.00	500.00

Sale of 728 blue and 30 white fox skins at St. Louis, Mo., May 14, 1928—Continued

Lot No.	Number of skins	Trade classification	Price per skin	Total for lot
		BLUE-FOX SKINS—continued		
343	10	II low	$52.00	$520.00
344	10	III	30.00	300.00
345	5	Fine	98.00	490.00
346	3	Fine silvery	118.00	354.00
347	5	I dark	100.00	500.00
348	6	I rusty	62.00	372.00
349	4	I silvery	102.00	408.00
350	3	I	80.00	240.00
351	14	II dark	66.00	924.00
352	12	II	58.00	696.00
353	6	do	62.00	372.00
354	12	do	56.00	672.00
355	10	do	52.00	520.00
356	8	II silvery	76.00	608.00
357	9	II rusty	46.00	414.00
358	12	II low	46.00	552.00
359	8	do	48.00	384.00
360	10	II low large	49.00	490.00
361	9	II low	46.00	414.00
362	6	II low rusty	38.00	228.00
363	12	III	24.00	288.00
364	1	Extra extra fine	132.00	132.00
365	2	do	120.00	240.00
366	4	Extra fine	108.00	432.00
367	2	do	106.00	212.00
368	1	Extra fine silvery	134.00	134.00
369	1	Extra fine	110.00	110.00
370	2	Fine	108.00	216.00
371	3	Fine silvery	108.00	324.00
372	2	do	110.00	220.00
373	1	Fine	108.00	108.00
374	2	do	84.00	168.00
375	5	do	96.00	480.00
376	3	I dark	80.00	240.00
377	4	I	82.00	328.00
378	2	I silvery	116.00	232.00
379	7	do	88.00	616.00
380	4	I	86.00	344.00
381	3	I blue	76.00	228.00
382	5	I pale	70.00	350.00
383	7	II low	50.00	350.00
384	5	Fine	94.00	470.00
385	4	Fine silvery	92.00	368.00
386	4	I dark	74.00	296.00
387	6	I	65.00	390.00
388	3	I silvery	86.00	258.00
389	3	I	74.00	222.00
390	14	II dark	60.00	840.00
391	12	II	60.00	720.00
392	8	do	52.00	416.00
393	6	do	54.00	324.00
394	9	II rusty	42.00	378.00
395	12	II silvery	64.00	768.00
396	8	II	52.00	416.00
397	7	II low	38.00	266.00
398	12	II low large	40.00	480.00
399	12	II low	46.00	552.00
400	12	do	32.00	384.00
401	6	II low rusty	32.00	192.00
402	12	III	18.00	216.00
403	5	Fine	82.00	410.00
404	4	Fine silvery	104.00	416.00
405	6	I	80.00	480.00
406	6	do	76.00	456.00
407	5	I silvery	93.00	465.00
408	7	I	70.00	490.00
409	14	II dark	56.00	784.00
410	12	II	55.00	660.00
411	7	do	52.00	364.00
412	7	do	54.00	378.00
413	11	II rusty	48.00	528.00
414	7	II silvery	64.00	448.00
415	6	II	48.00	288.00
416	3	do	46.00	138.00
417	9	II low	38.00	342.00
418	12	do	44.00	528.00
419	9	do	48.00	432.00
420	10	II low large	44.00	440.00
421	11	II low	40.00	440.00
422	4	IV	1.00	4.00
	728			44,657.00

Sale of 728 blue and 30 white fox skins at St. Louis, Mo., May 14, 1928—Continued

Lot No.	Number of skins	Trade classification	Price per skin	Total for lot
		WHITE-FOX SKINS		
430	13	I	$58.00	$754.00
431	13	II	44.00	572.00
432	1	III	5.00	5.00
433	3	Skins	36.00	108.00
	30			1,439.00
	758			46,096.00

Sale of 278 blue and 15 white fox skins at St. Louis, Mo., October 15, 1928

Lot No.	Number of skins	Trade classification	Price per skin	Total for lot
		BLUE-FOX SKINS		
401	1	Extra extra fine	$140.00	$140.00
402	1	do	161.00	161.00
403	1	do	126.00	126.00
404	1	Extra fine	120.00	120.00
405	1	do	119.00	119.00
406	1	do	133.00	133.00
407	2	Fine silvery	139.00	278.00
408	1	do	133.00	133.00
409	1	do	115.00	115.00
410	4	Fine	112.00	448.00
411	2	do	73.00	146.00
412	2	I silvery	115.00	230.00
413	4	I blue	88.00	352.00
414	1	I pale silvery	100.00	100.00
415	2	II dark	85.00	170.00
416	1	II silvery	72.00	72.00
417	3	II blue	61.00	183.00
418	1	Extra extra fine	162.00	162.00
419	1	do	110.00	110.00
420	1	Extra fine	116.00	116.00
421	1	do	78.00	78.00
422	1	do	132.00	132.00
423	1	Fine silvery	133.00	133.00
424	1	do	105.00	105.00
425	1	do	117.00	117.00
426	1	Fine	85.00	85.00
427	1	do	86.00	86.00
428	2	I	61.00	122.00
429	1	I blue	96.00	96.00
430	1	I rusty	62.00	62.00
431	1	II	59.00	59.00
432	3	II low	32.00	96.00
433	2	Extra fine	144.00	288.00
434	3	Fine	96.00	288.00
435	4	do	84.00	336.00
436	1	Fine silvery	143.00	143.00
437	1	do	131.00	131.00
438	3	I dark	84.00	252.00
439	6	do	81.00	486.00
440	2	I	77.00	154.00
441	5	do	75.00	375.00
442	6	do	80.00	480.00
443	7	do	79.00	553.00
444	7	I rusty	67.00	469.00
445	5	I silvery	95.00	475.00
446	4	do	87.00	348.00
447	10	II dark	69.00	690.00
448	8	do	60.00	480.00
449	7	II	62.00	434.00
450	8	do	53.00	424.00
451	2	II rusty	53.00	106.00
452	3	II silvery	70.00	210.00
453	3	do	58.00	174.00
454	2	do	61.00	122.00
455	5	do	73.00	365.00
456	4	II low	46.00	184.00
457	4	do	49.00	196.00
458	2	Extra fine	139.00	278.00
459	2	Fine	92.00	184.00

Sale of 278 blue and 15 white fox skins at St. Louis, Mo., October 15, 1928—Contd.

Lot No.	Number of skins	Trade classification	Price per skin	Total for lot
		BLUE-FOX SKINS—continued		
460	1	Fine silvery	$132.00	$132.00
461	1	do	104.00	104.00
462	6	I dark	81.00	486.00
463	3	do	70.00	210.00
464	3	do	75.00	225.00
465	2	I	74.00	148.00
466	7	do	75.00	525.00
467	10	do	78.00	780.00
468	7	do	67.00	469.00
469	7	I rusty	64.00	448.00
470	5	I silvery	96.00	480.00
471	2	do	87.00	174.00
472	1	do	121.00	121.00
473	2	do	69.00	138.00
474	2	do	73.00	146.00
475	1	do	110.00	110.00
476	1	I blue	68.00	68.00
477	4	I and II silvery	75.00	300.00
478	8	II dark	59.00	472.00
479	8	do	61.00	488.00
480	9	II	56.00	504.00
481	3	do	56.00	168.00
482	2	II silvery	65.00	130.00
483	2	do	52.00	104.00
484	2	do	68.00	136.00
485	6	II low	39.00	234.00
486	6	III	14.00	84.00
487	4	IV	1.00	4.00
	278			20,598.00
		WHITE-FOX SKINS		
491	3	I	67.00	201.00
492	8	II	50.00	400.00
493	2	II stained	30.50	61.00
494	2	II low	15.00	30.00
	15			692.00
	293			21,290.00

FUR-SEAL PATROL

UNITED STATES COAST GUARD

Four cutters, the *Haida*, *Snohomish*, *Unalga*, and *Northland*, were assigned by the United States Coast Guard to take part in the patrol for the protection of fur seals and sea otters in the waters of the North Pacific Ocean.

Beginning in the early part of April the *Snohomish* patrolled from the southern boundary of Washington to Dixon Entrance, southeast Alaska. The *Unalga* patrolled from Dixon Entrance northward and westward to Unalaska and then took part in the general patrol in the Bering Sea region. The *Haida* patrolled from Seattle to Unalaska, and then from Unalaska as headquarters. The season's patrol extended as far westward as Attu, the westernmost of the Aleutian Islands, and was prosecuted as long as the circumstances required.

BUREAU OF FISHERIES

The fisheries patrol boat *Brant* began a patrol of the waters off Cape Flattery in April and continued on this work until in the early part of June. The *Auklet* took part in seal patrol in the vicinity of Sitka in May, and the *Widgeon* also patrolled in that region in June.

SEALING PRIVILEGES ACCORDED ABORIGINES

The North Pacific Sealing Convention of July 7, 1911, permits Indians and other aborigines dwelling on the coasts of the waters designated by the convention to take fur-seal skins under certain specified conditions. There have been authenticated by agents of the Government 1,481 fur-seal skins taken in 1928 by Indians in the waters off the coasts of Washington and southeast Alaska. The details are as follows:

Washington.—A total of 708 skins were taken by the Indians of Washington. Of these, 252 were from male seals and 456 from females. Dr. Carl B. Boyd, superintendent of the Neah Bay Indian Agency, Neah Bay, Wash., authenticated the skins.

Alaska.—Seven hundred and seventy-three skins were taken in the waters off Biorka Island and Cape Edgecombe by natives of Sitka, of which 457 were from males, 220 from females, and 96 from unborn pups.

An official report received by the bureau stated that 2,421 sealskins were taken by natives of British Columbia in 1928.

JAPANESE SEALSKINS DELIVERED TO THE UNITED STATES

The North Pacific Sealing Convention of July 7, 1911, provides that 10 per cent of the fur-seal skins taken annually upon Robben Island, or any other islands or shores of waters defined therein subject to the jurisdiction of Japan, shall be turned over to the United States Government, unless the number of seals frequenting the Japanese islands falls below 6,500 enumerated by official count.

The United States' share of fur-seal skins taken in 1927 under the jurisdiction of Japan was 161 skins. These were received at St. Louis on March 28, 1928, and were sold at public auction on October 15. One hundred and forty-four were sold dressed, dyed, and machined, 1 washed and dried, and 16 raw salted. Details of the sale are given on page 314.

The United States' share of fur-seal skins taken under the jurisdiction of Japan in 1928 was 152 skins. They were received at St. Louis in January, 1929.

FUR SEALS FOR EXHIBITION

On September 20 there were placed aboard the Coast Guard cutter *Haida* at St. Paul Island six 2-year-old fur seals (two males and four females) to be forwarded for exhibition purposes at the Steinhart Aquarium, Golden Gate Park, San Francisco, and at the National Zoological Park, Washington, D. C. The consignment was later transferred to the Coast Guard cutter *Northland* and was delivered to the Steinhart Aquarium on October 5. One of the animals, a male, died en route. Three of the seals (one male and two females) were later shipped to Washington, D. C., and on December 8 were delivered to the National Zoological Park. In the latter part of December one of the animals retained at the Steinhart Aquarium and one of the three shipped to Washington died.

Due to the interest that attaches to fur seals generally and to the scarcity of living specimens in captivity, the animals make an especially attractive exhibit. The Steinhart Aquarium and the

National Zoological Park contain the only Alaska fur seals on exhibition in the country.

FUR SEALS AT ST. LAWRENCE ISLAND

Through Capt. J. F. Hottel, commanding U. S. Coast Guard cutter *Northland*, it was learned that three fur seals were killed by natives of Gamble, St. Lawrence Island, in December, 1927. Two were killed on the ice and one on land. The skins from these animals were seen by Captain Hottel, and no doubt exists as to their identification. Two of the skins were from medium-sized males and the third was from a seal somewhat smaller. Captain Cochran, of the U. S. Coast Guard, who has made many trips to the Arctic regions, has stated that he has knowledge of an occasional fur seal having been killed in the vicinity of Gamble from time to time, but never more than one in a season. The presence of these stray animals so far from the limits of their regular migration route is recorded as a matter of scientific interest.

GUADALUPE FUR SEALS

Recently considerable attention has been directed to the Guadalupe fur seals. These animals were first described as a distinct species by Dr. C. Hart Merriam, the description being published in the Proceedings of the Biological Society of Washington for 1897. The species was given the name *Arctocephalus townsendi*. No living specimens were available at the time the species was described, and apparently none had been preserved in any museum, the description being based on four skulls collected on the beach at Guadalupe Island in 1892 by Dr. Charles H. Townsend, now director of the New York Aquarium. The Guadalupe fur seal formerly occupied not only Guadalupe Island but other islands off Lower California, and there is some reason for believing that it was this species that formerly occupied the Farallone Islands.

For years the Guadalupe fur seal was thought to be virtually extinct, but in 1928 the Zoological Garden at San Diego, Calif., received two fur seals that were identified as Guadalupe fur seals. The location of the herd from which these seals were secured was not made public. It also appears that these seals are still in existence in considerably greater numbers than had been thought, and that they are present over a considerable area of coastal waters.

Following correspondence with the San Diego Zoological Society and with Dr. Charles H. Townsend, representing the New York Zoological Society, the question of giving international protection to these seals was taken up with the State Department. In December the State Department received from the American Embassy at Mexico City a memorandum, dated November 28, 1928, from the Mexican Foreign Office, as follows:

> The Ministry of Agriculture and Fomento, in an official statement, No. 26150, of the 14th instant, reports that by a resolution adopted on July 6, 1928, the island of Guadalupe and the territorial waters surrounding it were declared restricted, with a view to the protection of the breeding grounds of fur seals, situated off the coasts of Lower California.
>
> The above-mentioned ministry has issued instructions to the Department of Fisheries in Lower California, advising it to inform those shipping companies which send their vessels to fish in Mexican waters to order their captains and

owners not to molest nor to allow their crews and fishermen to capture elephant seals and fur seals, nor to accept these animals for transportation when requested to do so by private individuals.

In conclusion, the Ministry of Agriculture and Fomento points out that if the Government of the United States will issue similar instructions to the fishing authorities in California, an efficacious cooperation will be established between the Mexican and American Governments that will secure the protection necessary to avoid the extinction of fur seals and elephant seals.

It is noted that the Mexican authorities are heartily in accord with the desire to preserve the Guadalupe fur seal and that they have also afforded protection to the elephant seals.

COMPUTATION OF FUR SEALS, PRIBILOF ISLANDS, 1928

By Harry J. Christoffers

The count of harem and idle bulls was made on St. Paul Island on July 16 to 19, inclusive, and on St. George Island on July 20 to 23, inclusive. Special Agent A. Christoffersen accompanied the writer and verified all counts. The count on South Rookery, St. George Island, was made by H. L. Oliver, schoolteacher. Some portions of Reef Rookery, St. Paul Island, could not be counted, as the harem area had increased to such an extent that it was impossible for the enumerators to find a place from which they could observe the inclined area between the water and higher land. These places could be observed from the tripods but were rather distant for an accurate count. In such places very careful conservative estimates were made.

Assuming that the harem areas will continue to expand at the same rate as during the last few years, it will soon be necessary for the bachelors to find new hauling grounds, as in some instances they are now closely hemmed in between breeding areas. A number of harems were situated on hauling grounds this season.

Weather conditions prevented a harem and idle bull count on Sivutch Rookery this year. A conservative estimate has been included.

It was the intention to make an actual count of pups on all rookeries this season. However, when the greatly extended harem areas were observed and the large number of surplus bulls noted, the taking of a pup count was deemed impractical, as it would have been the cause of killing large numbers of pups.

It would be possible to take a pup count on all but the larger rookeries, but this would result in a very inaccurate estimate of the growth of the herd as a whole, as the larger rookeries, if conditions are anywhere near favorable, will increase much faster than the sm ller rookeries. In addition, late ice around the islands or other natural conditions cause individual rookery growth to vary considerably from year to year, even though the growth of the herd as a whole is not affected. For this reason, any estimates as to the average growth of the herd will give a very inaccurate estimate when applied to individual rookeries, as uncontrollable conditions often cause them to decrease for a given season, but other rookeries will increase proportionately to take care of the decrease of the individual rookery. If the average rate of increase of 8 per cent is hereafter applied to pups and cows it will answer all practical purposes for determining the increase of the herd as a whole.

The above statement may also be applied to the growth of the herd on each island. In previous years it has been shown that ice conditions caused a great many seals credited to St. Paul Island to haul out and remain at St. George Island for the season.

The ice pack remained around the islands so late this season that it was necessary for early arriving bulls to haul out on ice-covered rookeries. Kitovi and Lukanin were covered with ice until after the first week of June. This accounts for the actual decrease in the number of bulls on these rookeries as compared with the count for 1927.

BULLS

A great many iron-branded 8-year-old bulls were observed on the rookeries and also among the surplus bulls on the hauling grounds. These 8-year-old surplus bulls should all be holding harems or at least should be idle bulls. This brings up the question of the difference between idle and surplus bulls. Whether an 8-year-old bull, or other mature bull, becomes a harem bull, idle bull, or surplus bull depends considerably on the time of his arrival in the spring. Weaker and younger bulls in some instances have harems. If a mature bull arrives early and secures a good position he becomes a harem bull; if he arrives too late he must remain in the rear of the rookery and become an idle bull for the major part of the season, or he may remain on the hauling grounds and be classed as a surplus bull. Often, bulls that are surplus during the major part of the season secure harems in the rear of the rookeries before the season is over. Surplus bulls will and do become idle and harem bulls when the cows become so plentiful that they work to the rear of the rookeries. Many bulls take up positions as idle bulls early in the spring and only secure a cow or two after the rookeries have become thickly populated. Surplus bulls may remain on the hauling grounds until after the middle of July and then secure fair-sized harems. Most of the idle bulls are easily driven from their positions and then become surplus bulls.

After a drive, where hauling grounds are situated in the center of rookeries, as on Gorbatch, Zapadni, and Reef, many of the idle bulls are disturbed and join the hauling-ground males as surplus bulls. It follows that if a count of bulls is made shortly after a drive very few idle bulls will be found, while if a count is made the day before a drive several times as many may be present in the rear of the harem areas.

From a breeding standpoint, there is no difference between an idle bull and a surplus bull. Both are potential breeders and in most cases will breed before the end of the season. Most of the idle bulls, being close to the harem bulls, will secure cows having pups. Most of the surplus bulls will breed with virgin cows before the end of the season. There is, therefore, no valid reason for retaining the two classifications of surplus and idle bulls unless the total number of the two classes is considered in determining whether there are sufficient mature bulls to take care of virgin cows and late arriving pregnant cows. It is impossible to make an accurate count of surplus bulls and likewise impossible to make an accurate count of idle bulls, as the number varies considerably from day to day, more especially after drives.

It is obviously inaccurate to state that there must be one idle bull for every five harem bulls, without also taking into consideration the surplus bulls. Considerable attention must be given to personal observations made throughout the season, as surplus bulls can not be accurately counted. It is believed that there are now sufficient surplus and idle bulls on the rookeries to answer present requirements.

Skins from seals killed early this season appeared to have a larger percentage of "bites" on them than usual. This may have been due to the greater number of large seals in drives, especially during the early part of the season.

Number of harem and idle bulls, approximate ratio of idle bulls to harem bulls, and average harem, 1928

Rookery	Date	Harem bulls	Idle bulls	Total	Approximate ratio of idle bulls to harem bulls	Average harem
St. Paul Island:						
Kitovi	July 16	198	39	237	1:5	47.56
Lukanin	do	81	16	97	1:5	56.21
Gorbatch	July 17	467	111	578	1:4	51.20
Ardiguen	do	57	5	62	1:11	39.68
Reef	do	1,028	254	1,282	1:4	46.72
Sivutch (estimated)		350	75	425	1:5	41.99
Lagoon	July 16	2	0	2		57.50
Tolstoi	do	459	97	556	1:5	61.60
Zapadni	do	373	99	472	1:4	72.84
Little Zapadni	do	208	58	266	1:4	66.59
Zapadni Reef	do	23	7	30	1:3	20.91
Polovina	July 18	278	69	347	1:4	35.12
Polovina Cliffs	do	147	38	185	1:4	36.37
Little Polovina	do	48	9	57	1:5	40.56
Morjovi	July 19	159	38	197	1:4	22.01
Vostochni	do	1,181	293	1,474	1:4	32.99
Total		5,059	1,208	6,267	1:4	45.91
St. George Island:						
North	July 21	358	92	450	1:4	52.93
Staraya Artil	do	236	48	284	1:5	60.50
Zapadni	July 20	99	28	127	1:4	20.35
South	July 23	30	17	47	1:2	15.73
East Reef	July 22	89	19	108	1:5	48.80
East Cliffs	do	179	37	216	1:5	69.25
Total		991	241	1,232	1:4	52.93
Total (both islands)		6,050	1,449	7,499	1:4	47.06

AVERAGE HAREM

Inasmuch as the pups were not counted in 1928, the average harem is only estimated. The average rate of increase of 8 per cent for cows and pups will answer for all practical purposes, and therefore it was used in making the computation for this year, except in the case of Lagoon Rookery, where an actual count was made. It has been the custom to include an actual count for this rookery, as it has long been a declining rookery, and it was therefore presumed that it would soon disappear.

On account of the increase in harem and idle bulls as a result of the creation of a marked reserve the average harem shows a satisfactory decrease.

Computation of breeding cows, based on annual increase of 8 per cent, and of average harems, in 1928

Rookery	Breeding cows		Harem bulls, 1928	Average harem		Increase (+) or decrease (−) in 1928 from 1927
	1927	1928		1928	1927	
St. Paul Island:						
Kitovi	8,719	9,417	198	47.56	37.58	+9.98
Lukanin	4,216	4,553	81	56.21	47.37	+8.84
Gorbatch	22,139	23,910	467	51.20	67.50	−16.30
Ardiguen	2,094	2,262	57	39.68	51.07	−11.39
Reef	44,470	48,028	1,028	46.72	62.46	−15.74
Sivutch	13,607	14,696	350	41.99	42.66	−.67
Lagoon (actual count pups)	40	115	2	57.50	40.00	+17.50
Tolstoi	26,179	28,273	459	61.60	66.95	−5.35
Zapadni	25,158	27,171	373	72.84	74.43	−1.59
Little Zapadni	12,824	13,850	208	66.59	62.86	+3.73
Zapadni Reef	445	481	23	20.91	24.72	−3.81
Polovina	9,041	9,764	278	35.12	50.23	−15.11
Polovina Cliffs	4,950	5,346	147	36.37	38.37	−2.00
Little Polovina	1,803	1,947	48	40.56	37.56	+3.00
Morjovi	3,241	3,500	159	22.01	34.12	−12.11
Vostochni	36,075	38,961	1,181	32.99	45.61	−12.62
Total	215,001	232,274	5,059	45.91	54.90	−8.99
St. George Island:						
North	17,544	18,948	358	52.93	60.50	−7.57
Staraya Artil	13,219	14,277	236	60.50	84.74	−24.24
Zapadni	1,866	2,015	99	20.35	32.74	−12.39
South	437	472	30	15.73	23.00	−7.27
East Reef	4,021	4,343	89	48.80	70.54	−21.74
East Cliffs	11,478	12,396	179	69.25	77.55	−8.30
Total	48,565	52,451	991	52.93	66.80	−13.87
Total (both islands)	263,566	284,725	6,050	47.06	56.77	−9.71

PUPS AND COWS

The average rate of increase of 8 per cent, as determined from complete pup counts made in 1917 and in 1922, has been used to compute the number of pups and cows this season. An actual count was made on Lagoon Rookery only. The percentage of dead pups found in 1922 has also been applied to each rookery. Until some abnormal condition appears, these percentages should work out approximately correct.

In 1927 the cows arrived at the usual time, but the bachelors reached the islands much later than usual.

In 1928 the bachelors arrived early, while the cows were much later than usual. Comparatively few cows had arrived by July 10, but they appeared in large numbers between July 10 and 15.

The seasons of 1927 and 1928 were both abnormally cold. It is possible that in 1927 the cows were not bred quite as quickly after the pups were born.

On July 7 two females were observed at Polovina fighting over a pup. Each female secured a good hold on the pup and refused to let go. They fought for a considerable period and each attempted to take the pup away from the other. It is possible that one of the cows may have lost her pup.

Distribution of pups on the Pribilof Islands, August 10, 1928, and comparison with distribution in 1927

Rookery	1928 Living pups	1928 Dead pups	1928 Total pups	1928 Per cent dead pups	1927, total pups	1928, increase
St. Paul Island:						
Kitovi	9,279	138	9,417	1.47	8,719	698
Lukanin	4,454	99	4,553	2.17	4,216	337
Gorbatch	23,704	206	23,910	.86	22,139	1,771
Ardiguen	2,208	54	2,262	2.39	2,094	168
Reef	47,327	701	48,028	1.46	44,470	3,558
Sivutch	14,337	359	14,696	2.44	13,607	1,089
Lagoon (actual count)	114	1	115	.87	40	75
Tolstoi	27,880	393	28,273	1.39	26,179	2,094
Zapadni	26,704	467	27,171	1.72	25,158	2,013
Little Zapadni	13,504	346	13,850	2.50	12,824	1,026
Zapadni Reef	477	4	481	.80	445	36
Polovina	9,615	149	9,764	1.53	9,041	723
Polovina Cliffs	5,247	99	5,346	1.85	4,950	396
Little Polovina	1,898	49	1,947	2.51	1,803	144
Morjovi	3,429	71	3,500	2.02	3,241	259
Vostochni	38,151	810	38,961	2.08	36,075	2,886
Total	228,328	3,946	232,274	1.70	215,001	17,273
St. George Island:						
North	18,683	265	18,948	1.40	17,544	1,404
Staraya Artil	13,909	368	14,277	2.58	13,219	1,058
Zapadni	1,992	23	2,015	1.12	1,866	149
South	464	8	472	1.72	437	35
East Reef	4,277	66	4,343	1.51	4,021	322
East Cliffs	12,211	185	12,396	1.49	11,478	918
Total	51,536	915	52,451	1.74	48,565	3,886
Total (both islands)	279,864	4,861	284,725	1.71	263,566	21,159

MORTALITY OF SEALS AT SEA

In 1925, owing to the information secured through branding operations of 1923 and 1924, the mortality rates for loss at sea during the first three years were greatly increased. In 1927 observations as to the number of 3-year-old males on hauling grounds after the end of the killing season indicated that the new mortality rates established in 1925 were somewhat too high. This season (1928) there should have been, according to the mortality rates established in 1925, a total of 34,937 3-year-old males. As a matter of fact, 28,539 3-year-old males were killed and 8,852 were branded up to August 10, making a total of 37,391 3-year-old males handled during the season. Observations indicated that there were still some unbranded 3-year-old males on the hauling grounds at the close of the season. It is, of course, well known that it is impossible to handle every 3-year-old male during the season.

It may be that the 1928 generation of 3-year-olds had a very low mortality rate during the first three years at sea, possibly lower than the average. Favorable conditions may have lowered the mortality rate for all classes of seals in the past three years. It might also be that a larger percentage than usual hauled out this season.

Applying the mortality rates used prior to 1925 to this season's generation of 3-year-olds (40 per cent for the first year, 17.5 per cent for the second year, and 12.5 per cent for the third year), there should have been 47,833 3-year-old males on hand this season.

Observations and available evidence do not indicate that there were that many.

Applying a 50 per cent mortality rate for the first year, 17.5 per cent for the second year, and 12.5 per cent for the third year would give a total of 39,672 3-year-old males for this season. Inasmuch as the total number killed and reserved indicates that at least this number was on hand, these mortality rates will be applied to the present computation. Therefore, an adjustment has been made in the present computation to take care of the greater number of seals due to declining of mortality rate from 25 per cent to 17.5 per cent in the second year (1927) of the 1928 generation of 3-year-old males.

The mortality rate for 2-year-old females has been reduced from 22.5 per cent to 15 per cent in the present computation. This is the same rate as was used prior to 1925. An additional adjustment for mortality rates of yearlings may be necessary another season.

COMPLETE COMPUTATION

Following is a summary of the method used for computing the number of animals in the Pribilof Islands fur-seal herd in 1928, together with a recapitulation of the herd by classes. It will be noted that the increase in the total number of seals over 1927 was 62,643, or 7.74 per cent. The increase in 1927 over 1926 was 47,589, or 6.25 per cent.

Complete computation of fur seals, Pribilof Islands, as of August 10, 1928

Class	St. Paul Island	St. George Island	Total
Pups, estimated	232,274	52,451	284,725
Breeding cows, 3 years old and over, by inference	232,274	52,451	284,725
Harem bulls, counted	5,059	991	6,050
Idle bulls, counted	1,208	241	1,449
Yearlings, male and female, estimated:			
Females born in 1927	107,501	24,282	131,783
Natural mortality, 45 per cent	48,375	10,927	59,302
Yearling females, Aug. 10, 1928	59,126	13,355	72,481
Males born in 1927	107,500	24,283	131,783
Natural mortality, 50 per cent	53,750	12,142	65,892
Yearling males beginning 1928	53,750	12,141	65,891
Yearling males killed 1928	29	1	30
Yearling males, Aug. 10, 1928	53,721	12,140	65,861
2-year-olds, male and female, estimated:			
Yearling females, Aug. 10, 1927	54,765	12,366	67,131
Natural mortality, 15 per cent	8,215	1,855	10,070
2-year-old females, Aug. 10, 1928	46,550	10,511	57,061
Yearling males, Aug. 10, 1927	49,784	11,242	61,026
Yearling males killed fall 1927	....	....	....
Yearling males end of 1927	49,784	11,242	61,026
Natural mortality, 17.5 per cent	8,712	1,967	10,679
2-year-olds beginning 1928	41,072	9,275	50,347
2-year-olds killed 1928	1,072	188	1,260
2-year-old males, Aug. 10, 1928	40,000	9,087	49,087

Complete computation of fur seals, Pribilof Islands, as of August 10, 1928—Con.

Class	St. Paul Island	St. George Island	Total
3-year-old males, estimated:			
2-year-old males, Aug. 10, 1927 (on basis former mortality rate)	33,507	7,745	41,252
Adjustment to decrease mortality rate from 25 to 17.5 per cent	3,458	780	4,238
	36,965	8,525	45,490
2-year-old males killed fall 1927	87	63	150
2-year-old males end of 1927	36,878	8,462	45,340
Natural mortality, 12.5 per cent	4,610	1,058	5,668
3-year-old males beginning 1928	32,268	7,404	39,672
3-year-old males killed 1928	21,036	7,503	28,539
3-year-old males, Aug. 10, 1928	(1)	(1)	11,133
4-year-old males, estimated:			
3-year-old males, Aug. 10, 1927	9,475	255	9,730
3-year-old males killed fall 1927	406	200	606
3-year-old males end of 1927	9,069	55	9,124
Natural mortality, 10 per cent	907	5	912
4-year-old males beginning 1928	8,162	50	8,212
4-year-old males killed 1928	338	76	414
4-year-old males, Aug. 10, 1928	(1)	(1)	7,798
5-year-old males, estimated:			
4-year-old males, Aug. 10, 1927	(1)	(1)	14,448
4-year-old males killed fall 1927			
4-year-old males end of 1927			14,448
Natural mortality, 10 per cent			1,445
5-year-old males beginning 1928			13,003
5-year-old males killed 1928			2
5-year-old males, Aug. 10, 1928	(1)	(1)	13,001
6-year-old males, estimated:			
5-year-old males, Aug. 10, 1927	15,349	724	16,073
5-year-old males killed fall 1927			
5-year-old males end of 1927	15,349	724	16,073
Natural mortality, 20 per cent	3,070	145	3,215
6-year-old males beginning 1928	12,279	579	12,858
6-year-old males killed 1928	1		1
6-year-old males, Aug. 10, 1928	12,278	579	12,857
Surplus bulls, 7 years and over, estimated:			
6-year-old males, Aug. 10, 1927	12,099	1,351	13,450
6-year-old males killed fall 1927			
6-year-old males end of 1927	12,099	1,351	13,450
Natural mortality, 20 per cent	2,420	270	2,690
7-year-old males beginning 1928	9,679	1,081	10,760
7-year-old males killed 1928			
7-year-old males, Aug. 10, 1928	9,679	1,081	10,760
Surplus bulls, Aug. 10, 1927	4,470	357	4,827
Natural mortality, 30 per cent	1,341	107	1,448
Remaining surplus for 1928	3,129	250	3,379
Breeding bulls of 1927	4,762	853	5,615
Natural mortality, 30 per cent	1,429	256	1,685
1927 bulls remaining 1928	3,333	597	3,930
Breeding bulls 1928	6,267	1,232	7,499
1927 bulls remaining, deducted	3,333	597	3,930
Increment of new bulls in 1928	2,934	635	3,569

[1] It appears that a large number of 3, 4, and 5 year old seals credited to St. Paul Island hauled out on St. George Island.

Complete computation of fur seals, Pribilof Islands, as of August 10, 1998—Con.

Class	St. Paul Island	St. George Island	Total
Surplus bulls, 7 years and over, estimated—Continued.			
7-year-old males computed for 1928	9,679	1,081	10,760
Surplus bulls computed for 1928	3,129	250	3,379
Total theoretical surplus bull stock 1928	12,808	1,331	14,139
New increment of breeding bulls deducted	2,934	635	3,569
Surplus bulls in 1928	9,874	696	10,570
50 per cent deducted for losses due to fighting, natural causes, and errors in loss percentage in previous years	4,937	348	5,285
Surplus bulls, Aug. 10, 1928	4,937	348	5,285

RECAPITULATION

Class	Total	Class	Total
Pups	284,725	5-year-old males	13,001
Cows	284,725	6-year-old males	12,857
Harem bulls	6,050	Surplus bulls	5,285
Idle bulls	1,449	Total, 1928	871,513
Yearling females	72,481		
Yearling males	65,861	Total, 1927	808,870
2-year-old females	57,061	Numerical increase, 1928	62,643
2-year-old males	49,087	Per cent increase, 1928	7.74
3-year-old males	11,133		
4-year-old males	7,798		

O

BIBLIOGRAPHY ON COD-LIVER OIL IN ANIMAL FEEDING, WITH NONCRITICAL COMMENTS AND ABSTRACTS[1]

By JOHN RUEL MANNING

Associate Technologist, U. S. Bureau of Fisheries

CONTENTS

INTRODUCTION

The purpose of this publication is to give a review and bibliography of the researches, both American and foreign, in the field of the experimental feeding of cod-liver oil to various species of animals, including comments on the results of these researches. Every effort has been made to condense the contents and to make this treatise concise. The details, except the very essential ones, of the voluminous experiments conducted by numerous investigators have been omitted, for to burden the reader with such a mass of material would defeat the purpose of this publication.

This manuscript is intended not only for the scientist or biochemist, but also the animal feeder and for those engaged in the production of cod-liver oil. For this reason, in that it must serve a dual purpose, it has been somewhat difficult to arrange the subject matter in order that it may render maximum usefulness to all. It is believed that the animal feeder and the fishery industry concerned will gain full knowledge of the text by reading the introduction and conclusions and possibly the section on vitamin content of cod-liver oil. The rest of the publication consists of brief abstracts of the published researches in this field of investigation and is designed primarily for the research worker, to enable him to determine the

[1] Appendix VII to the Report of the U. S. Commissioner of Fisheries for 1929. B. F. Doc. No. 1065. Submitted for publication May 8, 1929.

nature and contents of the published data so that he may more easily select, from the bibliography, those references of particular interest to him.

For the benefit of those readers who may wish to study the history and development of the cod-liver oil industry, the chemical and physical characteristics, methods of preparation or manufacture, and methods of assay or estimation (biological and chemical), there are listed in the bibliography a number of references covering these subjects which have not been discussed in this publication.

Cod-liver oil is produced from cod and related species taken in our North Atlantic fisheries. Until recently a comparatively small quantity of the cod livers taken has been utilized. In 1926 the United States produced only 2 per cent of the world supply. If all of the livers available from the present catch in the United States were utilized, the maximum potential annual production would be approximately 800,000 gallons of oil, or about 45 per cent of domestic consumption. Following are statistics of the domestic production and imports for consumption of cod oil and cod-liver oil, as obtained from reports published by the Bureau of Fisheries and the Bureau of Foreign and Domestic Commerce:

Year	Domestic production of crude cod-liver oil	Imports for consumption	
		Cod oil	Cod-liver oil
	Gallons	*Gallons*	*Gallons*
1924	106,415	1,915,657	930,931
1925	138,345	1,755,070	1,220,440
1926	175,516	2,425,599	1,921,422
1927	283,817	2,114,264	2,375,297
1928	267,882	1,569,234	2,571,936

The principal countries of the world in which cod oil and cod-liver oil are produced are Norway, Denmark, Germany, Iceland, the Netherlands, the United Kingdom, Canada, Miquelon and St. Pierre Islands, Newfoundland and Labrador, Japan, Latvia, and the United States.

A general review of the literature indicates the following facts:

SUMMARY

Experiments of the various investigators feeding cod-liver oil may be summarized as follows:

1. The vitamin content of cod-liver oils varies according to methods of manufacture, food and condition of the fish, and other factors influencing the quality of the oils; therefore, an assay of cod-liver oil purchased for feeding purposes is necessary.
2. Growth of young farm animals is promoted to the extent that profitable returns can be realized from the marked increases in weight and rapidity of growth.
3. By aiding calcium and phosphorus assimilation, cod-liver oil assures strong, well-formed bones in growing animals.
4. The iodine content of milk is increased by feeding cod-liver oil.
5. All authorities are agreed that the mortality rate in baby chicks is reduced considerably.

6. Ruffled plumage in poultry is prevented by feeding a good grade of cod-liver oil.

7. There is some difference of opinion as to the improvement in egg production, but the majority of investigations, particularly those of more recent date, show that cod-liver oil increases egg production.

8. Likewise, there is some difference of opinion regarding the influence of cod-liver oil on the hatchability of eggs, but most of the authorities are of the opinion that hatchability is affected favorably.

9. The reports on five investigations indicated no improvement in the fertility of eggs, but the work of Dowell (1927) revealed 95 per cent fertility of eggs as a result of cod-liver oil feeding, whereas in the controls the fertility was 81 per cent.

10. Two reports mention the effect on the texture of eggshells, one indicating an improvement and one stating that no appreciable increase in weight of egg or texture of shell was observed.

11. All sources of data show that cod-liver oil has great therapeutic (medicinal) value.

12. Ophthalmia, an eye disease resulting from a deficient diet, is prevented or cured through feeding cod-liver oil.

13. Rickets, resulting from a deficiency in bone formation, is prevented or cured.

14. Cod-liver oil is beneficial in the treatment of tuberculosis in guinea pigs.

15. Vitamin D in cod-liver oil is very effective in preventing pneumonia in guinea pigs and "snuffles" in rabbits.

16. The recovery of dogs from distemper is hastened.

17. There seems to be general agreement on the recommendation of doses as follows:

Poultry: 2 per cent or 1 pint per hundred birds per week.
Pigs: 0.25 ounce to 1 ounce daily.
Pregnant sows: 1.5 ounces to 2 ounces daily.
Cows: 2 ounces daily.

18. The United States Department of Agriculture Bulletin No. 1033 rates cod-liver oil 97.7 per cent in digestibility.

19. In interpreting the results of the studies made on the effect of storage on cod-liver oil mixed in the ration in advance of feeding, it is evident that the vitamin-A potency of the oil diminishes materially, and there is some indication that the effectiveness of vitamin D is slightly impaired, unless great care is observed in regulating the conditions of storage as set forth in this article. Poultrymen of the United States Department of Agriculture recommend that the cod-liver oil be mixed in the ration not sooner than 10 days in advance of feeding.

20. The feeding of cod-liver oil in proper dosage to farm animals does not give the meat an oily taste if the feeding of cod-liver oil is discontinued a short time before the animals are slaughtered.

21. Reports of cod-liver oil poisoning of calves and swine indicate that the animal feeder should select a good grade of oil and avoid overdosage.

22. Attempts to cure polyneuritic fowls by the administration of cod-liver oil were unsuccessful, which means that cod-liver oil is lacking in vitamin B. Cod-liver oil also has scorbutic (scurvy) properties, indicating a deficiency in vitamin C.

23. The comparative value of cod-liver oil and irradiation is still somewhat in doubt. It is safe to say, for the present at least, taking into consideration the factor of economy, that as far as the feeding of farm animals is concerned, cod-liver oil appears to be preferable to anything else.

VITAMIN CONTENT OF COD-LIVER OIL

The beneficial effect of cod-liver oil as a therapeutic agent and a nutritional factor in the diet is due primarily to its vitamin content. In other words, the vitamins in cod-liver oil are the active principles of that oil. Various investigators have shown that cod-liver oils vary in their vitamin content according to methods of manufacture, condition of fish, and many other factors affecting the quality of the oils. Cod-liver oil contains three known active vitamins, namely, A, D, and E. Vitamin A is the antiophthalmic vitamin, or active principle of cod-liver oil and other substances. Vitamin D is the antirachitic factor. Cod-liver oil is rich in these two vitamins. Vitamins A and D both play an important rôle in metabolism, but vitamin D maintains the optimal calcium and phosphorus ratio in bone formation. Vitamin E, the reproductive vitamin, is present in smaller quantities in cod-liver oil, especially in the high-grade medicinal oils. To illustrate the vital importance of vitamins in cod-liver oil, the wide divergence of their relative effectiveness and quantity in different brands or samples of cod-liver oil, and the factors influencing this divergence, the essential results of a number of investigations are given herewith.

A number of investigators [2] reported that the variation in the potency of the oil obtained at different times is due to the food and physiological condition of the cod rather than its age. Holmes (1922, 1923), in experiments with rats, showed that cod-liver oils from plump fish have a higher vitamin potency than those from lean or emaciated fish; and, further, that 1 milligram of oil from plump fish was the equivalent in vitamin potency to 3.4 milligrams from emaciated fish.

Vitamin A is more unstable than vitamin D. Certain conditions of storage, light, heat, and oxidation adversely affect vitamin A. There can be no doubt about these facts. Experiments have been conducted with rats and poultry by a number of investigators (Clare and Soames, 1928; Wokes and Willimott, 1927; Southgate, 1925; Poulsson, 1924) to prove conclusively that the vitamin-A potency of cod-liver oils does suffer from exposure to such conditions. On the other hand, Holmes has shown that the oil can be stored safely, under the proper conditions, without any loss in vitamin-A potency. If the oil is stored in dark containers at a temperature not exceeding 70° F. and mixed with the feed as used, the vitamin-A effectiveness of the oil will not diminish to any appreciable extent.

Peacock (1926) reported a study of the possible relation of loss of fluorescence in cod-liver oil, on exposure to light, to the content of vitamins A and D in the oil. The results indicated that there is no association between fluorescence and antirachitic value, but that loss of fluorescence and destruction of vitamin A parallel each each other

[2] Zilva, Drummond, and Graham, 1924; Drummond, 1925.

to a certain extent. That the phenomena are not identical, however, was demonstrated by the observation that the destruction of vitamin A is complete before the fluorescence has been entirely destroyed and, furthermore, that fluorescence is gradually restored on keeping the oil in the dark, while there is no corresponding recovery of vitamin A. The changes in fluorescence were found to be accompanied by changes in the absorption spectrum of the soil. It is emphasized that "light is a variable factor which must be taken into account in all quantitative experiments concerning the growth-promoting properties of cod-liver oil and the manner in which such oil is stored."

The experiments of Holmes (1924) indicated that cod-liver oil produced by the rotting process is lower in vitamin A than medicinal oils.

Holmes and Pigott (1926) reported a comparison of the vitamin-A potency and the physical and chemical constants of six typical crude cod-liver oils of medicinal grade and of the same oils after pressing under commercial conditions by refrigeration in a brine-cooled tank. The differences in composition and biological value of the crude and pressed oils were not sufficiently marked to indicate any significant difference in the value of the oils.

Jones, Steenbock, and Nelson (1924) conducted an investigation that consisted of a comparative study of the potency of the same samples of butter and of cod-liver oil as sources of vitamins A and D. The vitamin-A studies were conducted on rats and the vitamin D on dogs. Using the time of incidence as well as the cure of ophthalmia as criteria, the vitamin-A content of the cod-liver oil was estimated to be from ten to twenty times as high as that of butterfat. As a source of vitamin D, or antirachitic vitamin, 0.05 gram of the cod-liver oil proved more effective than 10 grams of butterfat in preventive experiments, indicating that the oil is about two hundred times as potent as the butterfat. The above values, of course, are not to be taken as absolute figures. They are bound to vary with the seasonal conditions under which the butterfat and cod-liver oil are produced and the method of preparation of the latter. In the light of knowledge that under certain conditions the antirachitic factor, as well as vitamin A, is required for normal growth, the statement that cod-liver oil may be two hundred and fifty times as potent as butter may be taken to refer to the antirachitic factor rather than to vitamin A. Zilva (1922) stated that cod-liver oil contains two hundred times as much of vitamin A as butter contains.

Cooperative experiments conducted at the University College and Lister Institute at London and also at the National Institute of Dairy Research at Reading[3] revealed that when cod-liver oil was fed to cows the vitamin-A content of the milk was increased even over a light winter pasture.

McCollum, Simmonds, Becker, and Shipley (1927) in experiments with female rats, indicated that vitamin D of cod-liver oil does pass into mothers' milk. Cod-liver oil must be fed during pregnancy as well as during the period of lactation to produce a large amount of this vitamin. Even so, the feeding of cod-liver oil directly to the young is more potent in its reaction than the transmission of the antirachitic factor through the milk.

---

[3] Drummond, Coward, et al., 1928.

Experiments with rats were conducted in order to study the vitamin-E content of cod-liver oil (Nelson, Ohrbeck, et al., 1928). A high-grade medicinal oil was used. "This brand of cod-liver oil was potent for reproduction and was far superior to butterfat as the sole source of fat-soluble vitamins and vitamin E. Animals reproduced readily on 1 per cent of the oil as the sole source of vitamin E."

Nelson, Jones, et al. (1927) are quoted as follows:

> The food value of cod-liver oil has been tested by the biological method. It has been shown that a synthetic diet containing casein, salts, yeast, dextrin, and cod-liver oil as the sole sources of fat-soluble vitamins suffices for normal growth and normal reproduction. The results obtained with cod-liver oil depend on the manner in which the oil is fed. When fed separately, abnormal reproduction records were obtained. Results were not nearly so favorable when cod-liver oil was incorporated in kilogram quantities of the ration as when the oil was mixed in the ration daily. This is no doubt due to decomposition of the oil, either with formation of toxic products or the destruction of vitamins, or both. The odor of decomposed oil is similar to acrolein. Reproduction is much less favorable with filtered butterfat than with cod-liver oil.

Doctor Dubin (1927) discussed the advantages of the concentrate over the straight cod-liver oil. The concentrate to which the author referred is called "Oscodal." He claimed that it possessed the therapeutic properties of cod-liver oil without the latter's objectionable qualities. "Oscodal" is described in the Journal of the American Medical Association on page 671 of volume 87 (1926) as a preparation of the nonsaponifiable fraction of cod-liver oil containing the antiophthalmic and antirachitic fat-soluble vitamins.

Takahashi and Kawahami (1923) believe that they have isolated vitamin A in almost pure form from cod-liver oil, butter, and egg yolk. A detailed description of the process they used is set forth in their publication. The substance that they isolated was fed to mice at the point of death due to a lack of vitamin A. The mice were restored to health by the administration of 0.08 milligram of the substance per mouse daily for a period of 10 days.

From these investigations it can be seen that a beginning has been made toward the isolation, identification, and subsequent compounding of the vitamins into preparations more palatable than cod-liver oil and far more potent in their therapeutic and nutritional properties. This does not mean that cod-liver oil will cease to be valuable in the treatment of deficiency diseases. Quite the contrary is true, for the scientist naturally will turn to cod-liver oil as one of the richest sources of vitamins A and D for extraction purposes.

BENEFICIAL RESULTS FROM FEEDING COD-LIVER OIL

The beneficial results of feeding cod-liver oil may be classed under two principal headings—general feeding and treatment of diseases.

GENERAL FEEDING

Under general feeding the following possibilities of benefit are discussed: Growth-promoting properties of cod-liver oil, calcium and phosphorus metabolism, increase in iodine content of milk, prevention of mortality in baby chicks, ruffled plumage in poultry, egg production, hatchability of eggs, fertility of eggs, and shell texture.

GROWTH-PROMOTING PROPERTIES OF COD-LIVER OIL

Two milligrams of cod-liver oil, a little less of coalfish oil, and 10 to 15 milligrams of haddock oil were necessary [4] for the resumption of growth in rats. The feeding of cod-liver oil to rats somewhat accelerated growth.[5] Holmes (1925a) showed that 1 milligram or less of domestic cod-liver oil cured malnutrition, whereas 0.7 to 29.8 milligrams of shad body oil failed to restore rats to normalcy from the results of malnutrition.

Goldblatt and Moritz (1926) reported "experimental data which demonstrated the growth-promoting properties of vitamin D as well as vitamin A and the ineffectiveness of irradiation in synthesizing vitamin A or monopolizing its reserve in the tissues." A practical conclusion drawn from this study is that neither irradiation nor the feeding of irradiated oil can act as a complete substitute for cod-liver oil in growth-promoting experiments unless vitamin A also is given.

Cod-liver oil promoted growth [6] and prevented ophthalmia, except where the ration included blood meal with no casein or other fortified protein. Only questionable improvement resulted in the fish meal and tankage ration where the cod-liver oil used had been aerated or oxidized, thereby destroying the vitamin-A content. It would seem from these experiments that vitamin A is vitally linked with vitamin D in its curative powers.

In feeding tests in which rats were used as the experimental animals, Goldblatt and Zilva (1923) demonstrated that growth was promoted on a dose of 1.8 milligrams of cod-liver oil daily.

Osborne and Mendel (1914) showed the remarkable curative powers of cod-liver oil in their feeding experiments with young rats. Ophthalmia disappeared and growth was accelerated, as demonstrated by their continuous experiments over a long period of time. These men also showed (1921) that 14 milligrams daily proved sufficient to cure ophthalmia and promote renewal of growth in young rats on a diet deficient in vitamin A. They commented on the richness of cod-liver oil in vitamin A.

Hendrick (1913) reported the results of calf-feeding experiments with separated milk, cod-liver oil, and cottonseed oil. The results are shown in the following table:

Experiment	Kind of ration	Calves	Increase in weight	Total cost	Average cost per pound of increased weight
			Pounds		
1	Whole milk	14	207	$19.98	$0.0965
2	Cod-liver oil and separated milk	15	184	6.78	.0368
3	Cottonseed oil and separated milk	15	177	6.60	.0370

In considering these figures it should be noted that the results in the above table are based on 1913 prices in Great Britain. The economic feasibility on the basis of current prices should be considered.

[4] Zilva and Drummond, 1921. [5] Stammers, 1922. [6] Bohstedt et al., 1926.

The London Board of Agriculture's Report on Agricultural Education and Research (Campbell, 1899) contains a description of experiments conducted at the Manor Farm, Garforth. Cod-liver oil mixed with separated milk was fed to calves. The amount was increased gradually from ½ ounce to 2 ounces of cod-liver oil per 1½ gallons separated milk per head per day. Fifteen calves were used in these tests. Some of them were fed the above ration and some were fed calf meal. A third group was fed whole milk. Cod-liver oil was found to be an economical substitute for cream. The calves fed on new whole milk showed the greatest gain, but the cost was three times as great as in the case of the cod-liver oil ration, whereas the gain in weight on the whole-milk ration was only one-third better than on the cod-liver oil ration. Therefore, the greatest gain per unit of investment was in favor of the cod-liver oil. It was found advantageous to continue cod-liver oil as a supplement in the feeding after weaning. The investigators issued a warning that good grades of cod-liver oil must be used. Seton (1901, p. 7) also conducted feeding tests in which cod-liver oil was used as a substitute for cream in calf rearing. He said that cod-liver oil can be safely added to separated milk for feeding calves and is a more economical feed per unit of investment than whole milk. In these experiments 2 ounces of cod-liver oil were mixed with 1½ gallons of separated milk.

Jones, Eckles, and Palmer (1926) demonstrated that cod-liver oil in amounts of 20 cubic centimeters daily protected the calves from evidence of vitamin A deficiency, though the necessary amount might have been less. Calves suffering from a deficiency of this vitamin in the ration improved almost immediately when cod-liver oil was administered.

As related by Paterson (1924), cod-liver oil increased the weight of pigs at little additional cost. In the case of cattle the increase in weight equaled the increase in cost. Therefore, no advantage was gained. The Ohio Agricultural Experiment Station Bulletin No. 402, of 1927, reports as follows:

> Cod-liver oil, even when treated in such a manner as to destroy the vitamin A content and fed with yellow corn and tankage at the rate of one-half pound for each 100 pounds of feed, increased the rate of growth of swine and also decreased the amount of feed required to produce that growth.

According to Evvard et al. (1927), steam-rendered cod-liver oil accelerated the growth of fall pigs somewhat, at the lowest cost per unit of gain as compared with sun-tried cod-liver oil, tankage, cod-liver meal, and irradiation with ultra-violet light.

Kennard (1924) reported experiments in which chicks receiving additions of 2½ per cent and 5 per cent of cod-liver oil, respectively, or 15 per cent of raw egg yolk, to the ration grew rapidly and did not develop leg weakness, whereas leg weakness or death did occur in the control or check lots.

Cod-liver oil is beneficial[7] from the standpoint of development, mortality, and prevention of leg weakness. Cod-liver oil and raw liver produced the greatest gain on the smallest amount of food.

Hannas (1927) stated that Professor Halpin had demonstrated that a considerable acceleration in growth resulted from the feeding of cod-liver oil to poultry. Wood (1926) reported the following:

---

[7] Elford, 1924.

Experiments were conducted with groups of 25 chicks each. One group was placed behind ordinary window glass and fed a diet which would produce leg weakness. Another group was placed behind Cel-O-Glass and fed the same diet as above. The third lot was kept under the same conditions as the first group and fed the same ration as lot one except that 2 per cent of cod-liver oil was added to the diet. The growth of lot number one was subnormal, while the growth of the other two groups was normal.

In poultry investigations at the Dominion Experimental Farms, Elford (1925) reported a study of the vitamin feeds and rations for brooder chicks. The addition of refined cod-liver oil to the basal ration produced a greater increase in percentage weights of the chicks than that of any other ration. Mortality was also less in the case of cod-liver oil than in that of any other diet. The experiments extended over a period of two years.

The Scottish Journal of Agricultural (Orr, 1923) makes the statement that cod-liver oil is beneficial for promoting growth in poultry.

MacKenzie (1923), in experiments with poultry at the Indian Head Experimental Farm, showed that the growth of baby chicks was almost doubled through the use of cod-liver oil in the ration.

In experiments with laboratory animals, Iscovesco (1914) indicated that repeated doses of olive oil and cod-liver oil administered hypodermically in the neck muscles caused an increase in weight. Cod-liver oil seemed to be better tolerated than olive oil.

As shown by the above related experiments of various investigators, all of the authorities are agreed that cod-liver oil has marked growth-promoting properties and that the feeding of cod-liver oil in the ration to young animals is unquestionably profitable in producing increases in weight.

CALCIUM AND PHOSPHORUS METABOLISM

Powers et al (1922) stated that the function of sunlight, or certain factors in cod-liver oil, is to exert a regulatory influence over the mineral metabolism of the body having to do with ossification and calcification. The effects of sunlight and of cod-liver oil on the growth and calcification of the skeleton and on the animal as a whole seemed to be similar if not identical. These investigators also said that as the optimum ratio of phosphorus and calcium varies, so varies, in direct proportion, the necessary amount of antirachitic substance needed to bring the animal back to normalcy.

In later experiments (McCollum, Simmonds, Shipley, and Park, 1922) cod-liver oil was found to facilitate bone development and was far superior to butter fat.

In a study in which rabbits were used as the experimental animals, Sjollema (1923) found that cod-liver oil improved calcium and phosphorus metabolism. Cod-liver oil was found to improve calcium and phosphorus utilization[8] where dogs were used as the experimental animals.

Hart, Steenbock, and Hoppert (1921) demonstrated that calcium assimilation grew with the administration of cod-liver oil, and that

[8] Shohl and Bennett, 1928.

the same factor that affects calcium utilization is present in green oats, grasses, and cod-liver oil. Five goats were used in these experiments, three lactating and two dry.

Harvey (1927) showed that the feeding of cod-liver oil to goats improved the balance of calcium by reducing the amount excreted in the feces. The effects on phosphorus excretion were variable. In the case of animals in late lactation the percentage and total amounts of calcium in the milk were increased by feeding cod-liver oil.

Mattick (1928), in tests and analyses made of the milk, indicated that a higher content of calcium existed in the milk of cows fed cod-liver oil than in the milk of the controls. The phosphorus content was not changed.

Husband, Godden, and Richards (1923) made a report of the influence of cod-liver oil, linseed oil, and olive oil on the assimilation of calcium and phosphorus in the growing pig. Cod-liver oil and olive oil were found to be most potent.

From the results of the above described experimental data of the various investigators it isg noted that all of the authorities on this subject agree that cod-liver oil greatly aids calcium and phosphorus utilization.

IODINE CONTENT OF MILK INCREASED BY FEEDING COD-LIVER OIL

Harvey (1927) stated that the amount of iodine in the milk of goats was increased by feeding either cod-liver oil or potassium iodide. The fat content of the milk showed no definite changes as a result of feeding cod-liver oil. In a single experiment, in which cod-liver oil was replaced by olive oil plus an equivalent amount of iodine as potassium iodide, the effects of the former were not reproduced.

PREVENTION OF MORTALITY IN BABY CHICKS

All of the investigators [9] are in accord that the feeding of cod-liver oil produces remarkable results in reducing to a minimum the mortality rate. A high mortality rate is one of the greatest handicaps in the profitable raising of chickens.

RUFFLED PLUMAGE IN POULTRY

Ruffled plumage in poultry is one of the indications of a dietary deficiency. The following authorities are given herewith to show that the feeding of a good grade of cod-liver oil tends to clear up this condition: Hart, Halpin, and Steenbock, 1922; Ohio Agricultural Experiment Station, 1926.

EGG PRODUCTION

The following authorities reported that egg production was not improved by the feeding of cod-liver oil: Indiana Agricultural Experiment Station, 1925; Elford, 1925; Hall, 1925; Orr, Crichton, and others, 1924; and MacKenzie, 1923.

---

[9] Jackson (1924); Kennard (1924); Hart, Halpin, and Steenbock (1922); Elford (1924 and 1925); Idaho Agricultural Experiment Station (1926); Kennard and Bethke (1926); Dowell (1927); and Holmes, Doolittle, and Moore (1927).

Information of more recent date, however, indicates emphatically that the feeding of cod-liver oil materially increases egg production. Hayes (1927) says that cod-liver oil should be used from November to spring to compensate for the decrease in sunlight. Two per cent of cod-liver oil is ordinarily sufficient. Only cod-liver oil from reliable producers should be used. Good medicinal cod-liver oil acts like a generator, keeping the producing pullets charged, so that a maximum production is possible without harmful effects. One pint of cod-liver oil per week to 100 birds is recommended by this authority.

The Idaho Agricultural Experiment Station Bulletin No. 142 (1926) stated that cod-liver oil proved to be a good substitute for green feed. These experiments indicated that cod-liver oil was beneficial to hatchability and egg production. The mortality was also less.

The Ohio Agricultural Experiment Station Bulletin No. 402 (1927) reported that irradiating pullets and the feeding of cod-liver oil increased the egg production for six months from 27.7 eggs to 65 eggs. Additional minerals virtually doubled the egg production.

Kennard and Bethke (1927) reported that cod-liver oil fed at the rate of 2 per cent of the ration brought about a marked increase in egg production. Hart, Steenbock, Lepkovsky, et al. (1925) said that egg production is favorably influenced by the antirachitic factor. Kennard and Bethke (1926) found that the feeding of cod-liver oil increased egg production. Dowell (1927) reported experiments that indicated that pullets fed 1 per cent of cod-liver oil showed an average monthly egg production of 53 per cent, whereas the corresponding figure for the control lot, which received no cod-liver oil, was 48 per cent.

Kempster (1926 and 1927) indicated by experiments that egg production was improved by cod-liver oil, ultra-violet light, and direct sunlight. Sweet butter failed to increase the egg production. Holmes, Doolittle, and Moore (1927) showed that cod-liver oil materially increased egg production in both number and size of the eggs.

HATCHABILITY OF EGGS

The following authorities reported that the hatchability of eggs was not improved by the feeding of cod-liver oil: Indiana Agricultural Experiment Station, 1925; Orr, 1923; Ohio Agricultural Experiment Station, 1927; Kennard and Bethke, 1926 and 1927; and Kempster, 1926.

The following authorities, however, were of the opinion that the feeding of cod-liver oil did improve hatchability: Elford, 1924 and 1925; Harding, 1928; American Poultry Journal, 1926; Hannas, 1927; Idaho Agricultural Experiment Station, 1926; Holmes, Brown, et al., 1926; Penquite, 1926; Kempster, 1927; Dowell, 1927; and Holmes, Doolittle, and Moore, 1927.

FERTILITY OF EGGS

The following authorities stated that the fertility of eggs was not improved by the feeding of cod-liver oil: Indiana Agricultural Experiment Station, 1925; Hannas, 1927; Orr, 1923; Orr, Crichton, et al.. 1924; and MacKenzie, 1923.

However, Dowell (1927) reported experiments that showed that pullets fed 1 per cent of cod-liver oil evidenced fertility of 95 per cent, whereas the corresponding figure for the lot receiving no cod-liver oil was 81 per cent.

Holmes, Doolittle, and Moore (1927) conducted experiments in which the oil-fed birds produced a larger number and percentage of fertile eggs than the controls did.

SHELL TEXTURE

Elford (1925) stated that the feeding of cod-liver oil produced no appreciable increase in weight of egg or texture of the shell. Kennard and Bethke (1927) said that cod-liver oil fed at the rate of 2 per cent of the ration improved the shell texture of the eggs.

TREATMENT OF DISEASES

Under treatment of diseases the following possibilities of benefit are discussed: General therapeutic value of cod-liver oil, ophthalmia, rickets, tuberculosis in guinea pigs, pneumonia in guinea pigs, "snuffles" in rabbits, and distemper in dogs.

GENERAL THERAPEUTIC VALUE OF COD-LIVER OIL

Osborne and Mendel (1914) demonstrated marked curative powers for cod-liver oil in their feeding experiments with young rats.

Street (1915) stated that cod-liver oil was proved to have great therapeutic value in the treatment of wasting diseases as well as being a suorce of nutriment. Guy (1923) has given a brief historical survey of the various therapeutic uses of cod-liver oil from 1798 to the present time.

The American Poultry Advocate (1926) stated that cod-liver oil has splendid tonic value, and that the sanitary cooking process of manufacture is superior to the rotting process. "Practically every agricultural experiment station is recommending the use of cod-liver oil in one form or another. It rarely happens that a new idea, or new method, becomes universal practice within a few short years without any group or faction being opposed to it. This is true in the case of cod-liver oil for chicks and poultry."

OPHTHALMIA

Ophthalmia is an eye disease resulting from a dietary deficiency. It is one of the symptoms of a lack of sufficient vitamin A in the diet. The feeding of a diet deficient in vitamin A produces ophthalmia, or, inversely, a diet rich in this vitamin prevents or cures ophthalmia. Thus, it can be seen that studies of vitamin A, growth-promotion, and ophthalmia are closely related. In their studies of vitamin A and the growth-promotion properties of cod-liver oil, McCollum, Osborne, Mendel, Bohstedt, Bethke, and others mention ophthalmia, and they all assume that it is a deficiency disease.

RICKETS

Rickets is a bone disease resulting from a dietary deficiency. It is evidenced by a low calcium or phosphorus content of the bones, or both, or a disturbance of the optimal calcium-phosphorus ratio in the bones. Vitamin D tends to improve this diseased condition of the bones by aiding the metabolism of calcium and phosphorus. For this reason vitamin D is commonly known as the antirachitic vitamin.

Schultzer (1927) stated that the feeding of cod-liver oil brought about healing of rickets and increased calcium and phosphorus utilization. The effect of cod-liver oil was the same as that of ultra-violet light. He conducted experiments (1925 and 1925a) in which young rats weighing from 40 to 50 grams each were fed a low phosphorus rickets-producing diet for 10 days, after which they were placed in separate metabolism cages for an experimental period of 20 days divided into 5 periods of 4 days each. Some of the animals were continued on the rachitic diet throughout the whole period, and others at the end of 8 days were given cod-liver oil, ultra-violet light treatment, or additional phosphorus in the form of phosphates. All three of these treatments sufficed to cure rickets, which developed in the preliminary period and continued in the controls. From the calcium and phosphorus determinations of feces and urine by microchemical methods, figures representing the reduction in milligrams per gram gained in body weight were calculated. In the preliminary period the reduction figures for phosphorus and calcium in the controls averaged 5.2 and 9.5 milligrams, respectively, and in the final period 4.7 and 8.2 milligrams. The average figures in the other three groups were practically the same in the preliminary period, but following the various treatments there was a marked increase in both phosphorus and calcium, the averages being 10 and 15.7 milligrams for the group treated with ultra-violet light, 10.7 and 18.4 milligrams for the cod-liver oil group, and 10.6 and 18.6 milligrams for the phosphate group.

Mouriquand and others (1928) said that cod-liver oil, ultra-violet light, and irradiated dried milk have marked antirachitic effects. Yoder (1927) showed that rats that were fed a rachitic diet showed a decrease in calcium and phosphorus utilization, whereas those animals that were irradiated or fed cod-liver oil showed an increase in utilization of calcium and phosphorus.

McCollum and others (1921a) stated that a deficiency in the calcium content of the bones disappeared upon the feeding of cod-liver oil. Butter fat did not give this protection. Hess and Weinstock (1924) fed cod-liver oil to female rats during pregnancy and lactation to determine to what extent they could transmit immunity from rickets to their young through the milk; but this immunity was not as pronounced nor as effective as that produced by the direct feeding of cod-liver oil to these young rats.

Shohl and Bennett (1928) showed that cod-liver oil prevents rickets in dogs. Antirachitic properties were demonstrated [10] for

[10] Leané and Vagliano, 1924.

the milk and butter produced by a cow receiving 500 grams of cod-liver oil daily. Rickets occurred in young rats receiving butter from another cow; but this condition was cured when butter was supplied from the cow receiving the cod-liver oil. The milk of the cow receiving the cod-liver oil also tended to cure rickets in infants.

Mattick (1928) stated that the butter from the cows that were fed cod-liver oil showed greater antirachitic properties than the butter from cows that had not received the oil in their diet. Jackson (1924) said:

> Cod-liver oil has been proved to have high value in chick rations, particularly in the care of early broods when close confinement and lack of direct sunlight predispose them to rickets or leg weakness. Vitamin D is oftentimes termed "bottled sunshine."

At Storrs, Conn., it has been found that one-half of 1 per cent of cod-liver oil will prevent leg weakness under severe laboratory conditions, and 1 to 2 per cent will cure the ailment after it develops. All chicks receiving 2 per cent of the oil were raised, whereas all those not receiving it died. This author said that all experiment stations were making the same enthusiastic report.

Kennard (1924) showed that chicks receiving 2½ per cent of cod-liver oil did not develop leg weakness, but leg weakness did occur in the control or check lots.

Hart and others (1922) conducted experiments in which chicks were reared in confinement. The first lot was fed a daily ration of 97 parts of wheat, 2 parts of calcium carbonate, and 1 part of sodium chloride plus skimmed milk ad libitum. The second lot was fed the same ration plus 50 grams of cod-liver oil per kilogram of feed. The third lot, serving as a control, was fed a ration consisting mostly of wheat, oats, and bran. The first lot had high mortality, leg weakness, and ruffled plumage. All chicks of the second lot thrived and remained active and strong. Six of the chicks of the third lot were fed like those of the first. The third lot evidenced signs of leg weakness and ruffled plumage. These experiments indicate the necessity of adding cod-liver oil to the diet where chicks are raised in confinement. An examination of the phosphorus content showed a deficiency in this element wherever cod-liver oil was not fed and a higher phosphorus content with cod-liver oil feeding.

Serious leg weakness in the baby chicks was cured [11] by the end of the eleventh day through the addition of cod-liver oil to the diet. Hannas (1927) said that everything was tried to prevent leg weakness and consequent excessive mortality until direct sunshine, ultraviolet light, and cod-liver oil were used. Park and Howland (1921) indicated by radiographic evidence that cod-liver oil is a specific for rickets. Fifty cases of rickets were examined. Anthony (1928) said that tankage will not prevent rickets but cod-liver oil will do so.

The above experimental data indicate that cod-liver oil is an excellent specific for rickets. Particularly is this so in the treatment of leg weakness in poultry. For this reason cod-liver oil is an essential supplement to the diet of baby chicks reared in confinement, unless the chicks are irradiated or unless direct sunlight is obtainable.

---

[11] F. C. Elford, 1924.

TUBERCULOSIS IN GUINEA PIGS

Smith (1923) conducted experiments that showed that cod-liver oil is beneficial in the treatment of tuberculosis in guinea pigs. Life was prolonged when the diet was supplemented with cod-liver oil.

PNEUMONIA IN GUINEA PIGS AND "SNUFFLES" IN RABBITS

Ibsen (1927) has shown by experiments that vitamin D in cod-liver oil is very effective in preventing pneumonia in guinea pigs and "snuffles" in rabbits. It had the same effect in the treatment of "snuffles" as direct sunlight or ultra-violet rays when 2 per cent of the oil was fed to rabbits with their grain ration.

DISTEMPER IN DOGS

Schlingman (1925) stated that cod-liver oil was found to be very valuable in shortening the period of convalescence in dogs recovering from distemper. Its curative powers in this respect were demonstrated to be excellent and recovery undoubtedly was hastened by its administration.

TECHNIQUE OF FEEDING COD-LIVER OIL

This section treats the following subjects: Doses recommended, digestibility, effect of storage, effect on flavor of meats, cod-liver oil poisoning of calves and swine, deficiencies that cod-liver oil can not correct, and comparative value of cod-liver oil and irradiation.

DOSES RECOMMENDED

H. Steenbock, of the University of Wisconsin, found that maximum potency could be obtained from a dose of 0.001 gram of cod-liver oil daily per rat. Goldblatt and Zilva (1923) stated that growth was promoted on doses of 1.8 milligrams of cod-liver oil daily, and protection against rickets required a dose of 33.7 milligrams daily per rat.

Selvig (1925) reported a succession of experiments, in which the chicks were fed 1, 2, 3, 4, and 5 per cent of cod-liver oil, respectively, as a supplement to the dry mash. It was found that 1 to 2 per cent produced as good results as 3, 4, or 5 per cent in the mash. Chicks fed the dry mash without the cod-liver oil supplement developed leg weakness, which was cured as soon as the cod-liver oil was added to the mash.

The Indiana Agricultural Experiment Station report for 1925 stated that further experiments with chicks in confinement indicated that 1 per cent of the cod-liver oil is sufficient in all instances for the optimum calcification and prevention of rickets over a 2-month period. Tests were conducted with 0.5, 1, and 2 per cent of cod-liver oil, respectively.

Hayes (1927) reported that 2 per cent of cod-liver oil, or 1 pint of cod-liver oil per 100 birds, per week is ordinarily sufficient. Holmes, Brown, and others (1926) recommended 1 pint of cod-liver

62089°—29——3

oil per 100 birds per week. Drummond, Zilva, and Golding (1923) recommended daily doses of cod-liver oil, as follows: Pigs, 0.25 to 1 ounce daily; pregnant sows, 1.5 to 2 ounces daily; and cows, 2 ounces daily.

Poultry experiments conducted at the Wisconsin Agricultural Experiment Station (1927) indicated that 4 to 5 per cent of cod-liver oil to the ration is sufficient for laying hens; more than that is detrimental.

DIGESTIBILITY OF COD-LIVER OIL

Deuel and Holmes (1922) reported that cod-liver oil was rated 97.7 per cent on digestibility, which was higher than that of any other substance listed. Maignon (1912) said that cod-liver oil improved utilization of nitrogenous substances.

EFFECT OF STORAGE ON COD-LIVER OIL MIXED WITH THE RATION

Hart, Steenbock, and Lepkovsky (1925) reported that "storing the mixed ration did not appear to have any effect on the potency of the antirachitic vitamin, as the ash content of the tibia averaged 46.4 per cent in the lots of chicks receiving the ration containing 0.5 per cent of cod-liver oil stored for 3 and 6 months, and 44.8 per cent and 45.7 per cent, respectively, in the lots receiving the same ration freshly prepared. The same relative results were obtained by using 1 per cent of cod-liver oil in comparative tests with various lots of chicks. Calcification was relatively better with 1 per cent of cod-liver oil than with 0.5 per cent, in both freshly prepared and stored rations. Leg weakness was observed in the control pens, but no such symptoms occurred in any other pens where cod-liver oil was used in the ration, whether stored or freshly prepared."

In feeding experiments with poultry at the Ohio Agricultural Experiment Station (1926) "four lots of 30 white Leghorn day-old chicks each were fed on a basal ration consisting of ground white corn, wheat middlings, casein, and minerals, with the addition of 2 per cent of cod-liver oil. For lot 1 fresh cod-liver oil was added every two weeks to the basal ration after the ration had been stored at 70° F. for four months. For the other lots the cod-liver oil was mixed with the basal ration at the beginning of the four months' storage period; and the feed mixture for lot 2 was stored in gunny sacks at 32° F., for lot 3 in gunny sacks at 70° F., and for lot 4 spread out in 2-inch layers at 70° F. No signs of leg weakness were evident in any of the lots, but a ruffled condition of the feathers indicated a nutritional deficiency from both rations stored at 70°. Analyses of tibias at 12 weeks showed no difference in the ash content, indicating that the antirachitic vitamin was not injured by the four months' storage, but that vitamin A was wholly or partly destroyed."

EFFECT OF COD-LIVER OIL ON FLAVOR OF MEATS

Paterson and Cochrane (1925) reported a pig-feeding experiment conducted at the College Farm at Kilmarnock, in which ½ ounce of cod-liver oil was fed daily to each pig. The basal ration consisted of corn meal, wheat middlings, and barley meal (2:4:3). Cooked bacon from pigs fed the above daily ration plus ½ ounce of cod-liver oil had an oily flavor. This indicated that the cod-liver oil diet should have been discontinued some time before the pigs were slaughtered. In a previous experiment Paterson (1924) stated that the feeding of cod-liver oil had no adverse effect on the quality of the pork.

Seton (1901) stated that cod-liver oil not only did not taint the meat, but the manager of the Leeds Cooperative Stores stated that slaughter tests showed that the calves that were fed cod-liver oil were the best.

In studying the effect of cod-liver oil feeding on the flavor of poultry meat [12] at the Indiana Agricultural Experiment Station, 30 white leghorn chickens, which had been reared in confinement to five or six months of age on a ration containing 2 per cent of cod-liver oil, were divided into three lots, which received the following respective amounts of cod-liver oil: None, 2 per cent, and 4 per cent. The birds were killed at intervals and cooked by different methods. The flavor was judged by 15 persons. The results showed that when the 4 per cent diet was fed for two or more weeks, even after discontinuing the cod-liver oil for 10 days, an unusual flavor was present in the chicken meat; and when 4 per cent of cod-liver oil was fed up to the time of killing the flavor was very pronounced. The method of cooking and the temperature at which the meat was served were found to have a distinct effect on the amount of abnormal flavor reported. The flavor was least noticeable in fried chicken and most noticeable when the meat became cold. It is apparent from the results that chickens should be fed on rations free from cod-liver oil for at least two weeks before slaughtering.

These experiments indicate that the feeding of cod-liver oil in proper dosage to farm animals does not give the meat an oily taste if the oil feeding is discontinued a short time before slaughtering.

COD-LIVER OIL POISONING OF CALVES AND SWINE

Slagsvold (1925) reported a case of cod-liver oil poisoning among cattle in Sweden. Rodents thrived on the same oil that killed the calves. One case of poisoning was produced experimentally in order to observe the symptoms. The symptoms evidenced were stiffness, listlessness, tremors, loss of appetite, increased respiration and heart action, desire for lying down, convulsions (at times), dryness of skin, drooling or frothing at the mouth, tenacious feces, brownish urine, slightly increased temperature, cyanosis, and death in a few hours or days. This report serves to emphasize further the fact that a good grade of cod-liver oil must be used in feeding farm animals, for undoubtedly the poisoning resulted from feeding spoiled or high-acid oil.

Bolle (1928) reported a case of subacute atrophy of the liver in young pigs resulting from feeding spoiled cod-liver oil. The livers were seriously affected. This report cautioned agriculturists to take great care in the selection of the grade of cod-liver oil used in animal feeding.

---

[12] Carrick and Hauge, 1926.

DEFICIENCIES THAT COD-LIVER OIL CAN NOT CORRECT

Lax (1921) reported an attempt to cure polyneuritic fowls with alcohol extracts of cod-liver oil, which was unsuccessful, showing a deficiency of vitamin B in cod-liver oil. Mouriquand and Michel (1922) indicated that in feeding cod-liver oil the balance of the diet should be adequate, as cod-liver oil has an "osteodystrophic, perhaps scorbutic (scurvy), property." Guinea pigs were used in these feeding experiments.

The results of the above-mentioned experiments plainly show that cod-liver oil is deficient in vitamins B and C. Furthermore, it will not cure diseases caused by a deficiency of these two vitamins in the diet. Therefore, the balanced ration should contain ample provision for vitamins B and C from other sources when cod-liver oil is used as a vitamin supplement to that diet.

COD-LIVER OIL AND IRRADIATION

Attempts to increase the antirachitic activity of cod-liver oil by irradiation [18] in the same manner that cholesterol and other food materials are activated led to the destruction of the antirachitic vitamin already present, as tested by the use of the irradiated oil as a preventive and curative measure in rats and infantile rickets. Chemical and physical studies conducted on the irradiated oil are reported with the following results: The absorption spectrum for ultra-violet light showed a greater permeability for the irradiated than for the nonirradiated oil; the irradiated oil blackened photographic plates, showed no fluorescence, was more readily emulsified with gum tragacanth, and blackened on heating to 250° C.; the viscosity and surface tension of the oil increased rapidly with irradiation, the iodine number decreased, and the acidity, as measured by pH and also by titration, increased. The possible bearing of these changes on the chemical action involved in the inactivation of the oil is discussed, with the final suggestion that the sterols in cod-liver oil become inactivated by saturation.

Wyman and others (1927) stated that "cod-liver oil irradiated for 30 minutes under carefully controlled experimental conditions was found to have no greater antirachitic potency for rats, as judged by growth curves, blood calcium, and phosphorus, and X-ray and histological examination of the bones, than the same oil before irradiation. The same oil, after being irradiated for 2 hours, had a noticeably lessened antirachitic effect."

Daniels and Brooks (1927) conducted experiments in which six young rats were used. One group received untreated cod-liver oil; another group received cod-liver oil that had been exposed to direct solar rays; and a third group was fed cod-liver oil that had been irradiated with a mercury-vapor lamp. The irradiated oil was found to be no more effective than the untreated oil, as measured by growth.

Daniels and Fosbinder (1925) said that ultra-violet light is not emitted when cod-liver oil is oxidized. West and Bishop (1925)

---

[18] Adam. 1926.

were not successful in demonstrating ultra-violet radiation from cod-liver oil.

In experiments at the Indiana Agricultural Experiment Station,[14] two groups of newly hatched chicks were fed a ration of 80 grams of ground yellow corn and 20 grams of wheat middlings, with buttermilk ad libitum. Pyrex flasks containing cod-liver oil were placed in the feed troughs and among the birds in one lot. The results showed that rickets occurred in both lots, but 6 of the 15 original chicks were still living at 7 weeks of age in the irradiated lot. All of the 7 nonirradiated birds died within 34 days. It is concluded that the antirachitic substance in cod-liver oil may be transmitted by means of irradiation through pyrex flasks and, further, that the antirachitic substance in cod-liver oil is some form of ultra-violet energy.

Shohl, Bennett, and Weed (1928) reported that cod-liver oil and irradiated ergosterol were equally good in healing rickets and in increasing utilization of calcium and phosphorus. Hart, Steenbock, Lepkovsky, et al. (1925) reported that hatchability and shell texture were improved by irradiation of poultry.

The Ohio Agricultural Experiment Station Bulletin No. 402 (1927) stated that irradiation and the feeding of cod-liver oil both improved egg production. Irradiation caused a marked increase in the hatchability of the eggs, but cod-liver oil exerted no beneficial effect.

Goldblatt and Moritz (1926) reported that the experimental data demonstrated the ineffectiveness of irradiation in synthesizing vitamin A or mobilizing its reserves in the tissues. Rats were used in obtaining these results. " A practical conclusion drawn from this study is that neither irradiation nor the feeding of irradiated oil can act as a complete substitute for cod-liver oil in growth-promotion experiments unless vitamin A is also given."

Harding (1928) stated that cod-liver oil is recognized as more effective than ultra-violet irradiation in curing rickets. Evvard and others (1927) said that steam-rendered cod-liver oil accelerated growth somewhat at the lowest cost per unit of gain as compared with sun-tried cod-liver oil, tankage, cod-liver meal, and irradiation with ultra-violet light.

Holmes, Wyman, Smith, and Pigott (1928) reported that cod-liver oil was more effective against rickets in rats than ultra-violet irradiation. The cod-liver oil used in these experiments was prepared by the direct-steam method.

CONCLUSIONS

In conclusion it is well to note that there is a great deal of contradictory experimental data. This is unquestionably due, as stated by Bills (1927), to the wide divergence in quality and type of cod-liver oils used by the various investigators in this field of research and to the different methods of manufacture. There can be no doubt that a good standard grade of medicinal cod-liver oil should be used always in conducting feeding experiments with farm animals. One instance of the poisoning of calves and one in the case of poisoning of pigs have been reported in the above experimental data collected, which were attributed to the feeding of high-acid, spoiled cod-liver oil. All available information indicates that oil made according to the so-called " rotting process " is not fit to be fed to livestock.

---

[14] Carrick, 1925.

Oil made in accordance with the steam process has been shown to be far superior in every way to the other.

It is significant that out of all of the feeding experiments mentioned only a few of the investigators make any mention of the type, quality, or history of the cod-liver oil used in their tests. The standard for medicinal cod-liver oil required by the United States Pharmacopœia does not permit more than 1.41 per cent of fatty acid. Oil made according to the so-called " rotting process " is very high in fatty acid, often running as much as 12 to 14 per cent. It is obvious that cod-liver oil of the United States Pharmacopœia medicinal grade would be somewhat expensive for animal feeding. It follows that there is a great need for an oil of medium grade for stock feeding, which has been thoroughly tested for that purpose by experimental feeding researches.

Much excellent experimental work has been accomplished with laboratory animals in this field, but there is a dearth of scientific contributions on farm animals, with the exception of poultry. It is hoped that in the future activity will be stimulated on a larger scale along these lines. The potentialities of cod-liver oil as a tonic and metabolic factor in the rearing of farm animals have not been realized fully. Particularly is this so of the young animals in the acceleration of growth.

BIBLIOGRAPHY

No claim is made that the bibliography of this report is a complete résumé of all published literature in this field of research. It is believed, however, that it does include the more important references on the subject to date.

ADAM, A.

1926. Inaktivierung des antirachitischen Faktors im Lebertran durch bestrahlem mit Ultraviolettlicht. Klinische Wochenschrift, 5 Jahrgang, 1926, II Halbjahr, No. 36, pp. 1648–1650. Berlin und München.

1927. Ist das antirachitische Vitamin des Lebertrans ein bestrahltes Ergosterin? *Ibid.*, 6 Jahrgang, 1927, II Halbjahr, No. 27, p. 1289. Berlin und München.

1928. Lichtenergetische Untersuchungen über den antirachitischen Faktor des Lebentrans. Strahlentherapie, 28 Band, Heft 2, pp. 368–376, 8 figs. Berlin und Wien.

ADAMS, GEORGIAN, and E. V. MCCOLLUM.

1928. A method for the biological assay of cod-liver oil. Journal of Biological Chemistry, Vol. LXXVIII, No. 2, pp. 495–524. Baltimore.

AMERICAN POULTRY ADVOCATE.

1926. Care in selecting cod-liver oil. Vol. XXXV, No. 11, October. 1926, p. 258. Chicago.

AMERICAN POULTRY JOURNAL.

1926. Soft-shelled eggs and dead in shell. Vol. 57, No. 3, March, 1926, pp. 320–322. Chicago.

AMERICAN MEDICAL ASSOCIATION JOURNAL.

1926. Oscodal. Vol. 87, July–December, 1926, No. 9, p. 671. Chicago.

ANTHONY, ERNEST L.

1928. Butter versus oleomargarine in ricket control in pigs. Journal of Dairy Science, Vol. XI, No. 1, January, 1928, pp. 66–68. Baltimore.

ARKANSAS AGRICULTURAL EXPERIMENT STATION.

1927. Influence of certain feeds on the fertility and hatchability of hen's eggs. University of Arkansas Agricultural Experiment Station Bulletin No. 221, August, 1927, pp. 39–41. Thirty-ninth annual report, fiscal year ending June 30, 1927. Fayetteville, Ark.

ÁRVAY, A. v.
1926. Die Wirkung von Überfluss an A und B Vitamin in der Nahrung auf den Grundumsatz und die spezifisch-dynamische Wirkung der Nahrungsmittel. Pflüger's Archiv für die gesamte Physiologie des Menschen und der Tiere, 214 Band (1926), No. 4, pp. 421–438. Berlin.
ATCO FISHERIES NEWS.
1924. [Urge feeding cows with cod-liver oil.] Vol. 4, No. 4, p. 4. New York.
1928. Summary of the preliminary survey of the cod-liver oil industry and recommendations made with a view to standardizing trade terms and trade practices. Vol. VIII, June, 1928, No. 1, pp. 6–7. New York.
BECHEL, S. L., H. E. HONEYWELL, and R. A. DUTCHER.
1928. The effect of feeding heifers a ration deficient in vitamin A. Pennsylvania Agricultural Experiment Station Bulletin No. 230, pp. 20–23, 1 fig. State College, Pa.
BILLS, CHARLES E.
1925. Antirickettic substances. II. The action of *n*-butyl nitrite on activated cholesterol and the antirickettic vitamin. Journal of Biological Chemistry, Vol. LXVI (1925), No. 2, pp. 451–457. Baltimore.
1927. The principal chemical researches on cod-liver oil. Chemical Reviews, Vol. III, No. 4, February, 1927, pp. 425-442. Baltimore.
1927a. Antirickettic substances. VI. The distribution of vitamin D, with some notes on its possible origin. Journal of Biological Chemistry, Vol. LXXII (1927), No. 2, pp. 751–758. Baltimore.
BOHSTEDT, G., R. M. BETHKE, B. H. EDGINGTON, and W. L. ROBINSON.
1926. Results of rat feeding experiments. Ohio Agricultural Experiment Station Bulletin 395, July, 1926, pp. 177-178. Wooster, Ohio.
BOLLE, WALTHER.
1928. Über die subakute Leberatrophie, ein Beitrag zur Lebertranfütterung der Jungschweine. Archiv für wissenschaftliche und praktische Tierheilkunde, 57 Band, 3 Heft, pp. 264-272, 3 figs. Berlin.
BRITISH MEDICAL JOURNAL.
1922. Cod-liver oil and vitamin A. Recent investigations. Vol. II, September 30, 1922, No. 3222, p. 610. London.
BROCKLESBY, H. N.
1927. Determination of vitamin A content in liver oil of the dogfish, *Squalus sucklii*. Canadian Chemistry and Metallurgy, Vol. XI, No. 9, September, 1927, pp. 238–239, 2 figs. Toronto.
CAMPBELL, J. R.
1899. Cod-liver oil for calves. Great Britain Board of Agriculture, Annual Report on the Distribution of Grants for Agricultural Education and Research, 1899–1900, pp. 107–109. London.
CANADIAN FISHERMAN.
1928. Cod-liver meal proving valuable by-product. Controversy still raging over vitamins in Newfoundland and Norwegian cod liver oils. Canadian Fisherman, Vol. XV, No. 11, November, 1928, pp. 43–45. Gardenvale, Quebec.
CARRICK, C. W.
1925. Irradiation of chicks with cod-liver oil. American Journal of Physiology, Vol. LXXIV, No. 3, pp. 534–538, 2 figs. Baltimore.
CARRICK, CAREY W., and SIGFRED M. HAUGE.
1926. The effect of cod-liver oil upon flavor in poultry meat. Poultry Science, Vol. V, No. 5, pp. 213–215. Urbana, Ill.
CLARE, JOAN LEIGH, and KATHARINE MARJORIE SOAMES.
1928. The relative content of the fat-soluble vitamins A and D in a series of cod-liver oils. The Lancet, Vol. CCXIV, Vol. I for 1928, January 21, 1928, pp. 150–152.. London.
CONN, GEORGE H.
1927. El Aceite de Hígado de Bacalao. La Hacienda, Vol. XXII, No. VII, July, 1927, pp. 198–199. Lockport, N. Y.
COWELL, S. J.
1928. The antirachitic action of irradiated ergosterol in children and adolescents. British Medical Journal, No. 3522, July 7, 1928, pp. 5–7. London.

CRAFT, W. A., C. H. McELROY, and ROBERT PENQUITE.
1926. The influence of certain feeds upon the production of spermatozoa by the domestic chicken. Poultry Science, Vol. V, No. 4, pp. 187–198. Urbana, Ill.

CRAMER, W.
1923. On the mode of action of vitamins. The Lancet, Vol. CCIV, Vol. I for 1923, No. XXI, pp. 1046–1050, 6 figs. London.

CRUIKSHANK, ETHEL M., E. B. HART, and J. G. HALPIN.
1927. The vitamin A and vitamin D content of cod-liver meal. Poultry Science, Vol. VII, No. 1, pp. 9–16. 1 fig. Urbana, Ill.

DANIELS, FARRINGTON, and RUSSEL J. FOSBINDER.
1925. Ultra-violet light and the oxidation of cod-liver oil. Science, new series, Vol. LXII, No. 1603, September 18, 1925, p. 266. New York.

DANIELS, AMY L. and LILAH M. BROOKS.
1927. Growth-promoting value of cod-liver oil irradiated by sunlight and the mercury vapor lamp. Proceedings, Society for Experimental Biology and Medicine, Vol. XXIV, October–June, 1926–27, pp. 971–792. New York.

DEUEL, HARRY J., Jr., and ARTHUR D. HOLMES.
1922. Digestibility of cod liver, Java almond, tea seed, and watermelon seed oils, deer fat, and some blended hydrogenated fats. U. S. Department of Agriculture Bulletin No. 1, Professional paper 1033, July 27, 1922, 15 pp. Washington.

DICKHART, WALLACE H.
1927. The behavior of fish oils with uranium nitrate and pyrogallic acid. Developing a possible method for detection of adulteration in cod-liver oil. Oil and Fat Industry, Vol. IV, No. 9, September, 1927, pp. 326–328. New York.

DOWELL, A. A.
1927. Poultry experiments at the Crookston substation. Bulletin, University of Minnesota, Department of Agriculture, Report Northwest Experiment Station, Crookston, 1927, p. 55. St. Paul, Minn.

DRUMMOND, J. C.
1924. Cod-liver oil. Chemistry and Industry, Journal, Society of Chemical Industry, vol. 43, new series, No. 38, September 19, 1924, pp. 928–932. London.
1925. Selection of cod-liver oils for medicinal use. The Lancet, Vol. CCIX, Vol. II for 1925, No. 5326, pp. 679–680. London.

DRUMMOND, JACK CECIL, SYLVESTER SOLOMON ZILVA, and KATHARINE HOPE COWARD.
1922. The origin of the vitamin A in fish oils and fish-liver oils. Biochemical Journal, Vol. XVI, 1922, No. 4, pp. 518–522. London.

DRUMMOND, J. C., and S. S. ZILVA
1922. The preparation of cod-liver oil and the effect of the processes on the vitamin value of the oils. Journal, Society of Chemical Industry, Vol. XLI, 1922, No. 15, pp. 280 T–284 T, 1 fig. London.

DRUMMOND, JACK CECIL, KATHARINE HOPE COWARD, JOHN GOLDING, JAMES MACKINTOSH, and SYLVESTER SOLOMON ZILVA.
1923. Cod-liver oil in the winter feeding of milch cows. Journal of Agricultural Science, Vol. XIII, 1923, Part 2, April, 1923, pp. 144–152. Cambridge. [Extract in French by B. N. Göransson in Le lait, vol. 7, No. 68, October, 1927, pp. 764–766. Lyon.]

DRUMMOND, J. C., S. S. ZILVA, and J. GOLDING.
1923. The use of cod-liver oil in the feeding of farm animals. *Ibid.*, pp. 153–162. Cambridge.

DUBIN, HARRY E.
1927. Nutritional value and standardization of cod-liver oil and of its nonsaponifiable fat-soluble vitamine concentrate, (Oscodal). Journal, American Pharmaceutical Association, Vol. XVI, No. 1, pp. 41–45. Easton, Pa.

DUBIN, HARRY E., and CASIMIR FUNK.
1923. Studies on the chemistry of cod-liver oil. I. The effect of hydrogenation upon the vitamin content. Proceedings, Society for Experimental Biology and Medicine, Vol. XXI, 1923–1924, pp. 139–141. New York.
1925. The concentration of vitamins of cod-liver oil. Science, new series Vol. LXII, No. 1607, October 16, 1925, supplement, p. x. New York.

ELFORD, F. C.
1924. [Experimental work of the poultry division of the Dominion experimental farms.] Report of the Dominion Poultry Husbandman for 1924, *in* Report of the director, Dominion of Canada, Department of Agriculture, Dominion Experimental Farms, for the year ending March 31, 1925, pp. 9–30. 2 figs. Ottawa.
1925. [Poultry investigations at the Dominion experimental farms.] Report of the Dominion Poultry Husbandman for 1925, *in* Report of the director, Dominion of Canada, Department of Agriculture, Dominion Experimental Farms, for the year ending March 31, 1926, 67 pp., 15 figs. Ottawa.

ELY, J. O., HANNAH E. HONEYWELL, and R. ADAMS DUTCHER.
1927. The calcifying potency of cod-liver oil. Pennsylvania Agricultural Experiment Station Bulletin No. 213, p. 4. State College, Pa.

EVVARD, JOHN M.
1928. Iodine deficiency symptoms and their significance in animal nutrition and pathology. Endocrinology, Vol. XII, Sept.–Oct., 1928, No. 5, pp. 539–590. Los Angeles. [See p. 552.]

EVVARD, JOHN M., C. C. CULBERTSON, W. E. HAMMOND, C. F. BASSETT, and HUGO W. NILSON.
1927. [Cod-liver products and ultra-violet light irradiation in the production of fall pigs.] Iowa Agricultural Experiment Station Leaflet No. 24, November, 1927, p. 7. Ames, Iowa.

GOLDBLATT, H., and S. S. ZILVA.
1923. The relation between the growth-promoting and antirachitic functions of certain substances. The Lancet, Vol. II for 1923, pp. 647–649, 1 fig. London.

GOLDBLATT, H., and ALAN R. MORITZ.
1926. On the growth-promoting property of irradiated fat in the diet, of direct irradiation, and of cod-liver oil. Journal of Biological Chemistry, Vol. LXXI (1926–27), No. 1, pp. 127–137, 5 charts. Baltimore.

GUY, RUTH A.
1923. The history of cod-liver oil as a remedy. American Journal of Diseases of Children, vol. 26, 1923, No. 2, pp. 112–116. Chicago.

HALL, NOEL.
1925. Missouri State Poultry Association Year Book and Biennial Report of the Missouri State Poultry Board for the years 1923–1924, 165 pp. Mountain Grove, Mo.

HALVERSON, J. O.
1926. Animal nutrition. Effect of diets upon growth, reproduction, and rearing of young with laboratory animals. Forty-ninth Annual Report, North Carolina Agricultural Experiment Station, 1926, p. 47. Raleigh, N. C.

HANNAS, RALSTON R.
1927. What Wisconsin is doing for poultrymen. Hatchability, growth, vitality and egg production are greatly improved as a result of this work. American Poultry Journal, vol. 58, No. 4, April, 1927, p. 438. Chicago.

HARDING, T. SWANN.
1928. A history of cod-liver oil therapy. Scientific Monthly, Vol. XXVI, No. 4, April, 1928, pp. 338–341. Lancaster, Pa.

HART, E. B., H. STEENBOCK, and C. A. HOPPERT.
1921. Dietary factors influencing calcium assimilation. I. The comparative influence of green and dried plant tissue, cabbage, orange juice, and cod-liver oil on calcium assimilation. Journal of Biological Chemistry, Vol. XLVIII (1921), No. 1, pp. 33–50. Baltimore.

HART, E. B., J. G. HALPIN, and H. STEENBOCK.
1922. The nutritional requirements of baby chicks. II. Further study of leg weakness in chickens. Journal of Biological Chemistry, Vol. LII (1922), No. 2, pp. 379–386. Baltimore. Also in the International Review of the Science and Practice of Agriculture, vol. 13, December, 1922, No. 12, pp. 1571–1573. Rome.

HART, E. B., H. STEENBOCK, and S. LEPKOVSKY.
1925. Is the antirachitic factor of cod-liver oil, when mixed with ground grains, destroyed through storage? Journal of Biological Chemistry, Vol. LXV (1925), No. 3, pp. 571–578, pl. 1. Baltimore.

HART, E. B., H. STEENBOCK, S. LEPKOVSKY, S. W. F. KLETZIEN, J. G. HALPIN, and O. N. JOHNSON.

1925 The nutritional requirement of the chicken. V. The influence of ultra-violet light on the production, hatchability, and fertility of the egg. Journal of Biological chemistry, Vol. LXV (1925), No. 3, pp. 579–595. Baltimore.

HART, E. B., H. STEENBOCK, S. W. KLETZIEN, and H. SCOTT.

1927. Dietary factors influencing calcium assimilation. IX. Further observations on the influence of cod-liver oil on calcium assimilation in lactating animals. Journal of Biological Chemistry, Vol. LXXI (1926–27), No. 2, pp. 271–280. Baltimore.

HARVEY, DOUGLAS.

1927. The effects of cod-liver oil on the calcium and phosphorus metabolism of the lactating animal. Biochemical Journal, Vol. XXI, 1927, pp. 1268–1276, 2 figs. London.

HAWK, PHILIP B.

1929. Cod-liver oil and the antimony trichloride reaction for vitamin A. Science, new series, Vol. LXIX, No. 1781, February 15, 1929, p. 200. New York.

HAYES, J. B.

1927. Cod-liver oil and green feeds. Hoard's Dairyman, vol. 72, February 10, 1927, p. 160. Fort Atkinson, Wis.

HENDRICK, JAMES.

1913. Calf-feeding experiments with separated milk and oils. Transactions, Highland and Agricultural Society of Scotland, 5th Series, Vol. XXV (1913), pp. 259–282. Edinburgh.

HERVEY, GEORGE W.

1925. [Poultry investigations.] Report of the Department of Poultry Husbandry. Forty-sixth Annual Report, New Jersey State Agricultural Experiment Station and Thirty-eighth Annual Report, New Jersey Agricultural College Experiment Station, 1925, pp. 188–198. New Brunswick, N. J.

HESS, ALFRED F., LESTER J. UNGER, and A. M. PAPPENHEIMER.

1922. Spontaneous cure of rickets in rats. Proceedings, Society for Experimental Biology and Medicine, Vol. XIX, 1921–1922, pp. 236–238. New York.

HESS, ALFRED F., and MILDRED WEINSTOCK.

1924. Antirachitic effect of cod-liver oil fed during the period of pregnancy or lactation. American Journal of Diseases of Children, vol. 27, June, 1924, No. 1, pp. 1–5. Chicago.

HESS, ALFRED F., C. E. BILLS, M. WEINSTOCK, and H. RIVKIN.

1928. Difference in calcium level of the blood between the male and female cod. Proceedings, Society for Experimental Biology and Medicine, Vol. XXV, pp. 349–350. New York.

HESS, ALFRED F., CHARLES E. BILLS, and EDNA M. HONEYWELL.

1929. Antirachitic potency in relation to volume of oil in the liver of the cod. Journal, American Medical Association, vol. 92, No. 3, January 19, 1929, pp. 226–228, 1 fig. Chicago.

HEUSER, G. F., and L. C. NORRIS.

1926. Rickets in chicks. I. Variations in the antirachitic potency of different brands of cod-liver oil. Poultry Science, Vol. VI, No. 1, pp. 9–17, 2 figs. Urbana, Ill.

1926a. Rickets in chicks. II. Variations in the antirachitic potency of different grades of cod-liver oil. *Ibid.*, No. 2, pp. 94–98, 1 fig. Urbana, Ill.

HOLMES, ARTHUR D.

1922. Studies of the vitamin of cod-liver oils. I. The potency of crude cod-liver oil, pressed cod-liver oil and cod-liver stearin. Journal of Metabolic Research, vol. 2, 1922, pp. 113–122, 3 figs. Morristown, N. J.

1922a. Studies of the vitamin potency of cod-liver oils. III. The potency of pollock-liver oil—early summer oils. *Ibid.*, pp. 361–365. Morristown, N. J.

1923. Studies of the vitamin potency of cod-liver oils. II. The vitamin potency of "spring" cod-liver oil. *Ibid.*, vol. 3, 1923, pp. 393–398, 2 figs. Morristown, N. J.

HOLMES, ARTHUR D.—Continued.
1923a. Studies of the vitamin potency of cod-liver oils. IV. To what extent is quantitative estimation of vitamin A possible? *Ibid.*, pp. 583–587, 1 fig. Morristown, N. J.
1924. Studies of the vitamin potency of cod-liver oils. VIII. Potency of haddock-liver oil. *Ibid.*, vol. 5, Nos. 4–6, pp. 259–262, 1 fig. Morristown, N. J.
1924a. Studies of the vitamin potency of cod-liver oils. VI. The effect of storage of livers on the vitamin A potency of cod-liver oil. Industrial and Engineering Chemistry, vol. 16, 1924, No. 3, pp. 295–297, 3 figs. Easton, Pa.
1924b. Vitamin potency of cod-liver oils. IX. Oil produced by the rotting process. *Ibid.*, No. 9, pp. 964–965, 3 figs. Easton, Pa.
1924c. Vitamin potency of cod-liver oils. X. Medicinal cod-liver oils. *Ibid.*, No. 11, November, 1924, pp. 1181–1184, 9 figs. Easton, Pa.
1924d. Cod-liver oil and its by-products. Journal, American Pharmaceutical Association, vol. XIII, No. 12, December, 1924, pp. 1112–1115. Baltimore.
1924e. Studies of the vitamin potency of cod-liver oils. XII. The color reactions of cod-liver oil. *Ibid.*, No. 6, June, 1924, pp. 532–535. Baltimore.
1925. Vitamin potency of cod-liver oils. XI. Butter fats produced on summer feeds. Industrial and Engineering Chemistry, vol. 17, No. 1, January, 1925, pp. 75–78, 5 figs. Easton, Pa.
1925a. Studies of the vitamin potency of cod-liver oils. XVI. The vitamin A potency of shad body oil. Boston Medical and Surgical Journal, vol. 192, No. 7, 1925, pp. 300–302, 1 fig. Boston.
1926. Modern cod-liver oil. Medical Searchlight and Professional Economist, vol. II, No. 2, January 15, 1926, pp. 23–29, 7 figs. Lancaster, Pa.

HOLMES, ARTHUR D., and MADELINE G. PIGGOTT.
1925. Vitamin potency of cod-liver oils. XIII. Vitamin A potency of dogfish-liver oil. Industrial and Engineering Chemistry, vol. 17, No. 3, March, 1925, pp. 310–311. Easton, Pa.
1925a. Studies of the vitamin potency of cod-liver oils. XVII. The vitamin potency of salmon-body oil. Boston Medical and Surgical Journal, vol. 193, October 15, 1925, No. 16, pp. 726–728, 1 fig. Boston.
1926. Studies of the vitamin potency of cod-liver oils. XIV. The variation in daily food consumption of experimental animals. *Ibid.*, vol. 194, No. 12, March 25, 1926, pp. 537–538, 1 fig. Boston.
1926a. Studies of the vitamin potency of cod-liver oils. XX. Effect of light on the vitamin A content of cod-liver oil. *Ibid.*, vol. 195, No. 6, August 5, 1926, pp. 263–265, 5 figs. Boston.
1926b. Vitamin potency of cod-liver oils. XVIII. Effect on vitamin potency of cold-pressing cod-liver oils. Industrial and Engineering Chemistry, vol. 18, No. 2, February, 1926, pp. 188–189. Easton, Pa.

HOLMES, ARTHUR D., H. E. BROWN, J. WALTER SMITH, G. B. TREADWELL, and W. M. E. WHITELOCK.
1926. Studies of the vitamin potency of cod-liver oils. XIX. Influence of cod-liver oil on reproduction. Poultry Science, Vol. V, No. 3, pp. 110–116. Urbana, Ill.

HOLMES, ARTHUR D., and WALTER Z. CLOUGH.
1927. The chemical and physical characteristics of cod-liver oil. Results obtained from examination of over one hundred samples of known origin. Oil and Fat Industry, Vol. IV, No. 12, December, 1927, pp. 403-409, 1 fig. New York.

HOLMES, ARTHUR D., A. W. DOOLITTLE, and W. B. MOORE.
1927. Studies of the vitamin potency of cod-liver oils. XXI. The stimulation of reproduction by fat-soluble vitamins. Journal, American Pharmaceutical Association, Vol. XVI, No. 6, June, 1927, pp. 518–527, 4 charts. Easton, Pa.

HOLMES, ARTHUR D., EDWIN T. WYMAN, LAWRENCE W. SMITH, and MADELEINE G. PIGOTT.
1928. A comparison of cod-liver oil and ultra-violet light for use in the prevention of rickets. American Journal of Diseases of Children, vol. 36, No. 5, November, 1928, pp. 952–965. Chicago.

HUSBAND, ALFRED DUDLEY, WILLIAM GODDEN, and MARION BROCK RICHARDS.
1923. The influence of cod-liver oil, linseed oil, and olive oil on the assimilation of calcium and phophorus in the growing pig. Biochemical Journal, Vol. XVII, 1923, No. 6, pp. 707–719, 3 figs. London.

IBSEN, HEMAN.
1927. Cod-liver oil for "snuffles" in rabbits and pneumonia in guinea pigs. Science, new series, Vol. LXVI, No. 1717, November 25, 1927, pp. 509–510. New York.

IDAHO AGRICULTURAL EXPERIMENT STATION.
1926. [Experiments with poultry.] University of Idaho Agricultural Experiment Station Bulletin No. 142, January, 1926, p. 20. Moscow, Idaho.

INDIANA AGRICULTURAL EXPERIMENT STATION.
1925. [Experiments with poultry—Ultra-violet energy in cod-liver oil.] Thirty-eighth Annual Report, Purdue University Agricultural Experiment Station for the year ending June 30, 1925, pp. 34–35, 1 fig. Lafayette, Ind.

IOWA AGRICULTURAL EXPERIMENT STATION.
1927. [Action of antirachitic vitamin—Animal nutrition studies.] Annual Report for the fiscal year ending June 30, 1927, pp. 27–30. Ames, Iowa.

ISCOVESCO, HENRI.
1914. Sur les lécithides contenus dans l'huile de foie de morue. Comptes Rendus, Societe de Biologie, 66 Année, 1914, Tome 1, pp. 34–35. Paris.

JACKSON, HOMER W.
1924. Influence of vitamins on leg weakness in chicks. Reliable Poultry Journal, Vol. XXXI, No. 4, June, 1924, pp. 428–430. Dayton, Ohio.

JONES, J. H., H. STEENBOCK, and M. T. NELSON.
1924. Fat soluble vitamins. XXII. The comparative amounts of vitamin A and antirachitic factor in butterfat and cod-liver oil. Journal of Metabolic Research, vol. 6, Nos. 1–6, pp. 169–187, II Pls., 4 text figs. Morristown, N. J.

JONES, I. R., C. H. ECKLES, and L. S. PALMER.
1926. The rôle of vitamin A in the nutrition of calves. Journal of Dairy Science, Vol. IX, No. 2, pp. 119–139, 11 figs. Baltimore.

JONES, D. BREESE, J. C. MURPHY, and E. M. NELSON.
1928. Biological values of certain types of sea food. II—Vitamins in oysters (*Ostrea virginica*). Industrial and Engineering Chemistry, vol. 20, No. 2, February, 1928, pp. 205–210, Charts I–VIII. Easton, Pa.

KEMPSTER, H. L.
1926. [Nutritional requirements of poultry.] *In* Bulletin 244. University of Missouri College of Agriculture, Agricultural Experiment Station, pp. 47–49. Columbia, Mo.
1927. Nutritional requirements of poultry. University of Missouri Agricultural Experiment Station Bulletin 256, September, 1927, pp. 83–85. Columbia, Mo.

KENNARD, D. C.
1924. Rearing chicks indoors. Ohio Agricultural Experiment Station Monthly Bulletin, Vol. IX, Nos. 1 and 2, January and February, 1924, pp. 15–21, figs. 12 and 13. Wooster, Ohio.

KENNARD, D. C., and R. M. BETHKE.
1926. Supplements that improve the ration for layers. Ohio Agricultural Experiment Station Bimonthly Bulletin, Vol. XI, No. 5, September-October, 1926, pp. 194-197. Wooster, Ohio.
1927. Solving the green feed problem. [Experiments with poultry.] *Ibid.*, Vol. XII, No. 4, July–August, 1927, pp. 120–127. Wooster, Ohio.

KENTUCKY AGRICULTURAL EXPERIMENT STATION.
1927. [Experiments with poultry.] Fortieth Annual Report, Agricultural Experiment Station, University of Kentucky, 1927, Pt. I, pp. 21–25. Lexington.

KLEIN, G. T.
1927. A study of various methods of preventing rickets in chicks. Poultry Science, Vol. VII, No. 1, pp. 31–40, 4 figs. Urbana, Ill.

KORENCHEVSKY, V.
1921. Experimental rickets in rats. British Medical Journal, Vol. II, 1921, No. 3171, pp. 547–550. London.

KRAMER, BENJAMIN, SIDNEY D. KRAMER, DAVID H. SHELLING, and M. J. SHEAR.
1927. Cod-liver oil concentrate. Its value as an antirachitic agent when injected subcutaneously. Journal of Biological Chemistry, Vol. LXXI (1926–27), No. 3, pp. 699–706. Baltimore.

LANG, J.
1921. Die Vitamine und der Lebertran. Schweizerische Apotheker-Zeitung, Jahrgang LIX, 1921, No. 38, pp. 501–504. Zürich.

LAX, HEINRICH.
1921. Untersuchungen über die Ergänzungsstoffe des Lebertrans. Biochemische Zeitschrift, Band 125, pp. 265–271. Berlin.

LESNÉ and VAGLIANO.
1924. Production d'un lait de vache doué de propriétés antirachitiques. Comptes Rendus, de l'Académie des Sciences, Tome 179, No. 11, pp. 539–541. Paris.

LESNÉ, E., ROBERT CLÉMENT, and S. SIMON.
1928. Dissociation des facteurs de croissance et antirachitique. Comptes Rendus, Sociéte de Biologie, Tome XCVIII, pp. 928–930. Paris.

LEWKOWITSCH, J.
1914. Chemical technology and analysis of oils, fats, and waxes. 3 vols., 5th edition, Vol. II, pp. 424–445. Macmillan and Co., London.

LOFFLER, ERIC.
1929. More and better liver oils. Fishing Gazette, vol. 46, No. 5, May, 1929, pp. 14–16. New York.

MACKENZIE, N. D.
1923. [Experiments with poultry at the Indian Head Experiment Farm.] Dominion of Canada, Department of Agriculture, Dominion Experiment Farms, Report of the Superintendent Experiment Farm, Indian Head, Saskatchewan, 1923, pp. 39–42. Ottawa.

MAIGNON, F.
1912. Rôle des graisses dans l'utilisation de l'albumine alimentaire. Mécanisme de l'action thérapeutique de l'huile de foie de morue et des corps gras médicamenteux en général. Comptes Rendus, Société de Biologie, vol. 72, No. 24, pp. 1054–1056. Paris.

MARCELET, H.
1927. Les huiles d'animaux marins denos colonies. Chimie & Industrie, Vol. XVII, May, 1927, pp. 860–864. Paris.

MATTICK, ELFRIDA CONSTANCE VICTORIA.
1928. The chemical composition of the milk of cows receiving cod-liver oil. Biochemical Journal, Vol. XXII, No. 1, 1928, pp. 144–149. London.

MATTILL, H. A.
1927. The relation of vitamins B and E to fertility in the male rat. American Journal of Physiology, Vol. LXXIX, No. 2, pp. 305–315. Baltimore.

MCCOLLUM, E. V., NINA SIMMONDS, H. T. PARSONS, P. G. SHIPLEY, and E. A. PARK.
1921. Studies on experimental rickets. I. The production of rachitis and similar diseases in the rat by deficient diets. Journal of Biological Chemistry, Vol. XLV (1920–21), No. 2, pp. 333–341, pls. 2 and 3. Baltimore.

MCCOLLUM, E. V., NINA SIMMONDS, P. G. SHIPLEY, and E. A. PARK.
1921. Studies on experimental rickets. IV. Cod-liver oil as contrasted with butterfat in the protection against the effects of insufficient calcium in the diet. Proceedings, Society for Experimental Biology and Medicine, Vol. XVIII, 1920–1921, pp. 275–277. New York.

1921a. Studies on experimental rickets. VI. The effects on growing rats of diets deficient in calcium. American Journal of Hygiene, Vol. I, No. 4, pp. 492–511, 5 figs., Pls. XXV–XXIX. Baltimore.

1921b. Studies on experimental rickets. VIII. The production of rickets by diets low in phosphorus and fat soluble A. Journal of Biological Chemistry, Vol. XLVII (1921), No. 3, pp. 507–527, pls. 4–7. Baltimore.

McCollum, E. V., Nina Simmonds, P. G. Shipley, and E. A. Park—Continued.
1922. Studies on experimental rickets. XII. Is there a substance other than fat soluble A associated with certain fats which plays an important rôle in bone development? *Ibid.*, Vol. L (1922), No. 1, pp. 5–30, 16 figs., 1 pl. Baltimore.
1922a. Studies on experimental rickets. XVI. A delicate biological test for calcium-depositing substances. *Ibid.*, Vol. LI (1922), No. 1, pp. 41–49, 1 text fig., pls. 1 and 2. Baltimore.
1922b. Studies on experimental rickets. XV. The effect of starvation on the healing or rickets. Bulletin, Johns Hopkins Hospital, Vol. XXXIII, No. 371, pp. 31–33, pl. 1. Baltimore.

McCollum, E. V., Nina Simmonds, J. Ernestine Becker, and P. G. Shipley.
1927. Studies on experimental rickets. XXVIII. Does vitamin D pass into the milk? American Journal of Diseases of Children, vol. 33, 1927, No. 2, pp. 230–243. Chicago.

Mendel, Lafayette B., and William E. Anderson.
1926. Diet and body fat. Science, new series, Vol. LXIV, No. 1659, October 15, 1926, pp. 384–386. New York.

Mercer, Eric W., and F. H. W. P. Tozer.
1927. The effect of irradiation and cod-liver oil upon poultry. Journal, Ministry of Agriculture, Vol. XXXIV, No. 7, October, 1927, pp. 624–626. London.

Miller, R. J., R. Adams Dutcher, and H. C. Knandel.
1928. Nutritional leg weakness in poultry. Pennsylvania Agricultural Experiment Station Bulletin No. 230, pp. 7 and 8, 1 fig. State College, Pa.

Molkerei-zeitung.
1895. Leberthran als Zusatz zum Futter. 9 Jahrgang, 1895, No. 9, p. 125. Hildesheim.

Mouriquand, Georges, and Paul Michel.
1922. De l'action de certains aliments gras sur le métabolisme osseux. Adjuvants et antagonistes de la substance antiscorbutique. Comptes Rendus, Société de Biologie, vol. 86, No. 19, pp. 1170-1172. Paris.
1923. Sur les conditions expérimentales d'action de l'huile de foie de morue. Son pouvoir ostéodystrophique en présence d'un régime déficient. Comptes Rendus de l'Académie des Sciences, vol. 176, No. 5, pp. 338–340. Paris.

Mouriquand, G., A. Leulier, M. Bernheim, and J. Schœn.
1928. Recherches sur les fixateurs du calcium. La Presse Médicale, vol. 36, No. 14, pp. 209–213, 5 figs. Paris.

Munsell, Hazel E., and Hilda Black.
1928. The "assay of a so-called cod-liver oil extract" for vitamin A content and calcifying properties compared to cod-liver oil. Journal, American Pharmaceutical Association, Vol. XVII, No. 2, February, 1928, pp. 139–144, 1 fig. Easton, Pa.

Nelson, E. M., and H. Steenbock.
1925. Fat-soluble vitamins. XXIV. The nonprecipitability of the antiophthalmic and antirachitic properties from cod-liver oil by digitonin. Journal of Biological Chemistry, Vol. LXIV (1925), No. 2, pp. 299–312, 2 charts. Baltimore.

Nelson, V. E., R. L. Jones, Georgian Adams, and L. T. Anderegg.
1927. Cod-liver oil as food. Observations on the existence of vitamin E Industrial and Engineering Chemistry, vol. 19, No. 7, July, 1927, pp. 840–844. Easton, Pa.

Nelson, V. E., Esther Ohrbeck, R. L. Jones, and M. W. Taylor.
1928. Cod-liver oil for reproduction. American Journal of Physiology, Vol. LXXXV, No. 3, July, 1928, pp. 476–481. Baltimore.

Ohio Agricultural Experiment Station.
1926. [Feeding experiments with poultry.] Stability of cod-liver oil in feed mixtures. Bulletin 392, March, 1926, pp. 62–70, figs. 8–10. Wooster, Ohio.
1927. [Swine-feeding investigations.] Bulletin 402, February, 1927, pp. 81–85, fig. 13. Wooster, Ohio.
1927a. [Poultry experiments.] Bulletin 402, February, 1927, pp. 88–93, fig. 14. Wooster, Ohio.
1928. [Poultry experiments.] Bulletin 417, March, 1928, pp. 65–66 and 71–73, fig. 9. Wooster, Ohio.

ORR, J. B.
1923. Cod-liver oil for poultry. Scottish Journal of Agriculture, Vol. VI, 1923, pp. 349-351. Edinburgh.
1924. The influence of cod-liver oil on growth and egg production in poultry. Second World's Poultry Congress and Exhibition held at Barcelona, Spain, May 10–18, 1924. 416 pp., illus., 1927. The Graphic Art Co. (Ltd.), Barcelona.

ORR, J. B., A. CRICHTON, B. M. NORTH, A. KINROSS, M. MOIR, and H. NEWBIGIN.
1924. The effects of adding vitamin-rich substances to normal rations for poultry. I.—The fat-soluble vitamin or vitamin A. Scottish Journal of Agriculture, Vol. VII, 1924, pp. 266–277. Edinburgh.

OSBORNE, THOMAS B., and LAFAYETTE B. MENDEL.
1914. The influence of cod-liver oil and some other fats on growth. Journal of Biological Chemistry, Vol. XVII (1914), No. 3, pp. 401–408, 4 charts. Baltimore.
1921. Continuation and extension of work on vegetable proteins. Carnegie Institution of Washington Year Book No. 20, 1921, pp. 432–441. Washington.

PAPPENHEIMER, ALWIN M.
1922. Experimental rickets in rats. VI. The anatomical changes which accompany healing of experimental rat rickets, under the influence of cod-liver oil or its active derivatives. Journal of Experimental Medicine, vol. 36, No. 3, pp. 335–355, pls. 20–28. New York.

PAPPENHEIMER, A. M., G. F. MCCANN, T. F. ZUCKER, and A. F. HESS.
1921. The effect of various modifications of a diet producing rickets in rats. Proceedings, Society for Experimental Biology and Medicine, Vol. XVIII, 1920–1921, pp. 267–270. New York.

PARK, E. A., and JOHN HOWLAND.
1921. The radiographic evidence of the influence of cod-liver oil in rickets. Bulletin, Johns Hopkins Hospital, Vol. XXXII, No. 369, pp. 341–344, Pls. XLIV–XLVII. Baltimore.

PARK, E. A., RUTH A. GUY, and G. F. POWERS.
1923. A proof of the regulatory influence of cod-liver oil on calcium and phosphorous metabolism. American Journal of Diseases of Children, vol. 26, 1923, No. 2, pp. 103-111, 1 fig. Chicago.

PATERSON, WILLIAM G. R.
1924. Pig-feeding and cattle-feeding experiments. Transactions, Highland and Agricultural Society of Scotland, fifth series, Vol. XXXVI (1924), pp. 161–184; also West of Scotland Agricultural College Bulletin No. 102, pp. 119–144. Edinburgh.

PATERSON, WILLIAM G. R., and JAMES COCHRANE.
1925. Report on a pig-feeding experiment conducted at the college farm, Kilmarnock, during season 1924. West of Scotland Agricultural College Bulletin No. 104, pp. 159-177. Glasgow.

PEACOCK, P. R.
1926. The action of light on cod-liver oil. The Lancet, Vol. CCXI, Vol. II for 1926, pp. 328–330, 1 fig. London.

PENNSYLVANIA AGRICULTURAL EXPERIMENT STATION.
1927. The relative effects of ultra-violet light and cod-liver oil upon the eggs from fowls used for breeding purposes. Fortieth annual report, Pennsylvania Agricultural Experiment Station, fiscal year ending June 30, 1927, Bulletin No. 213, pp. 28–31, 3 figs. State College, Pa.

PENQUITE, R.
1926. [Poultry experiments at the Oklahoma Station.] Yellow corn, cod liver oil, etc. Oklahoma Agricultural and Mechanical College Agricultural Experiment Station biennial report, 1924–1926, pp. 57–61. Stillwater, Okla.

PHARMACOPŒIA OF THE UNITED STATES.
1925. Tenth decennial revision. Official from January 1, 1926, pp. 131, 263, and 469. Philadelphia.

PITTENGER, PAUL S.
1928. Biologic assays for vitamins. American Journal of Pharmacy, vol. 100, No. 2, February, 1928, pp. 63–91, 19 figs. Philadelphia.

POULSSON, EDVARD.
1924. A note of the durability of vitamin A of cod-liver oil. Biochemical Journal, Vol. XVIII, 1924, No. 5, pp. 919–920, 1 fig. London.

Powers, G. F., E. A. Park, P. G. Shipley, E. V. McCollum, and Nina Simmonds.
1922. The prevention of the development of rickets in rats by sunlight. Journal, American Medical Association, vol. 78, No. 3, January 21, 1922, pp. 159–165, 5 figs. Chicago.

Randoin, L., E. André, and R. Lecoq.
1928. Valeur antirachitique comparée de quelques huiles d'animaux marine et de l'huile de foie de morue. Journal de Pharmacie et de Chimie, 120 Année, 8 Série, Tome VII, June 1, 1928, pp. 529–539. Paris.

Reed, O. E.
1926. [Experiments with dairy cattle at the Michigan station.] Thirty-eighth Annual Report, Agricultural Experiment Station of the Michigan Agricultural State College, pp. 229–232. Lansing.

Richardson, William D.
1927. The economics of vitamins. Bulletin No. 11, August 1, 1927, Institute of Margarine Manufacturers, pp. 3–21. Washington.

Russell, E. J.
1913. The discussion on animal nutrition at Dundee. Science Progress, Vol. VII, No. 27, January, 1913, pp. 413–436. [Hendrick, pp. 428–430.] London.

Schlingman, A. S.
1925. The effect of cod-liver oil on dogs convalescing from distemper. Journal, American Veterinary Medical Association, Vol. LXVII, new series, vol. 20, No. 1, pp. 91–96. Detroit.

Schultzer, Poul.
1925. Le métabolisme du phosphore et du calcium chez de jeunes rats soumis au régime rachitigène riche en calcium, sous l'influnce des rayons ultraviolets, de l'huile de foie de morue et des phosphates. Comptes Rendus, Société de Biologie, Tome 93, No. 30, pp. 1005–1007. Paris.

1925a. Le calcium et le phosphore minéral du sérum des rats rachitiques sous l'influence de différents traitements. *Ibid.*, pp. 1008–1010. Paris.

1927. Studien über Phosphor- und Calciumstoffwechsel bei mangelhaften Kostformen. I. Die Einwirkung ultravioletten Lichtes. Biochemische Zeitschrift, Band 188, Nos. 4–6, pp. 409–426; II. Die Einwirkung von Lebertron, pp. 427–434; III. Veränderung des Phosphor- oder Calciumgehalts des Kost, pp. 435–447. Berlin.

Science News-Letter.
1926. December 11, 1926, Science Service Publication No. 296, p. 169. Washington, D. C.

Selvig, C. G.
1925. [Experiments with poultry at the Crookston substation.] Bulletin, University of Minnesota, Department of Agriculture, Report, Northwest Experiment Station, Crookston, 1925, pp. 70–71. St. Paul.

Seton, Robert S.
1901. Cod-liver oil as a substitute for cream in calf rearing. Yorkshire College, Leeds, and East and West Ridings Joint Agricultural Council, Pamphlet 18, pp. 3–7, table 2. Leeds.

Shipley, P. G., E. A. Park, E. V. McCollum, and Nina Simmonds.
1921. Studies on experimental rickets. III. A pathological condition bearing fundamental resemblances to rickets of the human being resulting from diets low in phosphorus and fat-soluble A: The phosphate ion in its prevention. Bulletin, Johns Hopkins Hospital, Vol. XXXII, No. 363, pp. 160–155, Pls. XXIV–XXVI, 1 fig. Baltimore.

1921a. Studies on experimental rickets. V. The production of rickets by means of a diet faulty in only two respects. Proceedings, Society for Experimental Biology and Medicine, Vol. XVIII, 1920–1921, pp. 277–280. New York.

1921b. Studies on experimental rickets. VII. The relative effectiveness of cod-liver oil as contrasted with butterfat protecting the body against insufficient calcium in the presence of a nominal phosphorus supply. American Journal of Hygiene, Vol. I, (1921), No. 4, pp. 512–525, 5 figs., Pls. XXX–XXXIII. Baltimore.

SHIPLEY, P. G., E. A. PARK, E. V. MCCOLLUM, NINA SIMMONDS, and H. T. PARSONS.
1921. Studies on experimental rickets. II. The effect of cod-liver oil administered to rats with experimental rickets. Journal of Biological Chemistry, Vol. XLV (1920–1921), No. 2, pp. 343–348, pls. 4 and 5. Baltimore.

SHOHL, ALFRED T., and HELEN B. BENNETT.
1928. Rickets in dogs. Metabolism of calcium and phosphorus. Journal of Biological Chemistry, Vol. LXXVI (1928), No. 3, pp. 633–642, 2 figs. Baltimore.

SHOHL, ALFRED T., and FRANKLIN C. BING.
1928. Rickets in rats. VIII. Rickets and tetany. American Journal of Physiology, vol. 86, No. 3, pp. 633–638. Baltimore.
1928a. Rickets in rats. IX. pH of the feces. Journal of Biological Chemistry, Vol. LXXIX, No. 1, pp. 269–274. Baltimore.

SHOHL, ALFRED T., HELEN B. BENNETT, and KATHARINE L. WEED.
1928. Rickets in rats. V. Comparison of effects of irradiated ergosterol and cod-liver oil. Proceedings, Society for Experimental Biology and Medicine, Vol. XXV, No. 7, April, 1928, pp. 551–554. New York.
1928a. Rickets in rats. VII. Metabolism of calcium and phosphorus of rats fed upon nonricketogenic diets. Journal of Biological Chemistry, Vol. LXXIX, No. 1 (1928), pp. 257–267. Baltimore.

SIMMONDS, NINA, J. ERNESTINE BECKER, and E. V. MCCOLLUM.
1928. The distribution of vitamin E. Journal of Nutrition, Vol. I, No. 1, September, 1928, pp. 39–47. Springfield, Ill.

SJOLLEMA, B.
1923. Studies in inorganic metabolism. I. The influence of cod-liver oil upon calcium and phosphorus metabolism. Journal of Biological Chemistry, Vol. LVII (1923), No. 1, pp. 255–270, 1 chart. Baltimore.
1923a. *Idem.* II. The influence of crude fiber and of protein upon calcium and phosphorus metabolism. *Ibid.*, pp. 271–284, 2 charts. Baltimore.

SLAGSVOLD, L.
1925. Transforgiftninger hos kalver. Norsk Veterinaer-Tidsskrift, Vol. VI, pp. 161–168. Oslo. Also in Journal, American Veterinary Medicinal Association, Vol. LXVIII, new series, vol. 21, November, 1925, p. 236. Detroit.

SMITH, MAURICE I.
1923. Studies on nutrition in experimental tuberculosis. I. The effect of the fat-soluble A vitamin on tuberculosis of the guinea pig, with especial reference to the value of cod-liver oil in experimental tuberculosis American Review of Tuberculosis, Vol. VII, March–August, 1923, No. 1, pp. 33–48, 6 figs. Baltimore.

SOAMES, KATHARINE MARJORIE.
1924. A preliminary note on the growth-promoting and antirachitic value of cod-liver oil when injected intraperitoneally. Biochemical Journal, vol. 18, No. 6, pp. 1349–1353, 1 fig. London.

SOAMES, KATHARINE MARJORIE, and JOAN CLARE LEIGH-CLARE.
1928. The assay of the antirachitic vitamin D. Biochemical Journal, vol. 28, No. 2. 1928, pp. 522–527. London.

SOUTHGATE, HERBERT WILLIAM.
1925. Note on the effect of high temperatures on the accessory food factor content of cod-liver oil. Biochemical Journal, Vol. XIX, 1925, No. 5, pp. 733–736, 1 fig. London.

STAMMERS, ARTHUR DIGHTON.
1922. Feeding experiments in connection with vitamins A and B. III. Milk and the growth-promoting vitamin. IV. The vitamin A content of refined cod-liver oil. Biochemical Journal, Vol. XVI, 1922, No. 5, pp. 659–667, 3 figs. London.
1924. Feeding experiments in connection with vitamins A and B. (V) Orange juice as a source of vitamin B. (VI) Ophthalmia in rats affected with avitaminosis. (VII) The vitamin content of cod-liver oil and malt extract. *Ibid.*, vol. 18, No. 1, pp. 9–15, 2 figs. London.

STEENBOCK, H., J. H. JONES, and E. B. HART.
1923. Fat-soluble vitamins. XVI. Stability of the antirachitic vitamin to saponification. Journal of Biological Chemistry, Vol. LVIII (1923–1924), No. 2, pp. 383–393, 3 figs, 3 charts. Baltimore.

STREET, JOHN PHILLIPS.
1915. The comparative nutrient value of cod-liver oil and cod-liver oil cordials. Journal, American Medical Association, Vol. LXIV, No. 8, pp. 638–643. Chicago.

TAKAHASHI, K., and K. KAWAKAMI.
1923. Chemistry of vitamin A—I. Separation of the effective constituent of cod-liver oil and its properties. [Translated title.] Journal, Chemical Society of Japan [Nippon Kwagaku Kwai Shi], vol. 44, No. 12, pp. 590–605 [abstract in Journal, Society of Chemistry and Industry, vol. 42, No. 8, p. 904A]. Tokyo and London.

TRESSLER, DONALD K.
1923. Marine products of commerce, etc. The Chemical Catalog Co. (Inc.). New York. [See pp. 442–450.]

TRESSLER, DONALD K., and ARTHUR W. WELLS.
1924. Iodine content of sea foods. Appendix I, Report, United States Commissioner of Fisheries for 1924. Bureau of Fisheries Document No. 967, 12 pp. Washington.

UNITED STATES BUREAU OF FISHERIES.
1921. Rules for making cod-liver oil in Newfoundland. From rules and regulations respecting the fisheries of Newfoundland, 1921, p. 50. [These data are set forth in Memorandum S-262 in the files of the Bureau of Fisheries and may be obtained on request.] Washington.

VON WENDT, GEORG.
1928. Die Bedeutung der biologischen Kontrolle von Lebertran und Lebertranpräparaten. Münchener Medizinische Wochenschrift, 75 Jahrgang, Nr. 11, March 16, 1928, pp. 473–474. München.

WELLS, JOHN W.
1902. The digestibility of fats and oils, with special reference to emulsions. British Medical Journal, Vol. II for 1902, No. 2181, pp. 1222–1224. London.

WEST, E. S., and G. H. BISHOP.
1925. The photochemistry of cod-liver oil. Science, new series, Vol. LXII, No. 1595, July 24, 1925, pp. 86–87. New York.

WISCONSIN AGRICULTURAL EXPERIMENT STATION.
1927. Science unlocks the door to better nutrition of poultry. Annual Report, Director, Agricultural Experiment Station, University of Wisconsin, for 1926–1927, Bulletin 396, pp. 47–53, figs. 11 and 12. Madison.

WOKES, FRANK, and STANLEY GORDON WILLIMOTT.
1927. A study of the effect of heat and oxidation on cod-liver oil as measured by color tests. Biochemical Journal, Vol. XXI, 1927, No. 2, pp. 419–425, 1 fig. London.
1927a. The detection and estimation of vitamin A and of vitamin D in cod-liver oil and various food products. Pharmaceutical Journal and Pharmacist, No. 3321, vol. 118 (4th series, vol. 64), June 25, 1927, pp. 752–757, 4 figs. London.

WOOD, WALTER F., Jr.
1926. A comparison of the growth of chicks behind window glass and a glass substitute. Poultry Science, Vol. VI, No. 2, pp. 62–70, 2 figs. Urbana, Ill.

WYMAN, EDWIN T., ARTHUR D. HOLMES, LAWRENCE W. SMITH, DONALD C. STOCKBARGER, and MADELEINE G. PIGOTT.
1926. A comparison of the antirachitic potency of irradiated cod-liver oils. Boston Medical and Surgical Journal, vol. 195, September 9, 1926, No. 11, pp. 525–535, 2 figs., 7 pls. Boston.
1927. Does the irradiation of cod-liver oil increase its antirachitic potency? American Journal of Diseases of Children, vol. 34, 1927, No. 5, pp. 753–764, 12 figs. Chicago.

YODER, LESTER.
1927. Effect of antirachitic vitamin on the phosphorus, calcium, and pH in the intestinal tract. Journal of Biological Chemistry, Vol. LXXIV (1927), pp. 321–329, 2 figs. Baltimore.

ZILVA, SYLVESTER SOLOMON.
1922. A note on the relative influence of cod-liver oil and butter on the deposition of calcium in the bone of growing rats. The Lancet, Vol. CCII, Vol. I for 1922. p. 1244. London.
1924. The stability of the vitamin A of cod-liver oil toward the hardening process. Biochemical Journal, Vol. XVIII, 1924, No. 5, pp. 881-882. London.

ZILVA, S. S., and J. C. DRUMMOND.
1921. Vitamin-A content of oils prepared from livers of the cod, coalfish, and haddock. The Lancet, Vol. CCI, Vol. II for 1921, pp. 753–754. London.
1922. Fish-liver oils and other highly potent sources of vitamin A. *Ibid.*, Vol. I for 1922, p. 1243. London.
1923. The cod-liver oil industry in Newfoundland. Journal, Society for Chemistry and Industry, vol. 42, No. 18, pp. 185T–188T. London.

ZILVA, SYLVESTER SOLOMON, JACK CECIL DRUMMOND, and MICHAEL GRAHAM.
1924. The relation of the vitamin A potency of the liver oil to the sexual condition and age of the cod. Biochemical Journal, Vol. XVIII, No. 1, 1924, pp. 178–181. London.

ZILVA, SYLVESTER SOLOMON, JOHN GOLDING, and JACK CECIL DRUMMOND.
1924. The relation of the fat-soluble factor to rickets and growth in pigs. III. Biochemical Journal, Vol. XVIII, No. 5, 1924. pp. 872–880, 1 fig., Pls. VI–VII. London.

ZUCKER, T. F.
1922. Further observations on the chemistry of cod-liver oil. Proceedings, Society for Experimental Biology and Medicine, Vol. XX, 1922–1923, p. 136. New York.

ZUCKER, T. F., A. M. PAPPENHEIMER, and MARION BARNETT.
1922. Observations on cod-liver oil and rickets. Proceedings, Society for Experimental Biology and Medicine, Vol. XIX, 1921–1922, pp. 167–169. New York.

ZUCKER, T. F., and M. J. MATZNER.
1924. On the pharmacological action of the antirachitic active principle of cod-liver oil. Proceedings, Society for Experimental Biology and Medicine, Vol. XXI, 1923–1924, pp. 186–187. New York.

OYSTER INDUSTRY OF THE PACIFIC COAST OF THE UNITED STATES [1]

By Paul S. Galtsoff, Ph. D., *In charge of oyster fishery investigations, U. S. Bureau of Fisheries*

CONTENTS

INTRODUCTION

In developing the program of oyster investigations of the United States Bureau of Fisheries it seemed desirable to extend the scientific studies of the oyster to the Pacific coast. In order to make a comprehensive plan of the investigations, a preliminary survey of the oyster problems of the Pacific coast was made by the author and H. C. McMillin.

The present paper embodies the results of the observations made during a 2-month trip on the Pacific coast and outlines the problems and the program of future research. The work was greatly facilitated by the cooperation extended by the department of fisheries and game of the State of Washington, which bore part of the expenses incidental to the trip and provided transportation facilities within the States. It is the author's desire also to express his thanks for valuable information and help received from Charles R. Pollock, supervisor of marine fisheries of the State of Washington, and E. N. Steele, secretary of the Olympia Oyster Growers Association.

Although comparatively little is known regarding the biology of the Pacific oyster and the physical and chemical characteristics of the water in which it lives, scattered bits of information can be found in various Government reports and publications. It is deemed desirable to collect all of the available information and to present it in a condensed form.

[1] Appendix VIII to the Report of the U. S. Commissioner of Fisheries for 1929. B. F. Doc. 1066. Submitted for publication May 13, 1929.

Along the great stretch of the Pacific coast of the North American Continent there are only a few inclosed bays or protected harbors that afford conditions suitable for the growth of oysters. Consequently, the oyster industry of the Pacific region is small; its annual output, according to the statistics of the United States Bureau of Fisheries, amounted in 1925 (the latest year for which the statistical data for the whole coast are available) to 143,646 bushels, valued at $404,344. The annual crop of market oysters on the Pacific coast constitutes only 0.8 per cent of the total annual yield of the whole country, but the value of the Pacific product constitutes 2.9 per cent of the total value of market oysters produced in the United States. This fact can be regarded as indicative of the high quality of the product and of a considerable demand for it, both conditions being favorable for the development of the industry.

Of the three Pacific Coast States the leading rôle in oyster production belongs to the State of Washington, which contributes about 95 per cent of the total production of oysters, 4 per cent being produced in California, and 1 per cent in Oregon. These figures show clearly that the oyster problem of the Pacific coast is primarily the oyster problem of the State of Washington. It would be, however, unwise to disregard conditions in California and Oregon, for though their production is negligible, yet there is no reason to believe that the cultivation of oysters in these States is impossible.

The industry of the Pacific coast utilizes three species of oysters, one of which (*Ostrea lurida*) is indigenous to the waters of the Pacific Ocean, while two others are imported, one from the Atlantic coast (*Ostrea virginica*) and one from Japan (*Ostrea gigas*). However, the native oyster is most important for its production in the State of Washington, comprising, according to statistics for the year 1926, 81.3 per cent of the total oyster crop of the State and constituting 87.5 per cent of the total value of the market oysters produced in the State. Our attention, therefore, should be directed primarily to the study of the biology and methods of cultivation of this species.

BIOLOGY OF THE PACIFIC OYSTER, WITH SPECIAL REFERENCE TO CULTURAL PROBLEMS IN WASHINGTON

The native oyster of the Northwest of America was named *Ostrea lurida* by P. P. Carpenter in 1864, who gave a brief description of this species: "*Ostrea lurida*, n. sp., shape of *edulis;* texture dull, lurid, olivaceous, with purple stains, 2 to 3 fathoms on mud flats" (quoted from Stafford, 1913). Apart from characters given by Carpenter, *Ostrea lurida* (fig. 1) can easily be distinguished from other species by its small size, rarely exceeding 5.5 centimeters in length and 4.5 centimeters in width, and thin shell with slightly pigmented muscle scar. According to Stafford (op. cit.), specimens 7 centimeters long and 5.1 centimeters wide were found, but they are very rare. The majority of the oysters examined by the author in October, 1928, in Puget Sound and Willapa Bay did not exceed 5.5 centimeters in length.

Ostrea lurida has a wide range of distribution, from Charlotte Sound in British Columbia to San Diego harbor in California; but along this line there are only a few localities where it grows in abundance. Undoubtedly lack of suitable space is the main reason why oysters are scarce on the Pacific coast.

The complete life history of the Pacific oyster has been little studied, and the only information regarding it is found in Stafford's papers (1913, 1915, 1917), which refer to the oysters growing in the waters of British Columbia.

One of the principal anatomical and biological characteristics that distinguish the native oyster from eastern American species is its hermaphroditism. In this respect it resembles the European species (*Ostrea edulis*) or another American species (*Ostrea equestris*), which occurs on the Atlantic coast but is of no commercial value. That *O. lurida* is hermaphroditic has been established by the observations of R. C. Scheidt and F. L. Washburn (quoted from Doane, 1901, p. 59). They discovered that both male and female germ

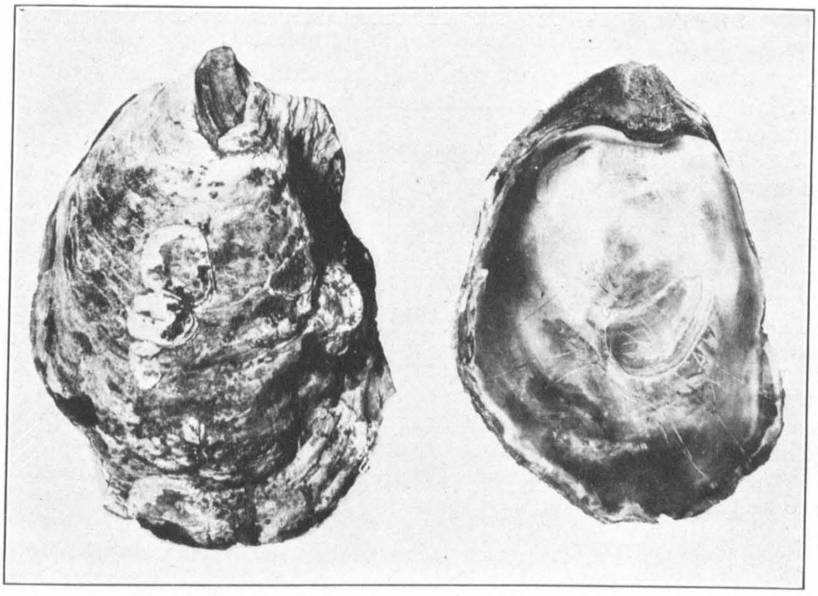


FIGURE 1.—*Ostrea lurida*, Oyster Bay, Wash. Size, 5.3 by 3.6 cms.

cells exist in the same individual and that during the spawning season the gonads of some of the specimens are filled mainly with sperm while the others contain mostly ova. The interesting problem of sex changes in the oyster was studied by Stafford (1913), who states that eggs and sperm in an individual oyster are not ripened in abundance at the same time, and that the oyster may be distinguished as a male at one time and as a female at another. According to his data all oysters in the early part of the summer show spermatozoa in some stage of development. As the summer advances greater numbers of eggs are to be found, until the eggs become the chief product of the gonads. As soon as the eggs are spawned a fresh brood of sperm develops. Thus, if Stafford's observations be correct, there exists a remarkable seasonal change in the development of the sex cells, the sperm being produced earliest and latest in the season, while the development of eggs occurs in the middle of the summer. Unfortunately, the description of sexual changes in *Ostrea lurida* made by Stafford is not supported by a thorough study of the gonad development, and the problem, which is of both scientific and practical importance, requires further investigation.

The spawning of the Pacific oyster is distinctly different from that of the eastern species. The eggs are not discharged into the water, but remain within the gill and mantle cavities, where they are fertilized by the sperm brought in with the incoming stream of water and develop into shell-bearing larvæ, which leave the parent and go through a free-swimming period before setting. Stafford (1913) makes the following estimate of the duration of the larval period:

From fertilization to gastrula stage	4 to 5 days.
From gastrula stage to conchiferous larva	7 days.
From conchiferous to straight-hinge larva (time when larvæ leave brood chamber)	5 days.
From beginning of free-swimming period to setting	14 days.

The whole period of embryonic and postembryonic development—i. e., from fertilization to the time of attachment of the larvæ—is about one month.

One should expect that the rate of development and the duration of the larval period are influenced by the temperature of the water, and Stafford's figures may be true only for the waters of British Columbia. At present we possess no information regarding the development of the larvæ on other sections of the Pacific coast. It is noteworthy that, although the whole period of development of the Pacific oyster is about twice as long as that of the eastern oyster, the duration of the free-swimming stage, when the organism is subjected to the vicissitudes of life in the open water and is not protected by the mother's body, in both cases lasts for about a fortnight. Thus, the fact that *Ostrea lurida* spends half of the period of its development within the brood chamber of its mother is of no particular advantage, and the free-swimming larvæ of both species have an equal chance to become prey to plankton-feeding organisms or to be carried away by the tides.

Setting of the Pacific oyster takes place late in July or in August. Stafford (1913) states that spat that attached in July may reach 6 mm. in length by the first part of August and by the middle of September be 20 mm. long. Apparently, as in the case of the eastern oyster, the rate of growth is dependent on the temperature of the water and other local conditions. In examining the beds of Willapa Bay, near Nahcotta, in October, 1928, the writer found the spat of *Ostrea lurida* to be about 15 mm. long, while at the mouth of Nasel River they varied from 6 to 9 mm. in length. The difference may be due either to a difference in the time of setting or to a difference in the rate of growth.

Sexual maturity of the oyster, according to Stafford, is attained when the organism is about 1 year old but in the second summer of its existence; in other words, oysters that set late in August will be sexually mature only when about 2 years old, while those that set earlier in the summer will have the gonads developed during the next warm season. Whether these conditions prevail in all the oysters along the Pacific coast or are found only in those grown in the waters of British Columbia we do not know. It is possible that considerable difference in the rate of growth and gonad development exists between the oysters from different localities of the coast.

OYSTER INDUSTRY IN THE STATE OF WASHINGTON

OYSTER BOTTOMS

Owing to the general conformation of the coastal waters of the State, the bottoms suitable for oyster culture are very limited and are found only in certain sections of Puget Sound and in Willapa Bay.

The large and irregular inlet of the ocean known as Puget Sound begins at the junction of Juan de Fuca and Georgia Straits and extends about 100 miles southward into the State of Washington. It is an almost landlocked body of water covering an area of approximately 2,000 square miles. The shore line is about 1,500 miles long and is very irregular, so that there are numerous branching bays and a number of islands, of which Vashon and Bainbridge are the largest. At the southern end the sound terminates in a maze of long and narrow fiords, into which empty several rivers and creeks. The principal streams flowing into the sound from the slope of the Cascade Mountains are the Duwamish, Nisqually, Nooksak, Skagit, Pungallup, Skokomish, and Snokomish. The sound is free from reefs or shoals, and the straits are open to the ocean. The water of the sound is generally deep, its depth varying from over 100 fathoms in the middle part to several fathoms in the inlets. The entrances from the ocean are not obstructed by bars, so that a free passage of ocean waters is assured. At the western side the sound forms a long and narrow inlet known as Hood Canal, in which the depth gradually decreases from 96 fathoms at the mouth to 3 fathoms at the headwaters. At present bottoms with cultivated oysters are found in Samish Bay near Bellingham, in the southern ramifications of the sound near Olympia, and in Hood Canal. Olympia, the capital of the State, is a center of the oyster industry; hence, the native oyster is often called the Olympia oyster. According to the State report for 1926 there were 2,071 acres of owned or leased oyster grounds in Puget Sound, but only 549 acres were listed as oyster-producing bottoms, the remainder apparently not being productive at present.

Willapa Bay, another important region of the State, is a long inlet of the ocean extending 16 miles southward parallel to the coast line. Its entrance on the ocean side is obstructed by sand bars, and the bay itself is filled with extensive shoals, large areas of which are bare at low tide. The channel is 65 feet deep and has a hard bottom. The Bear and Nasel Rivers empty into the southwestern end of the bay, and the Palix, Willapa, North, and Cedar Rivers discharge their waters into a broad northeastern corner of the bay. According to the State report for 1926 there are 7,807 acres of privately owned or leased grounds in Willapa Bay, of which 2,229 acres are listed as oyster-producing bottoms.

Twenty miles north from the northern end of Willapa Bay there is another inlet of the ocean known as Grays Harbor. It is 15 miles long and 2 miles wide at the entrance and is filled by shoals and flats, mostly bare at low water. The bottom is covered with a very soft mud. At present no oysters are grown for commercial purposes in this harbor, although an attempt to cultivate them was made in 1908, when one carload of eastern oysters was planted. The results were not satisfactory, so the planting was discontinued.

Apart from the privately owned and leased grounds there are 12,688 acres of State oyster reserve in Puget Sound and in Willapa Bay, which was established after 1895, when a law was passed by the State legislature allowing the citizens the privilege of buying certain oyster beds from the State. Doane (1904) mentions that at this time the State had reserved 8,680 acres, but that the great majority of reserved bottoms were so depleted that they were yielding virtually nothing. The author had the opportunity to examine some of the State reserves in Willapa Bay and in Puget Sound in October, 1928, and found that on many of the reserved bottoms, excepting certain diked areas in Hood Canal, oysters were absent, while on the others the oyster population was very scarce. At present only a small part of the State reserve is not depleted, and this is used as a source from which seed oysters are obtained. No reliable data are available to determine the productive acreage of the State reserve, but it is probably less than one-half of the total acreage of privately owned or leased oyster-producing bottoms. The total acreage of oyster-producing bottoms of the State is therefore about 3,700 acres (549 acres in Puget Sound, 2,229 in Willapa Bay, and about 1,000 acres of State reserves).

TEMPERATURE, SALINITY, AND TIDES

Among the various factors affecting the propagation and growth of the oyster the temperature of the water, its salinity and currents, are of greatest importance. Unfortunately, very little is known regarding the physical conditions of Puget Sound and Willapa Bay, and only scattered information referring to these bodies of water is available. It is a general opinion that the waters of Puget Sound are cold, although the only published temperature records the author was able to find refer to the northern part of the sound. Shelford and Towler (1925) state that in San Juan Channel and adjacent waters the temperature of the open water averages about 11.5° C. during the summer months. The lowest temperature recorded in July at the surface of the open water was 9.6°, and the highest temperature, 19°, was recorded in a small lagoon. Monthly temperature and density records were made in 1921–22 by the United States Coast and Geodetic Survey at Anacortes and are quoted in Table 1 from Shelford and Towler's paper (1925). They show that the highest mean temperature, 11.8°, occurred in July, although the maximum temperature of 15° was recorded in June. The coldest water of 5.5° was observed in December to February.

TABLE 1.—*Monthly temperatures observed at Anacortes, Wash.*

Year	Temperature			Density at 15° C.		
	Maximum	Minimum	Mean	Maximum	Minimum	Mean
1921						
December	8.5	5.5	7.21	1.0220	1.0189	1.02129
1922						
January	7.0	5.5	6.21	1.0232	1.0216	1.02201
February	6.5	5.5	6.04	1.0222	1.0218	1.02200
March	7.0	6.0	6.56	1.0228	1.0218	1.02220
April	8.5	7.5	7.72	1.0230	1.0219	1.02240
May	10.5	8.0	8.89	1.0240	1.0220	1.02277
June	15.0	9.5	10.88	1.0227		1.02214
July	14.5	10.5	11.80	1.0232	1.0196	1.02170
August	14.0	10.0	11.61	1.0239	1.0210	1.02230
September	14.0	10.5	11.50	1.0229	1.0192	1.02200
October	11.0	9.0	10.39	1.0232	1.0215	1.02239
November	9.5	8.0	8.97	1.0230	1.0218	1.02232

No published records of the temperature of the water in the southern part of the sound are available, except a few temperature readings made at Olympia by the United States Coast and Geodetic Survey steamer *McArthur* between November 25 and December 5, 1891, when the temperature at the surface of water varied from 0° to 11.1° C. (Townsend, 1893).

The data referring to Willapa Bay are as meager as those for Puget Sound. In 1890 the United States Coast and Geodetic Survey steamer *Gedney* made daily temperature readings in various sections of the bay (Townsend, 1893). All the readings were made at 4 a. m., when the temperature of the water was probably the lowest. The monthly fluctuations of temperature observed in various sections of the bay are given below:

Date:	Temperature (° C.)
July 25 to 31, 1890	13.9–16.7
August, 1890	15.0–18.3
September, 1890	11.7–15.6
October, 1890	11.1–13.3
Nov. 2 to 8, 1890	10.0–13.3

In the summers of 1899 and 1900 temperature observations were made by Doane (Washington State Fish Commissioner's Reports, 1899–1900) three times a day at four different stations in Willapa Bay. His records show much higher temperatures than those recorded in 1890. (Table 2.)

TABLE 2.—*Temperature of the water in Willapa Bay, 1899–1900*

Date	Temperature of water			Density of water at 15° C.		
	Maximum	Minimum	Mean	Maximum	Minimum	Mean
1899						
June 15–30			16.5			1.0151
July			20.1			1.0162
August			19.3			
September			18.6			
1900						
July 11–20	25.0	17.0	21.4	1.0192	1.0136	1.0180
July 21–31	26.0	18.0	22.0	1.0201	1.0126	1.0189
Aug. 1–10	23.0	18.0	20.9	1.0201	1.0162	1.0187
Aug. 11–20	23.0	18.0	20.1	1.0201	1.0171	1.0187

It was noticed by Doane that the maximum temperature of the water occurred shortly after the tide had set in, especially on clear days when the sun was shining for several hours and the exposed tidal flats were warmed. Little or no difference was observed between the temperature at the surface of water and that at a depth of 6 to 8 feet.

The thermal conditions of any inshore body of water connected to an open ocean are determined by three main factors—(1) the temperature of the ocean water entering it with each tide, (2) air temperature, and (3) solar radiation. During clear and hot summer days there may exist wide daily fluctuations in the water temperatures, so that in shallow lagoons or in pools left by the receding tides the temperature may be many degrees higher than that of the main body of water. Doane has shown, for instance, that in Willapa Bay the water temperature in the shallow pools left at low tide may reach

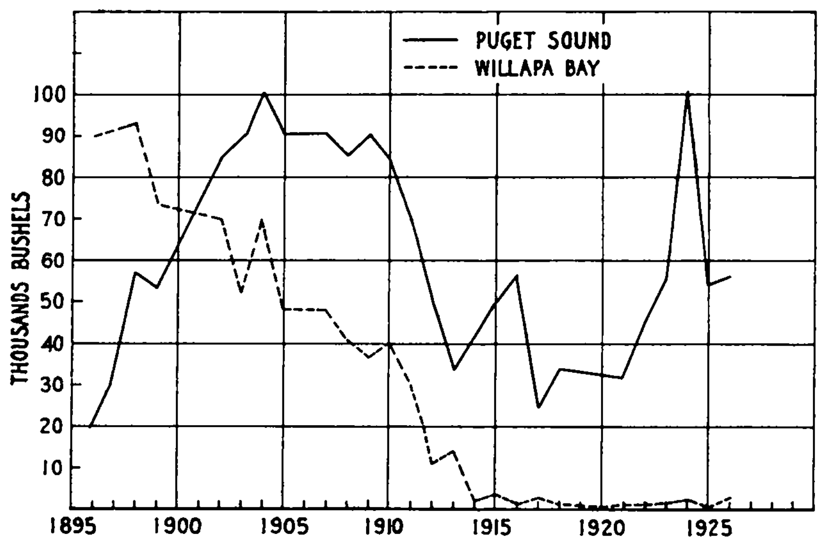


FIGURE 2.—Maximum and minimum air temperature, South Bend and Tacoma, Wash., July–August, 1928

27.8°. It is probable that the water of Willapa Bay, because of its shallowness and the extensive flats exposed at low tide, follows more readily the change in air temperature than the waters of Puget Sound; yet it is quite possible that the water temperature in the fiords and narrow inlets of the southern end of Puget Sound may be much higher than that recorded at Anacortes. A true picture of temperature changes can be obtained only by making a continuous record with a self-recording instrument. In the absence of such data some idea of possible temperature fluctuations can be obtained from a study of daily air-temperature fluctuations recorded by the Weather Bureau. The meteorological stations nearest to the southern end of Puget Sound and Willapa Bay are at Tacoma and South Bend, respectively. An examination of Figure 2 shows that in 1928 the highest temperature occurred between July 21 and 26, and that on these days the difference between maximum and minimum temperature was over 20° C. In the absence of records of the temperature of the water it is impossible to estimate how the latter was affected by a sudden rise of air temperature. One would expect, however, that the highest temperature of the water was reached on the days when the time of the maximum air temperature coincided with the time of low water.

A better understanding of the thermal régime in the inshore waters is essential for many practical problems related to oyster culture, and it is hoped that the proposed investigations in Puget Sound and Willapa Bay, which will be undertaken in cooperation with the State department of fisheries and game, will supply the necessary information and fill the gap in our knowledge of physical conditions in these important bodies of water.

TABLE 3.—*Salinity (parts per mille) of the water of Puget Sound off Alki Point (computed from Smith's data)*

Date	Surface	10 feet	20 feet	30 feet	40 feet
Oct. 25, 1924	31.11	31.15	31.26	31.26	
Nov. 9, 1924	31.15	31.15	31.15	31.15	
Nov. 22, 1924	30.72	30.75	30.79	30.86	
Dec. 7, 1924	30.35	30.50	30.50	30.50	
Dec. 31, 1924	29.99	30.14	30.21	30.14	
Jan. 15, 1925	30.14	30.14	30.14	30.14	30.14
Feb. 14, 1925	28.84	29.05	29.20	29.20	29.20
Feb. 27, 1925	29.20	29.20	29.20	29.20	29.20
Mar. 18, 1925	29.13	29.13	29.13	29.13	29.20
Apr. 4, 1925	29.13	29.13	29.13	29.13	29.20

The distribution of salinities in Puget Sound and Willapa Bay has been studied but little. The salinity, computed from density readings made at Anacortes (Table 1), shows that the total amount of salts dissolved in the water varied from 32.41 to 25.75 parts per mille. A few observations of salinity (chlorine content) made by Smith and Thompson (1927) at Alki Point near Seattle (Table 3) show that in the surface layer of water in this locality the salinity varied from 31.15 parts per mille in November, 1924, to 28.84 parts per mille in February. No salinity determinations ever were made in the southern end of Puget Sound. The salinity in Willapa Bay, computed from the density readings made by Doane (Table 2), varied from 17.43 to 27.14 parts per mille.

Tidal conditions affect the life of the adult oyster in two main respects: First, at low tide the oysters are either left exposed on the flats or submerged in shallow pools of water, the temperature of which undergoes wide fluctuations; second, fluctuation in water temperature and in the chemical compositions of water occurring with the tidal cycles may have a pronounced effect on the activity of the organism and especially on its spawning. Tidal currents play an important rôle, also, in distributing the oyster larvæ and controlling their setting. The knowledge of the effect of these factors on the life of the adults and larval oyster is prerequisite for the successful management of an oyster farm or for the development and maintenance of the natural oyster beds.

Our information regarding the tides in Puget Sound and Willapa Bay is unfortunately very limited, and consists in the data published in Tide and Current Tables, issued by the United States Coast and Geodetic Survey. The mean range of tides in Puget Sound at Olympia is 10.5 feet, and the spring range is 14.5 feet; but in the small inlets near by, owing to the configuration of the land, the difference between the lowest and highest water may be much greater and reach 20 to 25 feet. In Willapa Bay the range of tide is smaller and varies in different localities from 6.2 to 8 feet. Current velocities vary greatly, depending on local conditions and the stage of tide. At the strength of flood the surface currents in Puget Sound vary from 3.8 knots in the narrows at Point Evans to 0.4 knots in the channel at Olympia. No current data are available for Willapa Bay; but because of the smaller range of tide and considerable width of the bay, the currents are apparently slower than in Puget Sound.

OYSTER PRODUCTION IN PUGET SOUND AND WILLAPA BAY

The oyster industry in the State of Washington dates back to the days of first settlers, who bought oysters gathered by the Indians from the natural beds. According to Ingersoll (1881), the oyster beds in Willapa Bay (known at that time as Shoalwater Bay) were discovered in 1850, and 2,000 baskets of oysters were shipped during that year to San Francisco. Gradually the business became well organized, and the towns of Oysterville and Bruceport rose out of it. In 1860 the value of the oyster products marketed in Washington Territory was estimated at $44,597. Along with the taking of oysters from natural beds there began the attempts to relay them on staked-out bottoms nearer shore or to transplant them to San Francisco Bay. Transplantation to California was unsuccessful, however, for the oysters received from the North were poor and failed to fatten. There is scattered information published in San Francisco papers indicating that in 1867–68 the business began to decline and the Willapa Bay oyster ceased to be productive. Ingersoll (1881, p. 202) said: "What is the cause of this sudden and excessive decay of Shoalwater oyster beds no one can say. Of that stock which is planted three-fourths now dies."

While the cultivation of oysters was being developed in various bays and inlets of the southern end of Puget Sound, the oyster fishery in Willapa Bay consisted primarily in exploitation of natural bottoms. An indiscriminate fishing was carried on for a number of years and resulted in a gradual depletion of the natural resources.

In 1896 the State fish and game department began to publish statistical data relating to oyster fisheries, and a glance at Figure 3 and Table 4 (compiled from the State reports) is very instructive. A comparison of the productivity of native oysters in Puget Sound and in Willapa Bay shows that while in the first region the production is maintained at a certain level, which, although undergoing wide fluctuation, never falls below 24,500 bushels a year, the production in Willapa Bay shows a steady decline from 90,000 bushels a year in 1896 to 2,586 in 1926. The reason for such a difference between the two localities lies in the fact that while elaborate methods of oyster farming have been adopted in Puget Sound no real attempts to cultivate oysters in Willapa Bay have ever been made. It is obvious that the natural rehabilitation of the uncultivated oyster bottoms could not keep pace with the rate of fishing, and the beds became depleted or totally destroyed. In this respect the fate of Willapa Bay oyster bottoms is similar to that of the natural oyster beds in New England. It is known that the settlers on the shores of New Hampshire and Maine found rich oyster bottoms, which

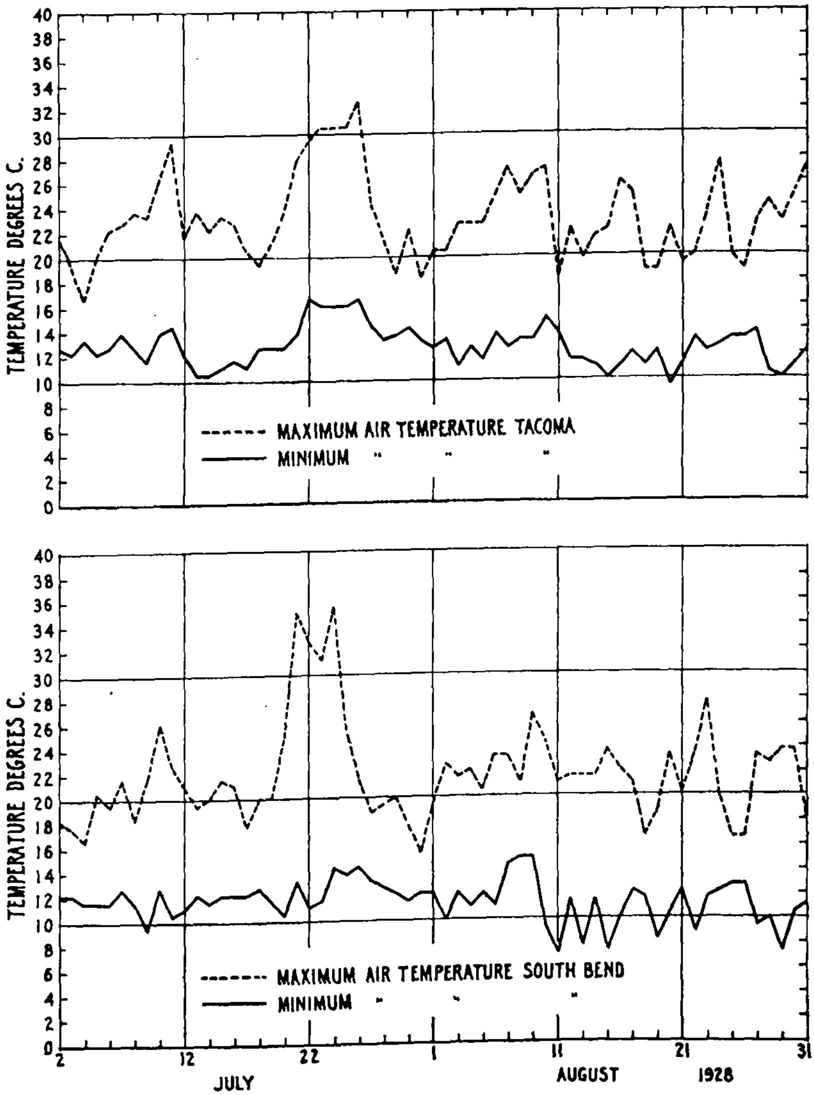


FIGURE 3.—Oyster production in Puget Sound and Willapa Bay from 1896 to 1926

after a few years of extensive fishing were totally destroyed, while the beds located in more southern latitudes were able to stand the strain more successfully. The apparent richness of the natural reef is often misleading because it represents the accumulation of an oyster population that lived undisturbed for a period of possibly several hundred years. Because of the low temperature of northern waters spawning and setting occur only in exceptionally warm years, so that the stock is not replenished regularly.

With the beginning of fishing operations the number of adult oysters on such bottoms quickly diminishes, thus decreasing the chance for good setting, and in a few years the whole population of a reef can be wiped out. This happened to the oyster beds of the northern part of New England, to the natural oyster bottoms of Europe, and apparently took place in Willapa Bay. Local fishermen still remember the old days when the bottoms of Willapa and Samish Bays were thickly covered with oysters, and the schooners on their return voyage to San Francisco used to take several tons of them for ballast. Such conditions now belong to the past, and the State oyster reserves of to-day, with a few exceptions, are nearly devoid of any oysters or even shells.

TABLE 4.—*Oyster production in Puget Sound and Willapa Bay (compiled from annual reports of State department of fisheries and game)*

Years	Puget Sound					Willapa Bay				
	Annual production, bushels		Acres under cultivation		Carloads eastern planted	Annual production, bushels		Acres under cultivation		Carloads eastern planted
	Native	Eastern	Native	Eastern		Native	Eastern	Native	Eastern	
1896	20,000					90,000				
1897	32,000					92,000				
1898	57,000					93,000				
1899	54,060					74,000				
1900										
1901										
1902	84,000					70,000	4,000			
1903	90,000				1	52,000	8,000			21
1904	100,000	135	500	30	5	70,000	10,000	1,000	100	21
1905	90,000	130	500	30		48,178	3,000	1,000	150	48
1906	90,000	450	550	40	8	48,000	5,000	1,000	150	95
1907	90,000	650	600	45	10	48,000	6,000	1,000	250	80
1908	80,000	2,600	850	75	10	41,000	6,500	1,250	250	2
1909	90,000	10,000	1,500	150	12	37,000	20,000	1,250	550	20
1910	84,000	7,200	1,650	200	40	40,000	20,000			45
1911	70,000	39,500	1,650	300	44	30,000	18,000	3,500	2,000	47
1912	50,000	8,000	1,800	400	33	11,280	2,300	3,500	2,000	62
1913	33,722	2,256	836	83		14,600	14,600	3,000	2,000	
1914	225,706	3,224	547½	85		2,400	8,000	2,200	1,500	
1915	49,140	2,582	1,049	66		3,806	13,800	22	980	
1916	57,488	4,292	763	44.5		1,186	15,930	555	1,795	
1917	24,598	9,150	799	20		2,236	18,020	672	1,830	
1918	33,980	9,592	566.7	36		998	19,460	360	2,192	
1919										
1920										
1921	32,026	3,414	411.5	25		566	5,280	870	900	
1922	45,666	5,048	439	10		554	6,476	15	538	
1923	55,622	1,400	541.3			998	6,422	65	655	
1924	104,194	2,240	568	7		2,128	5,146	915	1,285	
1925	54,644	4,000	529.6			590	1,412	730	644	
1926	55,480		549			2,594	3,380	895	785	

METHOD OF OYSTER CULTURE

In the southern part of Puget Sound the oyster industry has developed an elaborate method of cultivation, which in spite of adverse climatic and tidal conditions is successfully employed and gives good returns on the invested capital. This system of oyster culture, which is employed chiefly near Olympia, was developed through the utilization of methods used in France and by experimentation and observations made by the most progressive oystermen. It consists in leveling the tideland and in building concrete or wooden dikes around it to assure a few inches of water over the beds at low tide. Oyster culture near Olympia is carried on chiefly by small farmers and a few large companies, which operate on privately owned or leased grounds. As has been stated above, one of the characteristic features of this section of the country is the high range of tide. The receding tides leave extensive areas of flats exposed, and by building a system of dikes these barren flats can be converted into a system of pools similar to the " parcs " of France. The configuration of the land, the range of tide, and the slope of the flats determine in each case the shape of the pools and the number of levels at which the dikes are constructed. Sometimes the

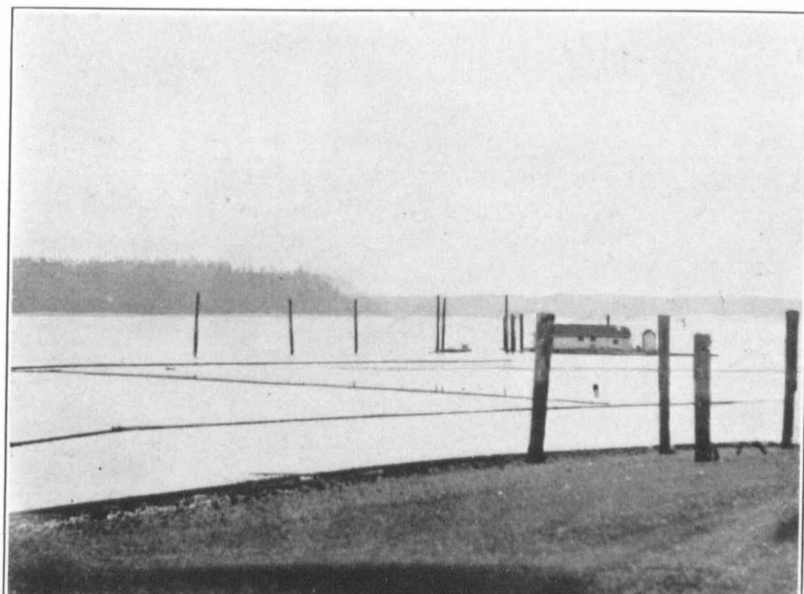


FIGURE 4.—Oyster farm near Olympia, Wash. Dikes at low tide

dikes are built at five different levels on the tidal slope until the low water level is reached. (Fig. 4.)

Each dike encircles an area of approximately 1 acre. Formerly all the dikes were made by placing two 12-inch boards on edge about a foot apart and filling the space between with gravel; the boards were held in place by nailing them to stakes driven deep into the mud. Another method consisted in fastening a single board on edge by means of the stakes and then driving short boards, 2 to 4 feet long, edge to edge along its side, thus forming a tight wall extending 1 foot above the surface of the mud and 3 feet into it. Wooden dikes were not practical because of the destruction caused by shipworms (Teredo) and other wood-boring organisms and were gradually replaced by dikes of cement construction. Usually the dikes of the upper level are 8 inches wide, from 12 to 18 inches high, and extend 6 inches into the bottom. The lower dikes stand 3 or 4 feet above the bottom, extend 1 foot into the mud, are 8 inches wide at the top, 18 inches wide at the bottom, and often are reinforced by concrete abutments. (Fig. 5.) The method of building consists in the following: The trench is dug out, then 1-inch boards are forced 2 or 3 feet deep in the bottom of the trench so as to form a continuous wall extending under the trench, which is then filled with concrete. The wooden wall is built for the protection of the dike against crawfish, a crustacean that burrows in the mud under the dikes causing the washing out and drainage of diked areas. Sometimes an additional wooden wall is built along the outside of the dike (fig. 6) at a distance of about 4 feet from it. It is built of creosoted boards 5 feet long and 1 inch thick driven vertically

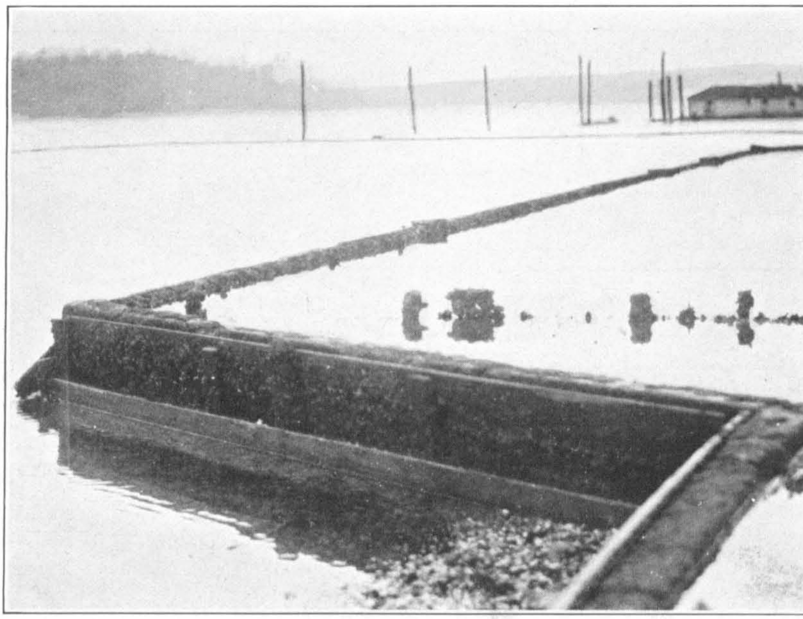


FIGURE 5.—Cement dike, Oyster Bay, Wash.

into the mud and kept together by a horizontal board nailed to them.

Wooden dikes built of lumber impregnated with creosote can last for a number of years. Dikes built eight years ago in Oyster Bay and examined by the author in October, 1928, were still in good condition. Cement dikes can stand indefinitely, and the only attention they require consists in repairing the washouts caused by crawfish.

After the dike is built the bottom inclosed in its walls should be leveled and if necessary reinforced with gravel. The amount of gravel necessary for this purpose depends on the softness of the mud. Sometimes a layer 2 or even 3 feet deep is planted over the bottom to make it sufficiently firm. After the bottom is ready seed oysters are planted and the operation of the oyster farm begins.

The building of dikes and the improvement of the bottoms represents an investment amounting to from $1,000 to $3,000 per acre. It is estimated that on the average the construction of a cement dike near Olympia costs $2 per linear foot.

The Olympia oyster is rather slow growing and reaches marketable size in four or five years. It spawns during the summer, but since accurate observations are lacking it is impossible to state the exact time of its spawning.

Shells are scattered over the diked areas for catching spat. The time of setting varies and, judging from the information received from local oystermen, takes place from July until the end of August. Shells of native oysters are used for cultch almost exclusively. They are bought from the shucking houses at Olympia at the average price of 35 cents a sack (2 bushels). It is estimated that it costs

FIGURE 6.—Outside wooden wall protecting the diked area from crawfish

about 50 cents a sack to plant them on the beds. Small farms of 25 to 35 acres plant about 2,500 sacks of shells each year.

The cultivation of oysters in diked areas requires constant attention; the dikes should be examined systematically and all crawfishes that burrow in the mud destroyed; after heavy rains or stormy weather oysters may be covered with fine silt or mud and smothered by them; and the bottoms must be kept clean from the accumulation of sea grass or sawdust, which in some localities in the vicinity of lumber mills constitutes an important problem.

After setting, which in certain localities, as for instance Totten Inlet (Oyster Bay), is more abundant on the higher levels of the tidal slope, the young oysters are left to grow undisturbed for a year or two and are then transplanted to lower levels, on which they grow for two more years.

72581—29——3

The center of operation of an oyster farm in the Olympia region is a small oyster house built on a float and kept anchored in the deep water of the channel. (Fig. 7.) It consists of living quarters, where the farmer's family dwells, and of a small culling and storage room, where oysters are culled, packed in sacks, and prepared for shipment. Around the house there are several floats for storage of oysters and a platform on which one often sees a small Japanese garden with a few flowers, vegetables, and dwarf trees.

For marketing the oysters are raked at low water and placed in floats, which are towed and left on the oyster beds at high water. Each float (12 by 45 feet) holds several hundred bushels of oysters. In fall and winter the lowest tides occur mostly during the night, and the work is done in the darkness. The oystermen wear special

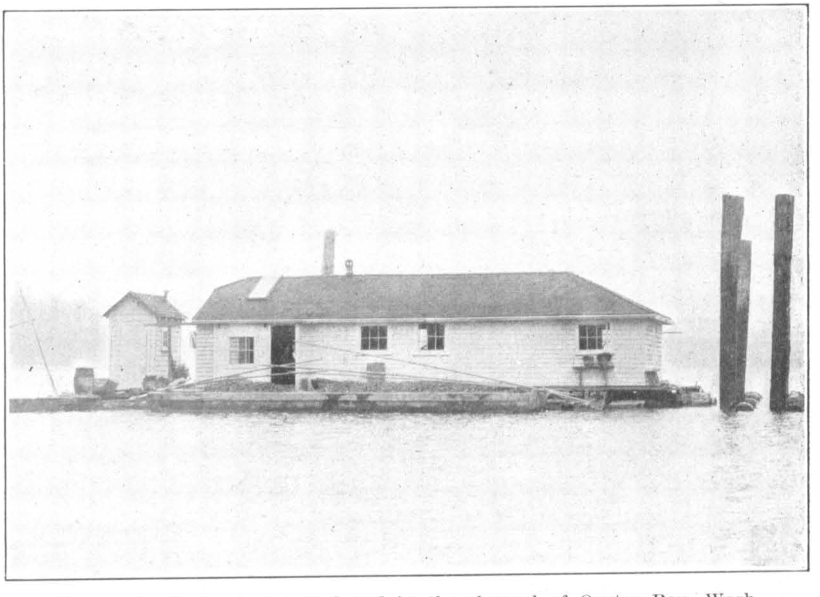


FIGURE 7.—Oyster house anchored in the channel of Oyster Bay, Wash.

shoes resembling snowshoes (fig. 8) in order to protect the oysters from being smothered while they are working on the beds.

The labor employed by the industry is almost exclusively Japanese, and a number of small farms of from 25 to 35 acres are owned by the Japanese. Small farmers rarely employ hired labor, for the members of the family perform all the tasks of harvesting, culling, and marketing the oysters and take care of the dikes and bottoms. Sometimes the owner of the farm makes an agreement with a Japanese family, which then lives in the owner's house and works on his bottoms, receiving a compensation of about $2 for each sack of oysters sold. In one instance the income of a Japanese family, consisting of two adults and one boy working under such an agreement, was from $250 to $450 per month. Large companies operating in Puget Sound prefer, however, to hire labor by the day or week.

Oysters produced on small farms are sold in the shell and shipped to Portland and San Francisco or are delivered to the shucking houses in Olympia. When the growth of the oysters is good, they average 2,000 to 2,500 to a sack. In October, 1928, oysters shipped from Oyster Bay averaged 4,000 to a sack. Because of its small size the Olympia oyster can not be sold to the ultimate consumer on the half shell and can not be canned. It is shucked and distributed in gallons or quarts.

The harvesting and handling of oysters is carried out under strict sanitary regulations. A few years ago United States Public Health authorities noticed that the discharge of domestic refuse from the oyster houses anchored in the immediate vicinity of the oyster beds

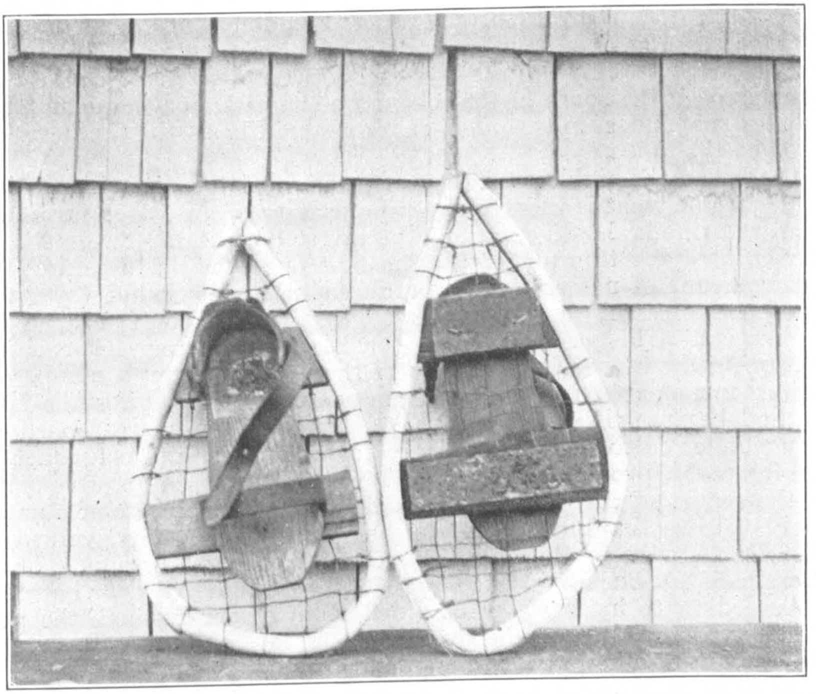


FIGURE 8.—Shoes for walking over the oyster bottoms, Puget Sound, Wash.

might result in their contamination. This defect was corrected, and at present any danger of pollution from this source has been eliminated by adopting an efficient and practical method of chemical treatment of all domestic refuse and its discharge at a considerable distance from the beds. Most of the houses, which as a rule are kept very clean, are moored in deep water at some distance from the oyster bottoms.

Shucking is carried on by several large companies located at Olympia. The shucking houses are built according to specifications established by the United States Public Health Service and in many respects surpass these requirements—the rooms where oysters are opened are sunny; the benches, tables, floors, and walls are of cement;

there is running water in front of each shucker, who wears a clean white smock and rubber gloves or fingers. The opening of the oysters is carried out under very efficient sanitary supervision, and all the workers, before they are allowed to work in the plant, must undergo medical examination and receive a clean bill of health. All the containers used in handling the oysters are noncorrosive Monel metal. Just before shipment shucked oysters are washed for two or three minutes in fresh water, then they are placed in cans and packed in crushed ice. In respect to cleanliness and compliance to the highest standard of sanitary requirements, the condition of the Olympia shucking houses is unsurpassed in any other oyster-producing State.

There are from 1,600 to 2,000 shucked oysters to a gallon. A very good shucker can open about 1,000 oysters per hour; he receives 22.5 cents for each quart, 5 quarts forming 1 gallon of solid pack. The average earning of a shucker is about $135 a month.

The market for Olympia oysters does not extend beyond San Francisco on the south and Spokane on the east, but the demand is greater than the supply, and there is a sound basis for the development of the industry.

In view of the high cost of the construction of dikes it is interesting to determine what is the average productivity of an oyster farm and what return one should expect on the invested capital. Two methods can be used for this purpose. The first one consists in taking the total amount of native oysters produced in Puget Sound (as given in the State report) and dividing it over the number of acres under cultivation. The second method consists in obtaining information regarding the actual productivity of the bottoms from a number of oyster farmers. There is some uncertainty in applying the first method because the number of acres listed in the State reports as being under cultivation may be greater than it is, and consequently the figures of productivity may be lower. Taking the figures given in the report of the State department of fisheries and game for the year 1926 we find that 55,480 bushels of native oysters, valued at $349,682.25, were produced on 549 acres of cultivated grounds, or an average of 101 bushels, valued at $636.94, per acre of oyster bottoms.

According to information obtained from oyster farmers the productivity of good oyster bottoms varies from 125 to 150 sacks each other year; in other words, the annual production is from 62.5 to 75 sacks (125 and 150 bushels) to an acre. The present market value of cultivated native oyster varies from $11.50 to $12.50 per sack, and the value of the annual output per acre is between $718.75 and $937.50. (The State report for 1926 estimates the average value of Puget Sound native oysters as equal to $12.65. However, in 1928 the prices were apparently lower, and the above-mentioned figures, $11.50 and $12.50, were regarded as a prevailing price in October, 1928.) By inquiring of a number of farmers in Oakland and Oyster Bays I found that the statements given by different farmers agree with each other. Inasmuch as the operating expenses are small and all the work on the small farm is done by the members of the family, the economic possibilities of oyster farming are very great. Suppose that in the Olympia region a small farm consists of 10 acres of good oyster bottoms. Its annual production should be from 1,250 to 1,500 bushels, valued at the current prices from $7,187 to $9,375. The operating expenses can be estimated as follows:

Cost of production (labor), 1,500 bushels at $1	$1,500
Planting of shells, 1,250 sacks at $0.50	625
Maintenance of buildings, boats, dikes, etc	500
Taxes, $35 per acre	350
Total expenses	2,975

Total income from $4,212 to $6,400.

In the case of an owner working on his own grounds with the members of his family and not hiring any labor, as it is on most of the small farms, the operating expenses are considerably less and the returns correspondingly higher.

The average value of 1 acre of first-class oyster bottom is around $2,000, while the unimproved tidal land can be obtained from the State at a nominal price. An important feature, from the economic point of view, of oyster farming is the fact that the land can be improved gradually, and each year 1 or 2 acres can be added to the existing bottoms. The construction of dikes and the leveling of bottoms can be done by the farmer himself without any expense except the cost of the material.

The importance and the possibilities of oyster farming in Washington can be appreciated better if one makes a comparison with the land farms. The following table shows the production per acre and the values of the principal crops of the State of Washington for the year 1928; the figures are taken from Crops and Markets, published by the United States Department of Agriculture (1928). In computing the value of the products the farm prices on December 1, 1928, were used; the value of the oyster product was taken from the State report of 1926 and, as has been shown above, is probably lower than the present value of cultivated oysters.

TABLE 5.—*Productivity and values of various crops in the State of Washington*

Product	Yield per acre (bushels)	Unit price (dollars)	Value of product per acre (dollars)	Product	Yield per acre (bushels)	Unit price (dollars)	Value of product per acre (dollars)
Corn	39	0.99	38.61	Oats	47	0.55	25.85
Spring wheat	15.4	1.08	16.63	Potatoes	135	.50	67.50
Winter wheat	25	.97	24.25	Cranberries	[1] 27.3	15.50	423.15
Barley	35.5	.70	24.85	Oysters	101	6.33	639.33
Rye	15.5	.90	13.95				

[1] Barrels.

The market value of the only product that approaches the oyster is that of the cranberry, while in comparison with the main agricultural products the cultivation of oysters in the State of Washington brings from 9.5 to 46 times better returns than the cultivation of any other crop.

It is interesting to note that, while great care is exercised by the oystermen in selecting, improving, and maintaining their lands, very little effort is made toward introducing better methods of propagation, growing, and fattening the oysters. This is obviously due to the fact that such important phases of oyster life as the spawning, distribution of oyster larvæ, and their setting can not be observed by a layman deprived of the use of the modern tools of scientific research and can be undertaken only by a well trained biologist. Practical oystermen are able to observe the spat about three or four weeks after it has set, while by applying scientific methods of study the life of the oyster larvæ can be followed very closely from its very beginning and such operations as the planting of cultch or collectors conducted accordingly. It is evident that by a thorough study of the biology of the oyster better methods can be devised for its propagation, and the productivity of valuable oyster bottoms can be increased.

ENEMIES OF THE OYSTER

The enemies attacking the oysters in the Olympia region are not numerous. Formerly the natural beds in Puget Sound suffered considerable damage from the attacks of starfishes; in the diked areas, however, this pest is absent. The greatest inconvenience for the oyster farmer is caused by a decapod crustacean, a crawfish (*Upogebia pugetensis* Dane), which burrows in sand and mud, making underground passages sometimes a yard long, and in doing so piles up excavated material, which smothers small oysters. The greatest damage, however, is caused when the passage, which, according to Stevens (1928), has the shape of a capital letter Y, extends under the dike from one side to the other, thus furnishing a channel for the water to run out. The damage done by Upogebia is very considerable, and the protection of dikes from the invasion of this crustacean requires the constant attention of the farmer.

The eastern drill (*Urosalpinx cinerea*) has been introduced with the shipment of eastern oysters, but is not abundant. The moon snail (*Polinices cewisii*) is another enemy that preys on oysters, but fortunately is not very destructive.

The very active enemies of the native oyster in the Olympia region are various species of ducks, which feast on small oysters. In 1914, at the request of the Olympia Oyster Growers Association, the United States Biological Survey made an investigation to determine the amount of damage done by the ducks. The investigation carried out in Oyster Bay in November–December, 1914, was conducted by W. L. McAtee, who arrived at the following conclusions:[2]

> During the first two weeks (November 16–29) of collecting 41 greater scaups were obtained. Twenty-six of them had been eating oysters to an average extent of about 60 per cent of their food. Fifty-three white-winged scoters were collected, of which 18 had taken oysters, the average amount in the stomachs being about 50 per cent. During this period 9 goldeneyes, 2 red-breasted mergansers, 2 canvasbacks, and 2 surf scoters were examined without finding any oysters.
>
> The scaups and scoters both increased their consumption of oysters during the next stage of the investigation, which covered December 2–14. Forty-five greater scaups were collected, of which 39 had eaten oysters, the average percentage of oysters in their stomachs being fully 78. Fifty-two white-winged scoters were examined, and 20 of them had eaten oysters to an average extent of 70 per cent of their food.
>
> For the present I estimate the number consumed daily by a scaup as 5 and by a scoter as 10. Assuming that the results of the second fortnight fairly represent the conditions to prevail throughout the winter, we may arrive at some idea of the damage done. During this period the number of scaups on Oyster

[2] The excerpt of McAtee's report is published here with his permission.

Bay averaged about 2,000, of scoters about 300. If about 87 per cent of the bluebills made 80.5 per cent of their food oysters, they would consume about 6,960 daily. Similarly, 38 per cent of the scoters taking oysters in the extent of about 70 per cent of their food would devour about 800. Together these two species would destroy practically 8,000 oysters per day.

The protective measures consist in chasing the ducks by shooting and scaring them by whistling the boat horn. The efficacy of these methods is very low, however, if they are not accompanied with real danger to the birds, which after a short experience disregard the shooting with blank cartridges and pay no attention to any noise-making devices.

EASTERN OYSTER

The first attempts to introduce the eastern oyster to the Pacific coast were made about 1870 on the completion of the first transcontinental railroad. Oysters shipped from the East were bedded in San Francisco Bay and kept for varying periods of time. It appeared that oysters were thriving and the business began to grow. In 1894 a carload of eastern oysters was shipped from New York to South Bend, Wash. The oysters arrived in good condition in 13 days and were planted in Palux Channel over an area of about 3 acres. This experiment was undertaken by the United States Bureau of Fisheries and the State fish commissioner under general supervision of C. H. Townsend (1896), who in 1889–1891 (Townsend, 1893) made a study of eastern oysters in San Francisco Bay and found that they propagate in that body of water. The increasing demand for the eastern oyster caused the State of Washington to carry out experiments in Puget Sound. In 1899 Doane (1901) conducted experiments in Tokeland and found that the oysters contained ripe reproductive elements but failed to spawn, except small numbers of them kept in a float. No spat was found, however, on the collectors that were scattered in the bay. The next year the experiment was continued with the oysters kept in the tanks and floats; oysters were found to be spawning on the beds inside of the bay, where the temperature of the water was 21.1° C., but only a few spat were found attached to the collectors. As a result of this experimental work Doane arrived at the conclusion that the eastern oyster will spawn and set in Pacific waters. These experiments apparently stimulated the interest of local oystermen, and the imports of eastern oysters began to grow. From the reports of the State department of game and fisheries we learn that importation of eastern oysters to Willapa Bay increased from 21 carloads in 1903 to 95 carloads in 1906. Since 1907, when 80 carloads were delivered, it dropped to 2 in 1908, recovered again in 1910 to 1912, and gradually diminished to an insignificant amount. There is no information available as to the number of carloads planted after 1912, but inquiry among the local oystermen discloses that there was a general dissatisfaction with the results of these operations. In many instances seed oysters failed to grow and fatten and could not be marketed. Attempts to cultivate the eastern oyster failed; oysters did not spawn, and there was no setting except a few spat of no commercial importance. Gradually the practice of importing eastern seed was discontinued as commercially unsound. A few eastern oysters are still brought in every year, but they are kept in the bay only for a short time and are disposed of in a few weeks.

The importation of eastern oysters in Puget Sound was not so extensive as in Willapa Bay, and a comparatively small number of them was planted in the bays around Olympia. A few spat were found occasionally, but setting never attained the intensity necessary for the commercial development of oyster farming.

At present scattered eastern oysters, some of them of considerable size (fig. 9), are found both in Willapa Bay and in Puget Sound. The examination of the oyster bottoms made by the author shows that a small number of 1-year-old eastern oysters and spat can be found in various sections of the bay, indicating that spawning took place in 1927 and 1928; it is doubtful, however, that cultivation of this species on the Pacific coast can be made profitable. It is a well-established fact that spawning of the eastern oyster takes place at a temperature of 20° C. and above. In the localities where spawning and setting are heavy and where the production of set is the chief concern of the oyster culturists the temperature of the water

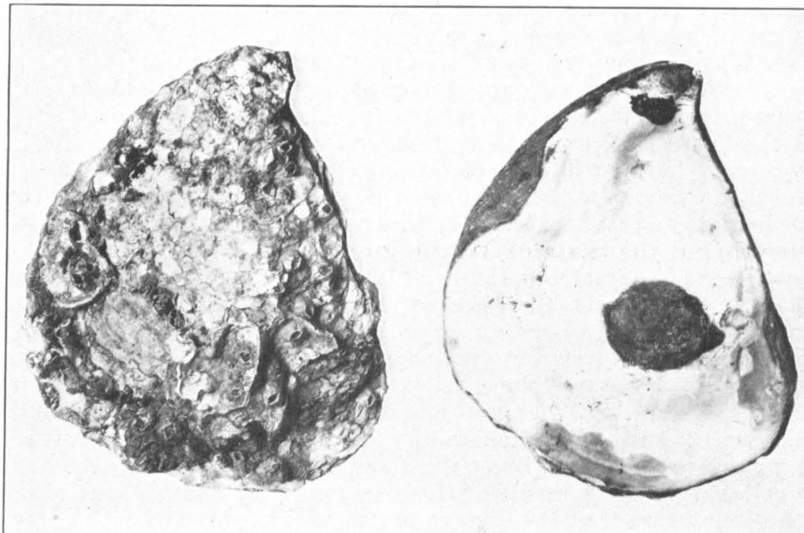


FIGURE 9.—Old eastern oyster from the mouth of the Nasel River, Wash. Size, 15.5 by 13 cms.

in July and August is high, varying between 23° and 27° C. It has been shown by Prytherch (1929) that there is a striking coincidence between the success or failure of oyster set in Long Island Sound and the temperature. During a number of years when the temperature in June and July was below normal there was a failure of oyster set, while in all successful years the temperature was several degrees above normal. It is therefore doubtful that in the cold waters of the Pacific coast the eastern oyster can be successfully cultivated.

In Willapa Bay or in Puget Sound it will probably spawn only in such localities where the temperature of the water in July and August stays above 20° C. The few spat found in these bays can not, however, be considered as proof that the cultivation of oysters can be carried out on a commercial scale. For successful oyster farming an intensive and regular setting is prerequisite, and unless this condition is satisfied oyster culture can not be put on a sound economic basis. It is the aim of the further investigations of the Bureau of Fisheries to find out whether localities exist within the State of Washington where the temperature and other conditions are suitable for the propagation of eastern oysters. These investigations will consist of a careful study of thermal conditions in the well-protected inshore waters, in the experimental planting of spawners, and in a study of the distribution and setting of larvæ.

JAPANESE OYSTER

The planting of the eastern oyster and the apparent success of the first experiments with its propagation led to the idea of importing oysters from Japan. In 1899 the question was taken up by the State

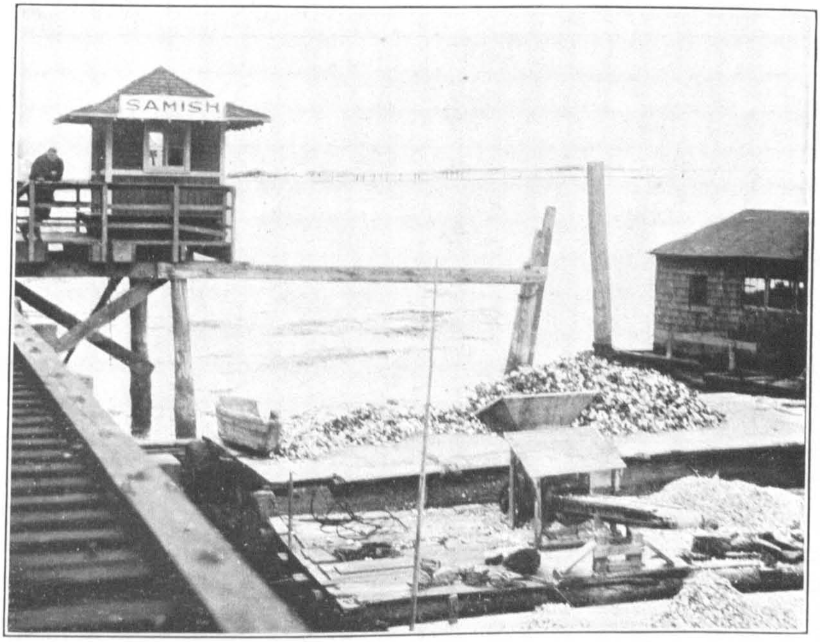


FIGURE 10.—Plant of Rock Point Oyster Co., Samish Bay, Wash.

fish commissioner with Professor Mitsukari, of the Imperial University of Tokyo, who suggested that the oysters from the beds at Akkeshi Hokkaido, the northern island, would be best adapted for transportation to America. In 1902 and 1903, 4 and 12 carloads of Japanese oysters were shipped from Japan and were planted in Puget Sound. Another attempt was made in 1905 by a group of Japanese, who acquired an area of oyster lands in Samish Bay near Bellingham. Their efforts were successful, for seed oysters shipped from Japan and planted on the tidal flats of Samish Bay grew well. Subsequent to the passage by a State legislature of a law (1922) restricting the ownership of land by aliens, the Japanese company was forced out of business, and their Samish Bay oyster lands and plant (fig. 10) passed into the hands of a corporation known as Rock Point Oyster Co., which has continued business on a much larger scale. At present the company has control over an area of about 600 acres, of which only 30 acres are utilized. All the bottoms of the company are located on the eastern shore of the bay on tidal flats and are exposed at low water. Samish Bay is a large and shallow body of water with a maximum rise in tide of about 8.5 feet. The water in summer is said to be cold; on October 13, 1928, its temperature was 11.2° C. and its specific gravity 1,021 (17.5° C.). The flats on which the oysters are planted are rather soft, and the company improves them by scattering ground shells. The beds are worked at low tide, when the bottom is exposed.

Seed oysters brought from Japan usually arrive between February and March. The voyage from Japan to Seattle takes 10 days; 2 days are probably spent before the oysters are shipped from the Japanese port; 1 or 2 days are necessary for reloading at Seattle

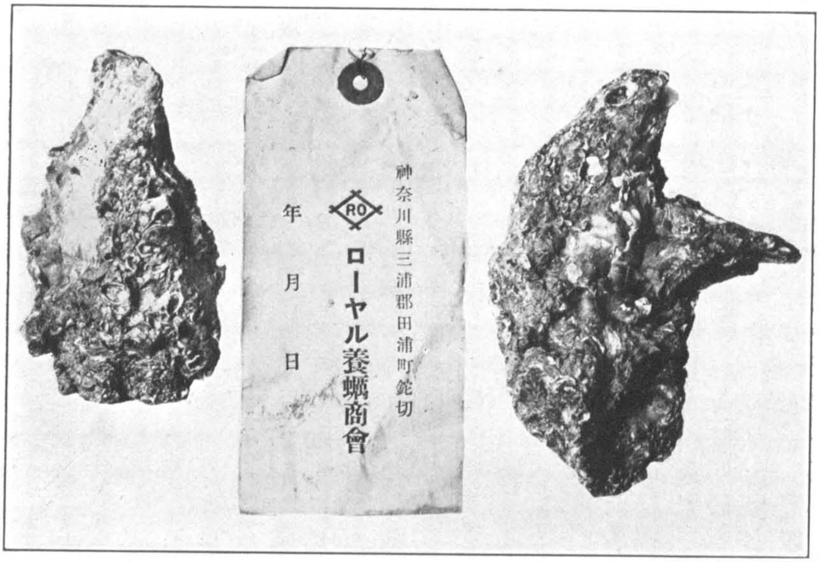


FIGURE 11.—Japanese seed oysters received from Japan. The inscription on the tag reads: "Royal Oyster Co., Kanagawa Ven Mitsura Gon Taura Machi, Natakin

and delivery to Samish. Altogether the seed is no more than 14 days en route. Japanese seed is bought in cases of 4 cubic feet capacity, containing from 10,000 to 15,000 spat on oyster shells. The size of seed oysters is small, varying from 0.2 to 1 cm. in length (fig. 11).

Several years ago seed oysters grown on bamboo sticks and averaging 4,000 to a box were received and planted. Now the use of seeds on bamboo has been discontinued because it has been found that better results can be obtained with seeds on shells.

Seed oysters are planted rather thickly and are left undisturbed for one year. At the end of the first year (after planting) they are transplanted to other grounds and left there until they reach marketable size, which in Samish Bay is reached by the third or fourth year.

The adult Japanese oyster can be distinguished from the eastern oyster by its rather thin shell with well-pronounced ribs (fig. 12), unpigmented muscle scar, and black edges of the mantle. It grows in Samish Bay rapidly; 4-year-old oysters, which were shucked in October, 1928, during my visit to Samish measured about 13 cms. in length and 7 cms. in width and were full of spawn. It has been noticed that Japanese oysters in Samish Bay become ripe in May and June but do not spawn. The manager of the Rock Point Co. asserts that they retain the spawn until the end November, when the gonads are reabsorbed and the oysters can be marketed without any difficulty. The failure of oysters to spawn is a handicap to the industry, not only on account of the failure to propagate but because ripe oysters with gonads full of spawn do not stand transportation and are not suitable for the market.

Samish Bay oysters are shucked at the company's plant; they are washed for two or three minutes in fresh water and are shipped on ice to Seattle, Spokane, and Portland. Very few of them go to San

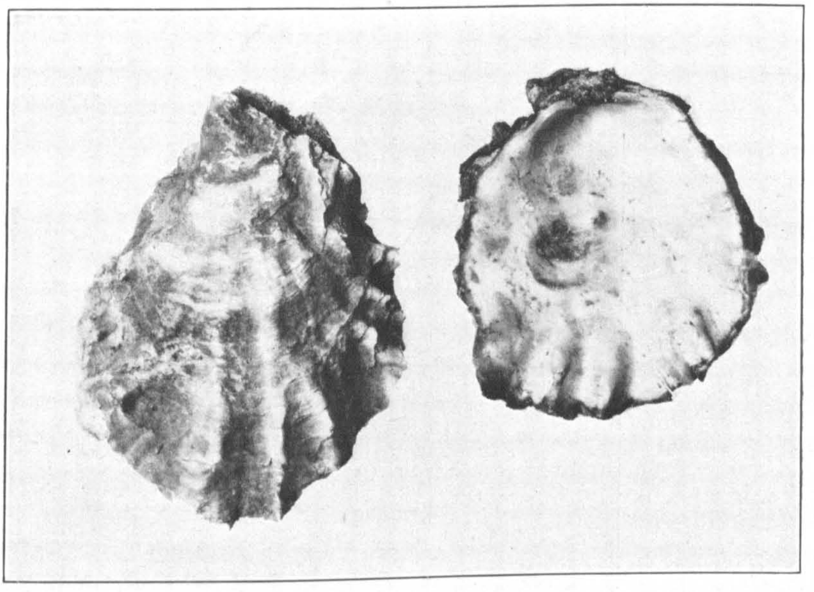


FIGURE 12.—Four-year-old Japanese oyster from Samish Bay. Size 11 by 8.4 cms.

Francisco. When being shucked, the oysters are sorted into three groups according to the size, No. 1 comprising 120 oysters to a gallon, No. 2, 160, and No. 3, 200 oysters to a gallon. The wholesale price of Japanese oysters in October, 1928, was $3.50 a gallon.

The growing of Japanese oysters from seed is regarded as a profitable business. The oystermen estimate that every box of seed oysters planted in Samish Bay will produce in three years $40 worth of oysters. If better seed is available, this figure can be doubled. Because of the low prices of seed oysters in Japan and the freight charges between Japan and Seattle, amounting only to $17 a ton, the growing of Japanese oysters is regarded as a very profitable enterprise. At present from 1,500 to 4,000 boxes are imported annually and bedded in Samish Bay. A few boxes also were planted in Mud Bay and other sections of Puget Sound and in Willapa Bay. The business undoubtedly will develop, and the import of oysters from Japan will grow.

The possible danger in unrestricted importation of seed oysters lies in the possibility of introducing various enemies and parasites, which may become destructive to the native species. Examining the oyster beds in Samish in October, 1928, the author collected a considerable number of conchs, which were identified as *Thais lamellosa*, a species widely distributed along the Pacific coast of America, and *Tritonalia japonica* Dunker [3] (fig. 13), a Japanese species that apparently was introduced with the Japanese seed oysters. There is always a potential danger in introducing with the oysters other animal forms that may become detrimental to the native species. Although at present there is no evidence that *Tritonalia japonica* is destructive to oysters,

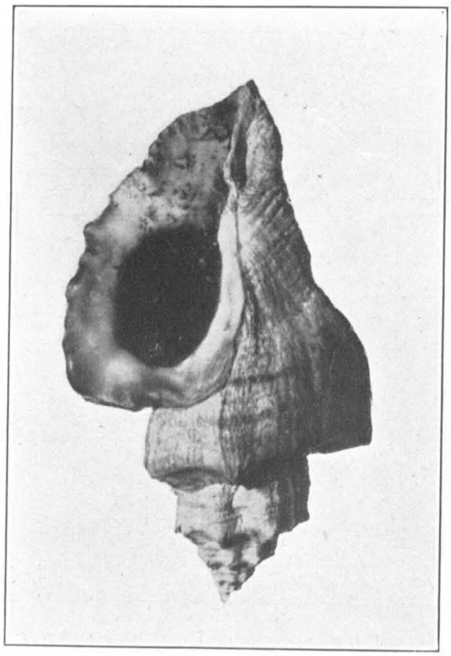


FIGURE 13.—*Tritonalia japonica* Dunker, from Samish Bay. Size 4.4 by 2.5 cms.

yet as a matter of precaution it is desirable to restrict the planting of Japanese species to the waters in the northern part of Puget Sound and not to extend them to the areas where high-priced Olympia oyster bottoms are located. The native oyster has a very thin shell and can become an easy prey to some of the predatory mollusks that may be brought in with the Japanese seed. This danger is fully realized by local oystermen, who think that the planting of Japanese oysters should not be made south of Deception Pass. It is certainly the duty of the State legislature to make laws that will protect the most valuable farms of the State. The steps that might answer this purpose will be discussed in the last part of this paper.

[3] The author is indebted to Dr. Paul S. Bartsch, United States National Museum, for the identification of these species.

OYSTER INDUSTRY IN OREGON

The oyster industry in Oregon is insignificant, for, according to the statistics of the United States Bureau of Fisheries, its annual yield in 1925 amounted to only 1,453 bushels, valued at $4,300. The coast line of the State is straight and unbroken, with very few small bays or harbors, which give the protection necessary for growth of the oyster. Along a coast line of over 300 miles from Fort Stevens, at the mouth of the Columbia River, to the California-Oregon State line there are only three localities (Tillamook, Yakima River, and Coos Bay) that produce oysters.

The Tillamook region consists of Tillamook and Netarts Bays. The first is a small inlet 64 miles south of the mouth of Columbia River that in recent years has produced no native oysters. Some years ago oysters were bedded out in the bay to await shipping and a few were left, but no young oysters were found when the place was visited in October, 1928. Netarts Bay is a small and shallow body of water that has very little fresh water entering it. According to Edmondson (1922) nearly all the water runs out, leaving the bottom exposed during extremely low tide. The salinity of the water is nearly that of the ocean. For some time native oysters were cultivated here, and a market was built up in the immediate vicinity, shucked oysters being sold in the city of Tillamook to the value of $600 per season. During the last 15 years the trade has been neglected. The amount of oysters left over an area of 200 acres of public and private bottoms is estimated by local fishermen to be approximately 100 bushels; but even with such a small number of adult oysters there is a fair set of young oysters every year. The number of oysters sold is negligible, most of them being consumed locally.

The Yaquina River is the center of the oyster industry in Oregon. The most productive areas are found about 1 mile above the town of Yaquina, near Oysterville, where both private and public natural beds are located, the latter being under the control of the State fish and game commission. According to Holmes (unpublished report to the Bureau of Fisheries, 1927) there are approximately 135 acres of oyster beds along the lower 4 or 5 miles of the river from the town Yaquina to Boon's Point. Several years ago a company known as the Oregon Oyster Co. acquired title to all of the private oyster bottoms and leased the publicly owned ones from the State.

According to Edmondson (1920) the setting of young oysters in Yaquina River takes place every year, but difficulty in the cultivation of oysters is caused by sediment carried down the river. To prevent the oysters from being smothered, the beds should be tonged frequently.

In 1897, under the direction of the State biologist, eastern oysters were planted near Oysterville. It was reported that the oysters spawned but no setting occurred, and after several years of trial the attempt to introduce the eastern oyster was given up.

Coos Bay, one of the larger bays of the State, is of irregular shape, having some resemblance to the inverted letter V and has broad mud flats that once supported an abundant growth of native oysters. This is shown by the great quantities of shells cast out by steam dredges in the process of deepening the channel. At present there are no oysters in Coos Bay. The Indians believe that they were destroyed during the great forest fire more than 80 years ago. According to Edmondson (1922), 14 acres were set aside by a group of local men and planted with native oysters in 1917. The experiment was a success, and a satisfactory amount of spat was collected in 1917 and 1918. The project to increase the acreage and plant more oysters was discussed but not undertaken and later on was discontinued entirely. During the author's visit to Coos Bay in October, 1928, there was no person in Marshfield and North Bend who knew anything about the oyster beds or planting experiments in the bay, although inquiries were made in the local chamber of commerce and among the fishermen. All the oysters sold in local fish markets were received from Olympia and Portland.

OYSTER INDUSTRY IN CALIFORNIA

The production of oysters in the State of California is but little greater than that in Oregon, and, according to the statistics of the United States Bureau of Fisheries, amounted in 1925 to 5,692 bushels a year, valued at $23,394. The statistical report of the State division of fish and game for 1927 states that there were 2,223,058 eastern oysters (approximately 7,410 bushels, counting 300 oysters to a bushel) marketed in the State. This figure can not be credited to the production of oysters in California, because the eastern oysters shown in the report were not grown in California waters but were brought in from the Atlantic coast and sold within two or three months.

The native Pacific oyster has never been commercially important in California. It is fairly abundant on rocky reefs in protected waters but never has been cultivated as in Puget Sound. Townsend (1893) states that *Ostrea lurida* was abundant in San Francisco Bay, but that on account of its small size it was utterly worthless as compared with oysters from Washington. Extensive deposits of shells of this species found in the shallow water along the western part of the bay and dredged for various purposes indicate its former abundance in San Francisco Bay.

Eastern oysters were introduced in San Francisco Bay in the early seventies, and planting operations were carried out also in Humbolt, Tomales, and San Diego Bays, and in Elkhorn Slough. Successful results in growing eastern seed oysters were obtained only in San Francisco and Tomales Bays. Although Townsend (1893) found that eastern oysters spawned and set in San Francisco Bay, the propagation of the species never was sufficiently extensive for commercial exploitation. The business consisted in relaying the seed brought from the East and keeping them from 2 to 4 years. Since 1887 the amount of oysters transplanted and grown in San Francisco Bay has increased, so that in 1910 the value of the oysters sold was nearly $1,000,000. It was the belief of the oyster companies that the water in San Francisco Bay was too cold for the propagation of the eastern oyster, and no attempts were made to cultivate them there. The method of growing the spat consisted in spreading them over the bottoms reinforced with old shells and protecting them from stingrays with stake fences. This method gave satisfactory results for a long time, but during the last decade it was noticed that the oysters did not grow as they formerly did, for their meats became watery, and many of them died. The oyster business gradually changed; and, instead of buying and growing seed oysters, large oysters of marketable size were brought in and placed on the beds for a short time to be sold as the trade demanded. One of the major fishing industries of California gradually shrank to its present insignificant state. Large oyster companies controlling extensive acreage of oyster bottoms in San Francisco Bay have discontinued their operations, and the present activities in oyster trade consist in importing marketable eastern oysters, placing them on the beds of Tomales Bay for a brief storage period, and disposing of them as soon as possible.

It is difficult to say just what changes in the water of San Francisco Bay had such a pronounced effect on the oysters. Various opinions were expressed, but pollution of water was regarded as one of the main causes. The recent investigation of San Francisco Bay made by Miller and others (1928) points to the conclusion that, contrary to the expectations of the authors, "contamination by sewage and industrial wastes has appeared to be a factor of little importance in its effect on the condition of the water in San Francisco Bay," and that the chemical effect of sewage being discharged into the bay at present is inconsiderable and quickly dissipated. Another opinion advanced by those interested in fishery problems of San Francisco Bay is that the reclamation of tide land, which prevented the ebb and flow of the tide on the flats, resulted in a decrease of food supply for oysters; or that heavy use of fresh water for irrigation purposes has diminished the flow of fresh water into the bay. It is futile to speculate as to the possible causes of the failure of oysters to grow; it may be possible that the absence of a necessary type of food is responsible for their poor growth and mortality; but, since we have no exact information as to the food requirements of the oyster and can not determine which of the important ingredients of their diet is missing, the problem at present can not be solved.

Oyster bottoms of Elkhorn Slough were examined in March, 1929, by H. C. McMillin. The slough begins near the eastern extremity of Monterey Bay, from which it is separated by the high sand dunes. The main course of the slough passes through a narrow opening in the dunes and turns south, parallel to the ocean beach and about one-fourth mile or less from the latter. It is about 2 miles long and varies in width from 50 yards to nearly a mile. Several branches join the main channel of the slough at various places, two of them extending well up into the highland. The bottom and banks of the slough are of clay. During the construction of a road piles were driven in the bottom, and rock, iron, and other material were thrown into the water. All of these have been found to give support for a good set of native oysters. Mussels and clam shells found on the bottom also have become the centers of oyster clumps covering the flats. All over the bay the setting is fair, the young oysters attaching themselves to any solid, clean surface.

Because of lack of cultch, not over 5 acres of ground has been found to be productive, from which during this year about 200 bushels of native oysters have been taken. Small eastern oysters from Texas were planted about 6 years ago. They survived and are still taken in small numbers. It is believed that by reinforcing the bottoms and planting the shells the productivity of the Elkhorn Slough oyster beds can be developed.

CONCLUSIONS

It was the purpose of the present paper to collect in condensed form scattered information regarding the oyster problems of the Pacific coast, and by an analysis of the present condition of the oyster industry to determine which line of scientific research should be adopted in order to promote oyster farming and to develop the natural oyster resources of the three Pacific States.

Of three species of oysters (*Ostrea lurida*, *O. virginica*, and *O. gigas*) only the first one is indigenous to the waters of the Pacific coast and occurs in protected harbors and bays from Alaska to Mexico. Although this native oyster is small, it is commercially valuable and easily cultivated. The lack of exact knowledge regarding the biology of this species makes it impossible to state the temperature and salinity limits for its successful cultivation, but the fact that it grows naturally along the western coast of the North American Continent indicates that this species is well adapted to life in the cool waters of the Pacific coast. Experience with imported species of oysters shows that their cultivation on the Pacific coast is not an easy matter. So far as the eastern oyster is concerned the biological studies carried out by the bureau during the last five years have demonstrated that it can be propagated successfully in waters in which the temperature is above 20° C. during the summer months. The reason why the Japanese oyster fails to spawn in Puget Sound at present is not known, but it is very likely due to the same cause—that is, low temperature of the water of the sound.

It is obvious that our efforts should be directed primarily to the study of the biology of the native species, which forms the basis of a valuable industry in the State of Washington and the cultivation of which brings good returns on the invested capital. First-class improved and diked oyster land in the State of Washington is very valuable and represents an investment of from $1,000 to $3,000 per acre. In spite of heavy taxation, amounting sometimes to $75 per acre, oyster farming is very profitable, and the income derived from it is much greater than that which one can expect to receive from the cultivation of wheat, oats, corn, potatoes, or any other crop. The demand for Olympia oysters is greater than the present supply, the prices are high, and new markets can be developed without any difficulty; there is, therefore, no danger of overproduction, so that the acreage of oyster-producing bottoms can be enlarged for the benefit of the whole State. The character of oyster lands in Washington and the methods of cultivation are such as to make it possible for the individual farmer with a small initial capital to undertake oyster farming and, by improving the acquired land, to build up a successful business. While considerable experience has been gained in the methods of dike construction and improvement and maintenance of tidal lands, very little attention has been paid to the biological side of the problem. This is undoubtedly due to the fact that observations of the critical phases of the oyster's life—namely, its spawning, free-swimming life of the larvæ, and their setting—are beyond the facilities of an ordinary oyster farmer. A dike can be constructed easily by every farmer with very little experience, but the determining of the exact time of spawning and setting can be done only by a trained biologist equipped with scientific instruments.

A study of the biology of the oyster and examination of the bottoms and water in the oyster-producing area may be of great help to the oyster growers, in that it would supply information regarding the value of various bottoms for oyster culture and regarding the development of better methods of cultivation. It is common knowledge that setting in Puget Sound and Willapa Bay is irregular and subject to wide fluctuations. For instance, there has been no set of commercial importance for the last two years in Puget Sound. The question arises whether the present method of spat collection is adequate and whether new and better methods can be applied for collecting seed oysters. Experiments carried out by the Bureau of Fisheries in New England waters show that the zone of heaviest setting varies in different waters, and that by using crate or wire-bag collectors planted in the zone of setting the productivity of seed oysters per given area of bottom can be increased materially. It is quite possible that the methods developed for catching a set of eastern oysters would be suitable for the Pacific coast and would give satisfactory results with the native species. Experience with eastern oysters shows that certain localities are good spawning and setting grounds, while the others are suitable for growing and maturing the oysters but unfavorable for their propagation. It is a common practice of the oyster culturists to shift the crop of oysters from one bed to another in order to obtain the best results. Similar conditions may exist on diked areas, and further examination will show which of them are best suited for the catching of spat and which should be reserved as maturing and growing grounds.

The water left by the receding tides inside the dikes is subject to considerable temperature fluctuations. the actual extent of which is unknown. How these fluctuations affect the life of the oyster must be the subject of scientific study, which will throw light on the operation of various factors affecting the life of the oyster and will be of great help in the evaluation of oyster bottoms.

The proposed scientific investigation that will attempt to solve these problems will be a cooperative undertaking of the United States Bureau of Fisheries and the State department of fisheries and game. The program calls for work to be carried on throughout the year and will consist of an extensive study of temperature fluctuations and changes in the chemical composition of water during the tidal cycles in several representative localities. The influence of the changes in temperature and salinity on the spawning of the oyster will be studied in a laboratory established close to the oyster bottoms in Oyster Bay. The life of the larval oyster will be studied with the view of determining the extent of the horizontal and vertical migrations of the free-swimming forms, and for the purpose of determining the factors controlling their setting. Various types of collectors and cultch will be tried in order to develop an efficient method of catching spat. It is believed that the results of this work will enable us to outline practical methods of culture that will be helpful to the industry of the whole Pacific region.

The possibility of cultivating eastern oyster appears to be rather uncertain, for temperature conditions along the Pacific coast are such as to preclude the possibility of its spawning and setting in the greater part of the inshore waters.

The cultivation of the Japanese oyster is an important problem. Although this oyster is inferior in quality, in comparison to either native or eastern species, there is a demand for it and it does not compete directly with the marketing of other species. There are many reasons to believe that the present success in growing Japanese oysters in Samish Bay will induce other oystermen to engage in this business, and the importation of Japanese seed will grow. From a biological point of view an unrestricted importation of one species into a new environment is always a dangerous procedure. The examples of the gypsy moth imported from Europe and the damage done to the British oyster beds by imported American drills are good illustrations of what might happen if some of the pests should be liberated in new territory where their natural enemies are absent. At present we have evidence to show that the Japanese gastropod (*Tritonalia japonica*) has been imported with the oyster seed. Although the destructiveness of this species has not been established, there always exists the possible danger that unknown pests may be introduced. The best method to use in dealing with the situation is to develop an efficient method of propagation of the Japanese oyster, which, as has been shown above, ripens but fails to spawn in the waters of Samish Bay. It is planned to carry out an experimental study of this problem with the view of determining the conditions under which this oyster would spawn.

At present neither the State nor the Federal Government exercises any power to regulate the importation of live shellfish. It seems that now is a proper time to take such a step and to put the importation of live fish and shellfish under the supervision of the Government. It must be borne in mind, however, that an examination of several hundreds of tons of shells is not an easy matter. Eggs and embryos of various predatory mollusks may be found in capsules attached to the shells and can easily be overlooked. It seems possible, however, to reach a friendly understanding with the Japanese producers of seed and request that with every shipment of seed oysters they submit a certificate from the proper local authorities certifying that the shipment comes from beds not affected by drills or other pests. Inasmuch as the local producers are always aware whether or not their bottoms are infested by drills or other pests, the practice of obtaining certificates may be more efficient than actual inspection.

Another protective measure consists in restricting the planting of Japanese seed to such bays and harbors where there are no cultivated beds of Olympia oysters. If planting of Japanese seed is restricted to areas where the native oyster does not grow, then the possible danger will be minimized.

As has been mentioned before, at present there is only a potential danger in importing some of the foreign species destructive to the native oyster. It is time, however, to take precautionary steps before the danger becomes obvious; the history of the struggle against injurious insects and plants teaches us that it is easier to prevent the danger than to combat it later.

BIBLIOGRAPHY

DOANE, R. W.

1901. A preliminary report respecting the investigations relative to the propagation of the eastern oyster in the State of Washington. Tenth and eleventh annual reports of the [Washington] State fish commissioner, 1899–1900 (1901), pp. 34–65. Olympia, Wash.

1904. Oysters and shellfish. Pacific Fisherman, Vol. II, No. 1, pp. 42–46. Seattle, Wash.

1905. Shellfishes of the Northwest. Pacific Fisherman, annual number, 1905, pp. 21–24, 4 figs. Seattle, Wash.

EDMONDSON, CHARLES HOWARD.

1920. Edible *Mollusca* of the Oregon coast. Occasional papers, Bernice Pauahi British Museum of Polynesian Ethnology and Natural History, Vol. VII, No. 9, pp. 179–201, 4 pls. Honolulu.

1922. Shellfish resources of the northwest coast of the United States. Appendix III, Report of the U. S. Commissioner of Fisheries for 1922 (1923). Bureau of Fisheries Document No. 920, 21 pp., 25 figs. Washington.

INGERSOLL, ERNEST.

1881. The oyster industry. Department of the Interior. Tenth census of the United States. The history and present condition of the fishery industries. Prepared under the direction of Prof. S. F. Baird, United States Commissioner of Fisheries, and G. Brown Goode, assistant director, U. S. National Museum, and staff of assistants. 251 pp., Pls. XXX–XLII, 1881. Washington.

MILLER, ROBERT C., WILLIAM D. RAMAGE, and EDGAR L. LAZIER.

1928. A study of physical and chemical conditions in San Francisco Bay, especially in relation to the tides. University of California Publications in Zoology, vol. 31, No. 11 (1928), pp. 201–267, 5 text figs., 5 charts. Berkeley, Calif.

PRYTHERCH, HERBERT F.

1929. Investigation of the physical conditions controlling spawning of oysters and the occurrence, distribution, and setting of oyster larvæ in Milford Harbor, Connecticut. Bulletin, U. S. Bureau of Fisheries, Vol. XLIV, 1928 (1929), pp. 429–503, 32 figs. Washington.

SHELFORD, V. E., and E. D. TOWLER.

1925. Animal communities of the San Juan Channel and adjacent areas. Publications, Puget Sound Biological Station of the University of Washington, Vol. V, 1925, pp. 33–73. Seattle.

SMITH, E. V., and TH. G. THOMPSON.

1927. Salinity of the Lake Washington ship canal. A study of conditions affecting the flow of sea water into the canal system. University of Washington Engineering Experiment Station Series, Bulletin Vol. XLI, pp. 1–104. Seattle.

STAFFORD, JOSEPH.

1913. The native oyster of British Columbia (*Ostrea lurida*, Carpenter). Province of British Columbia, Report of the Commissioner of Fisheries for the year ending December 31, 1913, pp. R. 79–R 102, II Pls. Victoria.

1915. *Idem. Ibid.*, December 31, 1914, pp. N 100–N 119, V Pls. Victoria.

1916. *Idem. Ibid.*, December 31, 1915, pp. S 141–S 160. Victoria.

1917. *Idem. Ibid.*, December 31, 1916, pp. S 88–S 120, 2 tables. Victoria.

STEVENS, BELLE A.

1928. Callianassidæ from the west coast of North America. Publications, Puget Sound Biological Station, University of Washington. Vol. VI, 1928, pp. 315–369, 71 figs. Seattle.

TOWNSEND, CHARLES H.

1893. Report of observations respecting the oyster resources and oyster fishery of the Pacific coast of the United States. Report, U. S. Commissioner of Fish and Fisheries for 1889 to 1891 (1893), pp. 343–372, pls. 2–11. Washington.

1896. The transplanting of eastern oysters to Willapa Bay, Washington, with notes on the native oyster industry. *Ibid.*, 1895 (1896), pp. 193–202, 1 pl. Washington.

1901. Report of the division of statistics and methods of the fisheries. *Ibid.*, 1900 (1901), pp. 163–184. Washington.

U. S. DEPARTMENT OF AGRICULTURE.

1928. Crops and markets. Vol. V, No. 12, pp. 441–496. Washington.

WASHINGTON STATE DEPARTMENT OF FISHERIES AND GAME.

1896–1926. Annual reports of the Department of Fisheries and Game, Division of Fisheries, 1896 to 1926. Olympia, Wash.

FISHERY INDUSTRIES OF THE UNITED STATES, 1928 [1]

By R. H. Fiedler,

Assistant in charge, Division of Fishery Industries

CONTENTS

FOREWORD

This report constitutes a yearbook on fishery statistics of the United States as well as a summary of activities of the division of fishery industries. As its name indicates, this division of the bureau is concerned with the activities and welfare of the fishery industries, including the commercial fisheries, the trade in fishery products, and the fish canning and preserving industries. Its functions are the collection and publication of fishery statistics, the prosecution of research designed to solve the technical problems of the industry, and the dissemination of authoritative and practical information to the fishery industries and the public. Results of technological investigations and marketing studies are published in separate documents as each project is completed. The information obtained from statistical surveys is published in Part 2 of this report, which includes all the detailed statistical information that has become available since

[1] Appendix IX to the Report of the U. S. Commissioner of Fisheries for 1929. Bureau of Fisheries Document No. 1067.

the issuance of the previous report,[3] together with such summarized statements and interpretations of the statistics as are deemed significant and useful. In the preparation of this report numerous members of the division's staff have taken part, and their assistance is appreciatively acknowledged.

Part 1. OPERATIONS OF THE DIVISION

COLLECTION OF STATISTICS

The statistical work of the division in 1928, as in former years, included the furnishing of statistics on the catch of fishery products and the gear employed in making the catch and statistics of related fishery industries. In the former group are those statistics that are intended primarily for the use of the fishery biologist, upon which to base wise conservation measures, although they are indirectly valuable for economic purposes. This is especially true of statistics for the landings of fish at principal fishing ports, which are published monthly. In the latter group are statistics that are of use mainly for economic or trade purposes. In this group are included statistics of the canned fishery products and by-products of the United States, cold-storage holdings of fish and amounts of fish frozen in the United States, fish and marine-animal oil production, and similar statistics.

That fishery statistics, both biological and trade, are becoming more generally appreciated by those interested in our fisheries is evidenced by the generous cooperation given the bureau by fishermen, fish wholesalers, those in related fishery industries, State fisheries agencies, and others. The bureau appreciates this cooperation and wishes to take this opportunity to thank the above for their support during the past year in an effort to give the fishing industry a statistical record upon which to base its activities. In this connection the bureau urges those in the industry to offer criticisms and suggestions for the betterment of statistics now being collected.

During 1928 unusual progress was made in the collection of statistics of the catch of fishery products in the United States. This was occasioned by greater cooperation with State fishery agencies and by the use of automobiles by agents, which has enabled them to canvass a larger territory than was formerly the case when travel was performed mainly by train. As a result, catch statistics for 1927 were obtained of the fisheries in our South Atlantic, Gulf, Pacific coast, and Great Lakes States and for the State of Connecticut. Continuous annual catch statistics are now available for the Great Lakes States from 1913, Pacific Coast States from 1922, Gulf States starting with 1927 (as it is now planned to canvass the latter States annually), and the State of Connecticut from 1924. The latest catch statistics now available on each geographical section are as follows: New England States, 1924; Middle Atlantic States, 1926; Chesapeake Bay States, 1925; South Atlantic, Gulf, Pacific coast, and Great Lakes States, 1927; and Mississippi River and tributaries, 1922. In addition to the general catch statistics, the collection and (or) publication of statistics on special subjects was continued during 1928 as follows: The landings of fish by American fishing vessels at

[3] Fishery Industries of the United States, 1927. By Oscar E. Sette and R. H. Fiedler, Appendix IX to the Report of the U. S. Commissioner of Fisheries for 1928, pp. 401-547. Bureau of Fisheries Document No. 1050.

the ports of Boston and Gloucester, Mass., Portland, Me., and Seattle, Wash., and landings of halibut at North Pacific coast ports (published monthly, and annual bulletins summarizing these landings for the year); catch of mackerel in the North Atlantic fishery; cold-storage holdings of frozen and cured fish and amount of fish frozen, which are furnished by the Bureau of Agricultural Economics (published monthly); production, consumption, and holdings of fish and marine-animal oils of the United States and Alaska (published quarterly by the Bureau of the Census); production of canned fishery products and by-products of the United States and Alaska during 1928; the catch of shad in the Potomac and Hudson Rivers and the catch of alewives in the Potomac River during 1928; transactions on the sponge exchange at Tarpon Springs, Fla., during 1928; volume of fishery products handled at the municipal fish wharf and market, Washington, D. C., during 1928; and volume of United States imports and exports of fishery products during 1928, furnished by the Bureau of Foreign and Domestic Commerce.

TECHNOLOGICAL INVESTIGATIONS

The fisheries industries of the United States are on the threshold of a new era. Revolutionary changes have taken place in the past decade, and still more are destined to occur in the next. Wiser use is being made of those resources that are taken from nature's greatest storehouse—the sea. A bystander, watching this development, has seen excessive overhead expenses reduced in fishing and in the preparation of fishery products; a larger number of inland towns being supplied with fresh fishery products in addition to those originally supplied in sealed tins; waste fishery products converted into valuable products of commerce; and studies of the nutritive value of fish and fishery products showing the necessity of these for the proper balancing of the diet of both man and beast. Much of this has been brought about as the direct result of applied fisheries technology, in which the Bureau of Fisheries has been largely instrumental.

The work of the division's technologists during the past year was concerned mainly with problems of net preservation, the utilization of by-products, the feeding value of marine products, and improved methods of handling fresh fish. In studying these problems, field work has increased greatly, as is attested by the fact that the Reedville laboratory was run all year instead of being closed at the end of the menhaden season. Summer laboratories also were in operation at Brunswick, Ga., and Erie, Pa. During the school year the bureau also had an employee working at Johns Hopkins University and another at the University of Wisconsin.

NET PRESERVATION

The work with net preservatives has continued with the perfection of treatments for use upon cotton nets in salt water, attention being paid to securing the most economical treatment. The treatment previously announced, which contains 6 pounds of pine tar, 12 pounds of coal tar, 2 ounces of mercuric oxide, and 5¼ pounds of cuprous oxide ground to pass a 350-mesh screen has shown itself to be cheap and effective. The mercuric oxide may be omitted in salt water, but is well worth retaining in fresh water. Other treatments have been studied, but few bid fair to replace this one, and hence no successors can be announced soon. The experiments with the test panels set out last year show that in all salt-water locations the section of the net treated with tar alone fouled badly. In most of the cases the fouling "bridged" across the 1-inch mesh, but the near-by sections that had been treated with cuprous oxide were fouled only slightly and in patches, presumably by growths that had floated against the net and found temporary anchorage. It was found that in some localities where fouling is not marked the amount of cuprous oxide might be halved safely. This is not advised, however, unless the nets are treated again in midseason. In sections such as the New Jersey coast the nets fouled badly, and even the best treatments should be repeated in midseason, and even then it would be best to increase the cuprous oxide to 8 pounds per 10 gallons. Nets placed in Puget Sound or similar localities do not foul but rot. It probably would be best to increase the strength of the mixture for use in similar localities. All this advice concerns practice designed to reduce to a minimum the cost of treating nets. It is estimated that by following the procedure recommended by the bureau the cost of preserving trap gear may be cut to about one-third of that prevailing where the best available commercial treatments are employed.

The investigators at the Erie station found that the deterioration of fish nets was due to bacteria alone, and demonstrated that the lake contains in all its reaches cellulose-digesting organisms that attack the cotton fiber. The concentration of the net-rotting organisms is greatest near shore. The slime found on the nets also affords bacteria a wonderful breeding ground. Since nets have been shown to harbor germs for some time after being dried in the usual manner, it is recommended that especial care be given to removing most of the contamination by thorough washing as soon as possible after removing from the lake. A search is being made for materials that may be added to the water used for washing in order to render the cleaning of the net more efficacious.

The bureau's trap-net treatment proved effective in fresh water. This treatment is flexible enough so that it was tried on gill nets of 70/6 thread to see what effect it would have upon the "fishing power" of the gear. Practical tests showed that these dark-colored nets, which had been reviewed so unfavorably by the fishermen themselves, caught very nearly as many herring as the untreated nets and showed the only difference, if any, in the incidental catch of whitefish. These practical tests showed that in Lake Erie the darkest treatments that the bureau has evolved are of practical use on gill nets, and hence the lighter treatments being perfected now may be expected to fish quite as well as untreated nets. Possibly nets treated with dark treatments would not show "fishing power" so nearly like the untreated nets in waters more clear than Lake Erie, but a practical fishing trial would be worth while in view of possible savings on gear.

BY-PRODUCTS

Menhaden.—The study of by-products problems includes as one of its most important phases a consideration of the menhaden industry. This industry is being studied very carefully because it is closely similar to the sardine, herring, and other waste-reduction industries, and also because the industry has in recent years encountered difficult problems that must be solved if the menhaden factories are to regain the full measure of prosperity formerly associated with them.

The study of any by-product process must include cost estimates. This is true because in many processes, especially those using vacuum dryers and elaborate machinery, the cost of production is high and the overhead expense so large that unless supplies of raw material are very constant the profits are in danger of being engulfed by fixed expenses. The menhaden industry, though utilizing cheaper machinery, is now suffering from the effect of variable supplies because the catch has been small in the last three seasons. This decrease in the supply of raw material is no doubt due to the natural fluctuations that have characterized the menhaden catch since the beginning of the fishery, but the effect is aggravated because of the huge size of the present plants, which were built or enlarged when several very successful years followed each other closely. The technologists have made a preliminary study of costs in the menhaden industry in order to guide themselves in attacking the most important sources of loss. Those problems that they could not properly handle they discussed with plant managers, and the ones that were proper subjects for technological study were investigated on a commercial scale, if at all practicable.

It seems that there are two main sources of loss, each of which accounts for over 5 per cent of the total product. These are losses due to dissolved protein and oil in the waste liquors and the loss of nitrogen due to oxidation in the present flame dryers. These problems, therefore, have received first attention, and two small-scale commercial type machines have been tested. One showed promise, and a slightly altered type will be tested next year. The other, a dryer, showed excellent results but will be run again next season because the supply of fish last year was not regular enough to allow the technologists to gather sufficient data upon cost and efficiency.

It is equally as important to save oil and to improve its quality as to improve meal, for both represent nearly equal portions of the profits of the menhaden industry. The presence of free fatty acid detracts from the usefulness of oil, and if present in too great quantities actually changes the channels of trades into which the oil may enter. Preliminary experiments have shown conclusively that water increases the free fatty acid content of oil in storage tanks and that sun and rain do not improve the quality of fish oils. Next year the study of this matter will be continued to see what effect improved practice will have on sales prices.

Ground fish and waste fish.—The favorable reception of fresh and frozen fillets by the consuming public has indirectly stimulated another phase of the fishery by-products industry, which in turn places problems of importance before the bureau technologists. As a result of the increasing demand for packaged fish, large quantities of waste accumulated at central points. This waste must be disposed of as it easily becomes a nuisance. The situation has another aspect also. In order to supply the necessary amount of haddock and other fish for filleting, the use of steam trawlers is growing in importance. In this type of fishing large quantities of trash fish are also taken in the trawl net and are available for reduction, as well as the viscera from the cleaned edible fish. Besides the two above-mentioned cases, small quantities of waste are accumulated in isolated localities or city fish markets; thus, there are three general conditions under which the supply of raw material accumulates.

The nature of the raw material makes the reduction of this waste more difficult than it would outwardly appear to be. The majority of the waste comes from nonoily fish having a high glue content. The presence of the gluey material causes difficulties in drying. In most of the centrally located plants a wet process is used, in which the material is cooked and pressed before drying is attempted. In this way the greater part of the gluelike material is eliminated, and difficulty in drying is not experienced. This process results in the loss of nitrogenous matter, but as this comes mainly from gelatin (a nitrogenous substance not as valuable as the other protein material) the decrease in the actual feeding value of the meal is probably not as great as it seems at first sight.

On board trawlers, where space is at a premium, the above-mentioned process is not practicable. Also, in the case of plants handling small amounts of material the cost of the additional equipment would be prohibitive unless extemporized equipment were utilized. For this reason, investigations have been conducted at the Reedville laboratory in an effort to develop a simple process applicable to trawler installation and small plants. This is a most difficult problem, for small plants and even larger ones utilizing vacuum-drying machinery work on a very narrow margin of profit. Large vacuum dryers are still subject to trouble due to sticking of the dried material and have a capacity much lower than would be expected on the basis of experience in drying other waste materials. The work upon the drying of "white fish meal" is being continued, for though much progress has been made, the results are not eminently satisfactory from a commercial standpoint.

Shrimp waste.—During the shrimp season of 1928 the bureau's technologists conducted experiments at Brunswick, Ga., upon the utilization of the waste accumulating during the process of heading and canning this crustacean. Four methods of reduction were adopted. These allow the waste to be handled with a minimum amount of interference with the plant operation—a most valuable matter in connection with the work of this industry. Shrimp packing is noted for the irregular manner in which raw material arrives, thereby taxing equipment and labor facilities to the utmost. Because of this fact, any proposed operations must not interfere with the primary operations. The proposed processes do not, as may be seen by the following description of one of them. The shrimp waste is collected by the men who previously placed the unpicked material on the tables, cooked, spread on the drying platform, and acidulated before the canning operations cease in the late afternoon. The time of boiling required is about 10 minutes, and 240 pounds of 60° sulphuric acid per ton of cooked waste is necessary. This is roughly 12 pounds per basket.

A second way of utilizing shrimp waste is to boil it vigorously for 10 minutes, then drain it on the floor of a cooling shed, where it is raked into layers not over 3 inches thick. The waste will cool rapidly and become dry enough so that it may be dried the next day in a simple shelf drier, which may be heated by oil stoves if quite small. The drying is continued until the waste may be ground easily, which corresponds to about 6 per cent water content.

The materials produced by the new methods are excellent for fertilizer and those low in salt content promise well as a feedstuff, although they have not been compared in actual feeding tests with "shrimp bran" dried in a steam drier. The product produced in the latter machine has been shown by preliminary experiments to be very valuable in feeding poultry and dairy cows. A valuable constituent is the iodine, which is present in larger amounts than in most fish meals and may be a great help to feeders encountering difficulties in regions where "big-neck" (goiter) now causes such losses. The mineral content also supplies material to replace the drain made upon the calcium and phosphorus stores of heavily-producing animals, such as dairy cows, laying hens, or swine being fattened for market. This drain is often so great as to remove so much calcium from the bones that they are weakened and fracture easily. In addition to showing how a valuable product may be placed upon the market, this work demonstrates the ease with which a nuisance-producing waste may be eliminated.

NUTRITIVE VALUE OF FISH

The studies upon new and upon improved marine feedstuffs have led naturally to a consideration of their food value. Products from the sea are by nature balanced in composition, for they come from a huge mixing bowl that suffers no local deficiencies of vital material as a result of man's interference, as too often happens on land. Therefore, fish products are a most valuable adjunct to the citizen's dietary and to the farmer's list of feeds. Not only is fish protein remarkably cheap, but it is good, as has been demonstrated by studies conducted by the bureau's investigator at Johns Hopkins University. These studies, as related previously, show haddock and herring protein to have a high supplementary value for cereal proteins, comparing very favorably in this respect with steak, liver, and kidney. In addition to this advantage, fish protein excells because it has associated with it many vitally needed elements, such as iodine, iron, and copper. The first of these plays a rôle in preventing thyroid disorders such as goiter; the others aid in the formation of hemoglobin in the blood. It is the effect of these accessory elements that is receiving a great deal of attention nowadays. It is true that there are available data from many different sources indicating that fish meal is more efficient, in dollars per hundred pounds gain in weight, in feeding swine than other protein concentrates; but the most interesting property of fish meals and other marine foods is to be found in their content of the chemical individuals called the "essential elements," because they play such a part in determining the processes of growth and well being. In order to learn more about the rôle played by the less common elements found in fish meal, and the possible use of marine products as corrective agents in animal feeding rather than as competitors or substitutes for products derived from the land, cooperative feeding tests have been arranged with State and Federal stations of the Department of Agriculture. A preliminary feeding test in which dried crab scrap was used has shown that hens fed with crab scrap added to their regular feed produced 938 eggs in a four-month period, during which time the hens used as controls produced 479 eggs.

As yet it has not been possible to determine what increase of iodine has taken place in the eggs or in milk in similar experiments, but this will be done soon because of the important part played by this substance in the diet of children, especially.

IMPROVED HANDLING OF FRESH FISH

Efforts are now being made to improve the handling of fresh fish in the South, it having been shown at Boston that advances can be made in this field. The greater part of the work in the South has been to minimize the handicap of hot weather by showing how refrigeration facilities may be utilized to their best advantage. The bureau is not conducting researches along this line, not having entered this field again after having done pioneer work in introducing the first brine freezers in America for the purpose of freezing fish, but is rather drawing to the attention of fishery operators the advantages that may be gained. A part of this program of education and assistance is the installation of a demonstration chilling tank at the fish freezer of a cooperating dealer in South Carolina and work on the adaptation of more recent methods of handling fish in a way suited to conditions in the South. At a meeting held in Louisiana a fishermen's and ice manufacturers' group was organized to study better ways of shipping and handling southern fish. Other groups have been helped, particularly in Texas, where State restrictions place a heavy burden upon the commercial fishermen.

The bureau's representative on the Boston Fish Pier has done much to help in the adoption of improved methods of unloading vessels and is aiding in drawing up plans for greater facilities needed at that point since the introduction of more trawlers and the growth of a desire to handle fish more expeditiously.

As a result of some studies conducted through the help of fishermen at Boston, the bureau has investigated the handling of cod livers on board vessels that do not carry reduction plants, and has shown that a few simple precautions and some care in handling will enable fishermen to bring in the livers in excellent shape. The problem now is one of price and lies between the producers and the buyers. A search is now being made for some process or machine more efficient than the present one, and for equipment suitable for schooners that now can not use "boilers" for lack of steam supply.

GENERAL SERVICE

The technologists of the division not only conduct research work but also disseminate information of a technological nature to the industry. This is done by answering, from our present fund of knowledge, inquiries coming by letter and by conferring with people who bring with them for discussion problems of a more intricate nature. Answering technological inquiries represents an important part of the work, for a great deal of the technologists' time is given to this service. In many cases the correspondence is lengthy, for there are very few sources of information other than the bureau, and there are no other sources of consultation that may be utilized. This service apparently is well known, for the inquiries are cosmopolitan in nature. Letters or visits have been received from people interested in the fisheries of Canada, Mexico, England, Norway, Sweden, Portugal, South America, India, South Africa, Haiti, and Porto Rico.

No matter how well trained the new investigators may be in the basic sciences—and nowadays it is difficult to find chemists equipped for original investigations in very many of the diversified fields covered by fisheries technology—they must be introduced to actual fisheries operations. Therefore, the newer technologists are given an opportunity to see actual operations in representative business and typical locations. Many contacts have been made in this manner to the mutual benefit of industry and the bureau, for at the same time that the bureau's representatives are learning first-hand details about particular fishery businesses they are able to give suggestions for improvements by drawing upon the general fund of engineering and scientific knowledge or good practice in related industries.

MARKET AND INDUSTRIAL SURVEYS

Surveys of this description are made to supply the trade with useful market information regarding the distribution and consumption of fishery products and to supply descriptive and economic data on our fisheries and fishery industries.

GOLDFISH INDUSTRY

During the winter of 1928 a survey was made of the principal goldfish-producing areas of the United States. No previous surveys have been made of this industry, but as it now commands an important position among the fish-farming industries a survey was thought expedient.

The principal centers of the industry are in Maryland, Ohio, and Indiana, but many small farms are scattered throughout the country.

The American production of goldfish in 1928 amounted to 21,500,000 fish, having a value to the breeders of about $942,000. This consisted of 17,000,000 common goldfish, valued at $573,000, and 4,500,000 fancy gold-fish, valued at $369,000. The breeders do not keep records of their production by sizes or individual varieties, so figures on this phase of the production could not be obtained. The value was arbitrarily based on the price received by the producers for the common and comet varieties.

At present there are about 770 acres of ponds in the United States devoted to the culture of goldfish. These ponds range in size from one-fourth acre to 10 acres. They are supplied with water from streams, springs, wells, and rain water. It costs from $50 to $1,000 an acre to build these ponds, depending upon the type of ground upon which they are constructed. The usual cost, however, is $150 to $200 per acre.

Most of the goldfish are shipped from September until the last of May. During the summer it is too warm to ship very many fish in each can and therefore the cost of shipping them is considerably higher. The fish are shipped in large galvanized cans that hold from 100 to 1,000 fish, depending upon their size, the distance to be shipped, and the weather.

Most of the goldfish to-day are handled by the 5-and-10-cent stores and by drug stores as an advertising feature. Pet shops in most of the large cities still carry them, however, and sell considerable numbers.

The full report of the survey is contained in Bureau of Fisheries Economic Circular No. 68, entitled "Goldfish Industry." This may be purchased from the Superintendent of Documents, Government Printing Office, Washington, D. C., for 5 cents.

PUBLICATIONS OF THE DIVISION

During the calendar year 1928 the following publications were prepared and issued by this division. The list does not include the monthly statistical bulletins of the landings of fish at Boston and Gloucester, Mass., Portland, Me., and Seattle, Wash., nor the monthly reports on cold-storage holdings of frozen fish. The documents may be purchased from the Superintendent of Documents, Government Printing Office, Washington, D. C., at the prices shown. The statistical bulletins are distributed free of charge upon request. Persons interested in securing the statistical bulletins as released may have their names placed on the bureau's mailing list upon request.

DOCUMENTS

Fishery Industries of the United States, 1926. By Oscar E. Sette. 8°, 147 pp. Document No. 1025. 25 cents.

Trade in fresh and frozen fishery products and related marketing considerations in Greater St. Louis, Mo. By R. H. Fiedler. 8°, 30 pp., 2 figs. Document No. 1026. 10 cents.

Containers and packages used in shipping shucked oysters. Results of a survey of shipping practices, with recommendations for improvements in the method now used. By Gerald A. Fitzgerald. 8°, 16 pp., 5 figs. Economic Circular No. 62. 5 cents.

Statistics of the catch of cod off the east coast of North America to 1926. By Oscar E. Sette. 8°, 12 pp., 1 fig. Document No. 1034. 5 cents.

Trade in fresh and frozen package fish products. By R. H. Fiedler. 8°, 12 pp., 1 fig. Economic Circular No. 63. 5 cents.

Trade in fresh and frozen fishery products and related marketing considerations in Jacksonville, Fla. By R. H. Fiedler. 8°, 26 pp., 2 figs. Document No. 1036. 10 cents.

Trade in fresh and frozen fishery products and related marketing considerations in Atlanta, Ga. By R. H. Fiedler. 8°, 18 pp. Document No. 1039. 5 cents.

STATISTICAL BULLETINS

Statement, by fishing grounds, of quantities and values of certain fishery products landed at Seattle, Wash., by American fishing vessels during the calendar year 1927. Statistical Bulletin No. 771.

Statement, by months, of quantities and values of certain fishery products landed at Boston and Gloucester, Mass., and Portland, Me., by American fishing vessels during the year 1927. Statistical Bulletin No. 772.

Statement, by fishing grounds, of quantities and values of certain fishery products landed at Boston and Gloucester, Mass., and Portland, Me., by American fishing vessels during the calendar year 1927. Statistical Bulletin No. 773.

Canned fishery products and by-products of the United States and Alaska, 1927. 14 pp. Statistical Bulletin No. 782.

Fisheries of New York, New Jersey, Pennsylvania, and Delaware, 1926. 7 pp. Statistical Bulletin No. 786.

Fisheries of Alaska, 1927. 4 pp. Statistical Bulletin No. 790.

Lake Fisheries, 1927. 3 pp. Statistical Bulletin No. 807.

Part 2. FISHERIES STATISTICS

REVIEW

According to the most recent statistics available, the fisheries of the United States and Alaska are in a sounder position than at any time in their history. They now employ nearly 127,000 commercial fishermen, and the annual catch amounts to nearly 3,000,000,000 pounds, valued at about $113,000,000. For transporting these products from the fishing grounds to market, or from port to port, over 4,000 persons are engaged aboard transporting vessels.

In 1928 the production of canned fishery products amounted to 617,328,000 pounds, valued at $95,872,000, and the output of by-products was valued at $14,881,000. Cold-storage holdings of fish averaged about 54,000,000 pounds monthly, while 113,638,000 pounds of fishery products were frozen. The production of fresh and frozen packaged fish amounted to 65,245,000 pounds, valued at $9,790,000. The production of goldfish was valued at about $1,000,000. Imports of fishery products were valued at $58,855,000, while exports were valued at $21,174,000. Compared with 1927, the value of canned fishery products and by-products was greater, more fish were frozen, larger quantities of packaged fish were produced, and the value of both imports and exports of fishery products was greater.

New England States.—The output of package fish in these States continued to increase rapidly, the production in 1928 being valued at over $9,000,000. To supply the demand for raw fish by the packers, more vessels fishing with otter trawls were added to the fleet, so that now 288 vessels of over 5 net tons are outfitted with this gear and operated from the three principal ports. Landings of fish at these ports by all vessels were larger in 1928 than in any year upon which there are records, and, also, the value was greater. The packaged-fish trade is now on a sounder basis, and methods used at the packing plants are being modernized. Larger quantities of packaged fish are being frozen, thereby making this product a more staple commodity of commerce. While Boston, Gloucester, and Portland continue to receive the greater portion of the landings of fish by vessels, larger quantities are being landed at other New England ports, especially at Vinal Haven, Me., and Groton, Conn. Sardine canning in Maine recovered from the slump of 1927 with a production valued at over $8,000,000.

Middle Atlantic States.—According to the latest general canvass of the fisheries of these States, made for 1926, the situation there is not encouraging. The production of many of the staple fish shows tremendous declines in 1926 under that for 1921. Notable examples of this are bluefish, which show a decline of 72 per cent; scup, 37 per cent; and squeteague or weakfish, 36 per cent.

New York City shared in the increases in the packaged-fish production, and landings of fresh fish by vessels in this area have increased accordingly. The menhaden industry recovered very slightly in 1928 from the previous year. The catch of shad in the Hudson River in 1928 was about three-fourths as large as the catch in 1927 and nearly equal to that made in 1926.

Chesapeake Bay States.—As the latest general canvass of the catch of fishery products for this region was made for 1925, no other later data are available on the general conditions of these States. However, an index may be obtained from statistics of the canning and by-products industries and certain other industries. The menhaden industry again suffered a poor year in 1928, the value of the products manufactured being one of the lowest on record. This situation should encourage those in this industry to improve methods in an effort to reduce overhead and to produce a high-grade product. The diversion of a greater amount of menhaden meal to feedstuffs should result in a better price for this product. To produce such a product would require but little additional expenditure in improving manufacturing methods.

In 1928 greater activity was evidenced in the alewife-canning industry, the value of the products being the highest on record. The oyster industry has regained its previous stride, although retail sales have not kept pace in some parts of the country. The crab industry recovered entirely from its previous poor years, and, according to reports of persons in the trade, the production was one of the largest on record. This section is rapidly becoming a factor in the production of packaged fish, especially packaged croaker and sea trout The catch of shad on the Potomac River in 1928 was larger than that made in any one of the past 27 years except 1922. The catch of alewife was larger than for any year since 1909 except 1924.

South Atlantic States.—According to the latest records the fisheries of these States have shown renewed activity, the production in 1927 exceeding that for 1923 by 14 per cent in quantity and 12 per cent in value. The fisheries of this region are confined largely to those along the shore, which are conducted by small operating units. For this reason the trade is confined chiefly to marketing primary products, except for canned shrimp and oysters. The production of canned shrimp in 1928 showed little change over the previous year, but there was a considerable gain in the production of oysters. A substantial gain in the output of menhaden products was registered in 1928.

Gulf States.—The fisheries of these States were more productive in 1927 than in any year upon which there are records since 1880, increasing 22 per cent in amount and 23 per cent in value, compared with the production in 1923. This was due chiefly to greater catches of shrimp and oysters. As with the South Atlantic States, the products of the fisheries here are marketed mainly fresh, except for canned shrimp and oysters. The production of canned shrimp in 1928 was considerably greater than in the previous year, although the market value did not increase correspondingly. The production of canned oysters in 1928 was but little different from the previous year. The quantity of sponges handled in the exchange in 1928 at Tarpon Springs, while above normal, varied but little from the amount handled in 1927.

Pacific Coast States.—Statistics for these States for 1927 reveal that the catch of fishery products that year was the largest on record, this being due mainly to greater catches of pilchard and tunalike fishes. In 1928 the pack of salmon was 44 per cent less than the previous year. This was due to smaller packs of pink and humpback salmon on Puget Sound, as 1928 was an "off" year. Compared with the previous "off" year—1926—there was an increase of about 1 per cent.

The pack of sardines was the largest on record in 1928, both in volume and value. The tuna-canning industry produced a smaller volume than in 1927, although the value was greater, being slightly under the highest value of any annual pack on record.

Unusual developments occurred in the mackerel-canning industry of California in 1928, the production being valued at about $2,000,000. In 1927 the production was so small that it was included in the statistics of other canned fish. Now mackerel is finding favor in the export trade with the Philippines.

The catch of the halibut fleet remained about the same in 1928 as in 1927, which was in excess of that for 1926; this in spite of the depleted condition of the fishery.

Lake fisheries.—The catch of fish by American fishermen in the lake fisheries in 1927 remained much the same as in the previous year, although there was a slight decline from the 10-year average. The average is being maintained by larger catches of some of the less favored species, while decreases are apparent in the catches of some of the choice species, such as the cisco of Lake Erie, which shows a decline of 81 per cent compared with the 10-year average. Increased catches were evidenced in every lake in 1927 over 1926, except in Lake Ontario, Lake Erie, and the international lakes.

Mississippi River and tributaries.—No recent general statistical canvass has been made for this section since 1922, and, therefore, recent developments can not be determined. A special canvass of the fisheries of Lakes Pepin and Keokuk for 1928 reveals a smaller catch, compared with that for 1927.

Alaska.—In 1928 the fishery industries in Alaska experienced one of the most productive seasons in history, producing fishery commodities valued at nearly $55,000,000. The salmon industry, always the most important, recovered entirely from the slump in 1927 and produced the third largest pack on record. The herring industry had a larger production than that for 1927, while the halibut industry produced less. The production of other products showed little variation when compared with the previous year.

Fisheries of the United States and Alaska

SUMMARY OF CATCH

[Expressed in thousands of pounds and thousands of dollars: that is, 000 omitted]

	New England, 1924		Middle Atlantic, 1926		Chesapeake, 1925		South Atlantic, 1927		Gulf, 1927	
Fish	365,475	$12,017	119,021	$4,648	241,221	$6,092	217,306	$3,758	89,447	$4,352
Shellfish, etc	41,248	6,795	48,991	7,808	91,985	7,856	43,363	1,938	110,625	5,815
Whale products	99	6								
Total	406,822	18,818	168,012	12,456	333,206	13,948	260,669	5,696	200,072	10,167

	Pacific, 1927		Mississippi River and tributaries, 1922		Lakes, 1927		Alaska, 1928		Total for the various years	
Fish	627,512	$20,341	53,466	$3,310	81,327	$6,795	688,576	$17,255	2,483,351	$78,568
Shellfish, etc	18,519	1,638	52,268	1,194	6,332	237	1,595	88	414,926	33,369
Whale products	5,166	327					8,835	454	14,100	787
Total	651,197	22,306	105,734	4,504	87,659	7,032	699,006	17,797	2,912,377	112,724

NOTE.—Catch of shellfish on the lakes is for 1922.

Fisheries of the United States and Alaska—Continued

OPERATING UNITS: BY DISTRICTS

	New England 1924	Middle Atlantic 1926	Chesapeake 1925	South Atlantic, 1927	Gulf, 1927 [1]
Fishermen:					
On vessels	4,736	4,364	3,800	1,229	2,268
On boats and shore	10,271	5,607	20,993	10,298	13,085
Total	15,007	9,971	24,793	11,527	15,353
Vessels:					
Steam	64	24	44	...	...
Net tonnage	6,149	3,038	5,010	...	...
Motor	536	492	134	117	377
Net tonnage	11,878	6,321	1,307	2,403	5,158
Sail	15	101	396	60	122
Net tonnage	505	1,821	4,523	489	2,555
Total vessels	615	617	574	177	499
Total net tonnage	18,532	11,180	10,840	2,892	7,713
Boats:					
Motor	5,227	2,112	8,314	3,084	4,416
Other	4,795	2,392	8,707	4,139	4,385
Apparatus:					
Haul seines	171	412	418	767	770
Purse seines	154	52	56	54	2
Otter trawls (including all types and sizes)	387	196	11	647	1,639
Gill nets	11,248	4,348	22,393	19,264	2,359
Trammel nets	...	...	...	4	687
Pound nets, trap nets, and weirs	770	650	3,712	2,781	3,837
Stop nets	...	84	9	...	241
Fyke nets	717	5,130	4,131	800	...
Bag nets and pocket nets	150	36	...	...	...
Other nets [4]	45	183	1,924	364	7,021
Hooks, snoods, or baits	(5)	(5)	(5)	190,784	250,847
Eel pots and traps	4,231	7,991	[7] 10,153	3,800	...
Lobster pots	256,662	28,900	...	...	...
Crab and crawfish pots, traps, drags, etc.	1,150	...	...	275	1,555
Clam dredges	222	...	...	...	2
Crab dredges	...	12	120	...	...
Mussel dredges	...	6	...	...	...
Oyster dredges	471	689	2,442	240	258
Scallop dredges and drags	3,089	1,357	685	808	...
Crabs scrapes	...	...	1,403	...	...
Tongs, rakes, hoes, forks, etc.	3,310	2,553	13,355	2,011	2,462
Sponge apparatus	...	...	...	...	291
Other apparatus [8]	(5)	(5)	97	1,001	350

[1] Includes the operating units used in the fisheries of Lake Okeechobee, Fla.
[4] Includes set nets, dip nets, scap nets, reef nets, and other minor nets.
[5] Number not determined.
[7] Includes a few pots fished for catfish in Virginia.
[8] Includes slat traps or baskets, machine traps, sluiceways and traps, harpoons, spears, grabs, and other minor apparatus not included under "Other nets."

Fisheries of the United States and Alaska—Continued

OPERATING UNITS: BY DISTRICTS—Continued

	Pacific, 1927	Mississippi River and tributaries, 1922	Lakes, 1927 [2]	Alaska, 1928	Total for the various years
Fishermen:					
On vessels	4,897		1,647	[3] 11,610	34,551
On boats and shore	15,617	12,310	4,178		92,359
Total	20,514	12,310	5,825	11,610	126,910
Vessels:					
Steam	6		145	7	290
Net tonnage	257		3,200	547	18,201
Motor	753		256	576	3,241
Net tonnage	12,341		2,752	10,794	52,954
Sail	8				702
Net tonnage	2,837				12,730
Total vessels	767		401	583	4,233
Total net tonnage	15,435		5,952	11,341	83,885
Boats:					
Motor	6,737	4,597	1,283	2,218	37,968
Other	1,049	10,941	1,085	4,667	42,160
Apparatus:					
Haul seines	236	708	247	145	3,874
Purse seines	309			684	1,311
Lampara nets	294				294
Otter trawls (including all types and sizes)					2,880
Beam trawls	52			8	60
Paranzella nets	14				14
Gill nets	5,631	866	105,732	3,877	175,718
Trammel nets	61	459			1,211
Pound nets, trap nets, and weirs	821	11	8,082	767	21,431
Stop nets					334
Fyke nets	816	49,652	2,373		63,619
Bag nets and pocket nets	89				275
Other nets [4]	341				9,878
Hooks, snoods, or baits	2,141,004	(5)	689,753	(6)	
Fish wheels	54			234	288
Eel pots and traps					26,175
Lobster pots					265,562
Shrimp nets and traps		4,360			4,360
Crab and crawfish pots, traps, drags, etc.	17,835		5,255	730	26,800
Clam dredges					224
Crab dredges					132
Mussel dredges					6
Oyster dredges					4,100
Scallop dredges and drags					5,939
Crab scrapes					1,403
Tongs, rakes, hoes, forks, etc.	3,060	1,810	244		28,805
Crowfoot bars (pairs)		3,490	311		3,801
Abalone outfits	16				16
Sponge apparatus					291
Other apparatus [7]	50	(5)	4		

[2] The crawfish pots, crowfoot bars, forks, etc., are for 1922.
[3] Includes persons in shore and boat fisheries.
[4] Includes set nets, dip nets, soap nets, reef nets, and other minor nets.
[5] Number not determined.
[6] There were 58,732 lines used. The number of hooks was not determined.
[7] Includes slat traps or baskets, machine traps, sluiceways and traps, harpoons, spears, grabs, and other minor apparatus not included under "Other nets."

NOTE.—Whaling apparatus, the number of which was not determined, was used in the Pacific and Alaska districts.

Fisheries of the United States and Alaska—Continued

CATCH: BY DISTRICTS

[Expressed in thousands of pounds and thousands of dollars; that is, 000 omitted]

Species	New England, 1924		Middle Atlantic, 1926		Chesapeake, 1925		South Atlantic, 1927		Gulf,[1] 1927	
FISH										
Albacore			35	$1						
Alewives	4,025	$53	2,495	47	25,611	$294	14,123	$149		
Amberjack							9	(3)	11	(3)
Angelfish and spadefish					4	(3)	24	1	54	$2
Barracuda									1	(3)
Black bass					93	15	235	31	514	45
Bluefish	82	21	922	216	215	27	1,637	147	703	55
Blue runner or hardtail							88	3	813	19
Bonito	18	2	598	46	304	17	15	(3)	40	1
Bowfin					25	1	28	1		
Buffalofish									25	
Butterfish	1,081	89	4,089	320	6,113	268	342	11	2	(3)
Cabio					3	(3)			9	(3)
Carp (German)	39	5	600	94	661	48	632	36		
Catfish and bullheads			221	19	1,009	58	2,402	92	3,409	162
Cero and kingfish							3,356	231	1,264	81
Cigarfish									311	9
Cod	89,218	3,076	4,874	233	17	(3)	1	(3)		
Crappie							376	28	654	21
Crevalle					701	25	210	7	98	3
Croaker			3,358	129	25,252	711	3,987	79	413	15
Cusk	4,227	81								
Drum, black			35	1	253	4	98	4	1,790	57
Drum, red			18	(3)	130	2	270	13	2,872	238
Eels	858	88	823	104	447	53	160	12		
Flounders	30,855	1,339	10,520	609	700	46	385	25	350	31
Garfish							3	(3)		
Gizzard shad					381	10	60	1		
Goldfish					3	(3)				
Grayfish	22	(3)	7	(3)						
Groupers							86	4	4,723	148
Grunts							35	2	81	3
Haddock	93,519	2,657	17,023	597	2	(3)				
Hake	18,499	307	627	16	12	(3)				
Halibut	4,501	789	10	4						
Harvestfish					46	2	937	29		
Herring, sea	60,236	662	238	7						
Hickory shad	21	1	19	1	256	12	605	41		
Hog-choker					24	1				
Hogfish							3	(3)	30	1
Jewfish							17	(3)	314	10
King whiting			101	16	126	9	718	44	138	6
Ladyfish									176	5
Mackerel	26,653	1,519	2,946	196	21	2				
Menhaden	7,536	79	39,891	162	150,493	1,435	157,965	689	13,466	61
Moonfish							4	(3)	1	(3)
Mullet and mullet roe			29	2	137	9	11,377	523	29,392	1,221
Mummichog			9	1						
Muttonfish							129	7	32	3
Paddlefish and paddlefish roe									6	(3)
Perch, white			198	24	1,057	95	505	41		
Perch, yellow			64	9	311	33	118	7		
Permit							9	(3)	52	2
Pigfish					142	8	303	8	36	1
Pike (jacks) and pickerel			1	(3)	89	20	22	3		
Pilotfish			4	(3)					7	(3)
Pinfish					1	(3)	330	10	16	1
Pollock	8,295	221	126	6						
Pompano			1	(3)	5	1	238	47	455	89
Porgies									96	4
Porkfish									12	1
Salmon: Atlantic	13	4								
Scup	1,352	70	3,504	221	447	31	16	1		
Sea bass	82	8	2,370	205	106	8	520	44	51	5
Sea gar									10	1
Sea robin			53	1	50	(3)				
Shad	516	38	952	234	7,364	1,637	3,104	621		
Sharks	51	2	64	2	17	1	8	(3)	1,200	9
Sheepshead (salt-water)					(3)	(3)	77	4	1,101	64

[1] Includes the catch of fish taken in Lake Okeechobee, Fla.
[3] Less than 500 pounds or dollars.

Fisheries of the United States and Alaska—Continued

CATCH: BY DISTRICTS—Continued

[Expressed in thousands of pounds and thousands of dollars; that is, 000 omitted]

Species	New England, 1924		Middle Atlantic, 1926		Chesapeake, 1925		South Atlantic, 1927		Gulf,[1] 1927	
FISH										
Silversides			63	$5						
Skates	55	$1	88	3	24	(3)	1	(3)		
Smelt	688	153	(3)	(3)						
Snapper, mangrove							41	$2	187	$7
Snapper, red							124	12	11,899	974
Snook							226	11	471	18
Spanish mackerel			14	2	128	$17	2,122	171	4,772	339
Spot			1,758	108	1,977	100	2,597	67	254	10
Squeteague	102	14	9,401	601	13,925	669	5,474	360	5,829	580
Striped bass	71	14	197	48	2,235	392	745	121		
Sturgeon and sturgeon roe	11	3	23	8	93	28	43	6	24	6
Sucker	273	23	194	28	8	(3)	17	1		
Sunfish					8	(3)	329	10	932	31
Swellfish			13	(3)	35	(3)				
Swordfish	2,882	528	61	11						
Tang									1	(3)
Tautog	395	34	82	7	3	(3)				
Ten pounder									2	(3)
Thimble-eyed mackerel			122	5	19	1				
Tilefish	238	17	1,802	111						
Tomcod and tomcod roe	81	1	58	3	18	(3)				
Tripletail					(3)	(3)	1	(3)	179	5
Tuna	232	12	144	12					1	(3)
Turbot									1	(3)
Whitebait			18	1						
Whiting	8,123	85	7,521	156	114	2				
Yellowtail							19	1	167	7
Miscellaneous fish	625	21	637	16	6	(3)			(3)	(3)
Total	365,475	12,017	119,021	4,648	241,221	6,092	217,306	3,758	89,447	4,352
SHELLFISH, ETC.										
Clams:										
Hard	1,679	505	1,277	626	1,190	469	372	79	954	42
Cockle	13	5								
Surf or skimmers			59	15						
Soft	6,259	557	409	81						
Razor	23	3								
Conchs									5	(3)
Crabs:										
Stone							6	1	58	10
Soft			163	48	3,748	422	269	44	145	50
Hard	1,976	62	231	14	25,853	827	1,146	34	3,682	124
King			2,888	13						
Sand	10	(3)								
Crawfish					(3)	(3)				
Lobsters:										
Common	9,716	3,072	1,119	331						
Spiny							261	21	131	11
Mussels			257	11						
Octopus							2	(3)		
Oysters: Eastern	11,302	2,070	39,511	6,171	60,264	6,022	10,447	458	36,013	2,169
Periwinkles	3	1								
Scallops:										
Sea	339	104	1,115	284						
Bay	929	304	300	92	361	74	835	120	13	5
Shrimp	5	3	43	4	1	(3)	29,992	1,173	68,877	2,344
Squid	3,075	76	1,576	100	464	26	2	(3)		
Frogs			2	(3)						
Sponges									600	1,035
Terrapin			1	1	10	6	20	8	88	21
Turtles			28	3	4	(3)	11	(3)	59	4
Miscellaneous shellfish, etc.	5,919	33	12	14	100	10				
Total	41,248	6,795	48,991	7,808	91,985	7,856	43,363	1,938	110,625	5,815
WHALE PRODUCTS[4]										
Oil, sperm	99	6								
Grand total	406,822	18,818	168,012	12,456	333,206	13,948	260,669	5,696	200,072	10,167

[1] Includes the catch of fish taken in Lake Okeechobee, Fla.
[3] Less than 500 pounds or dollars.
[4] The weight of the whales caught was not determined; therefore, the weight of the manufactured products is shown.

Fisheries of the United States and Alaska—Continued

CATCH: BY DISTRICTS—Continued

[Expressed in thousands of pounds and thousands of dollars; that is, 000 omitted]

Species	Pacific, 1927		Mississippi River and tributaries, 1922		Lakes, 1927		Alaska, 1928		Total for the various years	
FISH										
Albacore	4,579	$517							4,614	$518
Alewives									46,254	543
Amberjack									20	(3)
Anchovies	368	4							368	4
Angelfish and spadefish									82	3
Barracuda	6,200	596							6,201	596
Black bass			74	$11					916	102
Bluefish									3,559	466
Blue pike					7,324	$561			7,324	561
Blue runner or hardtail									901	22
Bonito	1,717	50							2,692	116
Bowfin			190	6					243	8
Buffalofish			17,267	1,014					17,292	1,015
Butterfish									11,627	688
Burbot					511	20			511	20
Cabio									12	(3)
Carp (German)	1,053	31	18,338	872	3,669	163			24,992	1,249
Catfish and bullheads	371	56	8,093	713	815	80			16,320	1,180
Cero and kingfish									4,620	312
Chubs					6,616	597			6,616	597
Chubs (tullibee)					662	31			662	31
Cigarfish									311	9
Cisco					2,350	289			2,350	289
Cod	5,355	305					1,905	$10	101,370	3,624
Crappie			512	49					1,542	98
Crevalle									1,009	35
Croaker									33,010	934
Cusk									4,227	81
Dolly Varden trout							46	5	46	5
Drum, black									2,176	66
Drum, red									3,290	253
Eels	(3)	(3)	16	1					2,304	258
Flounders	13,391	742					1	(3)	56,202	2,792
Garfish									3	(3)
Gizzard shad									441	11
Goldfish									3	(3)
Grayfish	415	6							444	6
Groupers									4,809	152
Grunts									116	5
Haddock									110,544	3,254
Hake	85	2							19,223	325
Halibut	11,655	1,557					35,074	3,094	51,240	5,444
Hardhead	33	3							33	3
Harvestfish									963	31
Herring, lake					22,177	763			22,177	763
Herring, sea	2,034	32					134,020	1,340	196,528	2,041
Hickory shad									901	55
Hog-choker									24	1
Hogfish									33	1
Horse mackerel	467	18							467	18
Jewfish									331	10
Kingfish (California)	529	16							529	16
King whiting									1,083	75
Ladyfish									176	5
Lake trout					10,493	1,720			10,493	1,720
Lingcod	1,640	65					13	(3)	1,653	65
Mackerel	4,741	121							34,361	1,838
Menhaden									369,351	2,426
Moon-eye			3	(3)					3	(3)
Moonfish									5	(3)
Mullet and mullet roe	40	4							40,975	1,759
Mummichog									9	1
Muttonfish									161	10
Paddlefish and paddlefish roe			1,411	163					1,417	163
Perch, white	323	17							2,083	177
Perch, yellow			22	2	4,995	349			5,510	400
Permit									61	2
Pigfish									481	17
Pike (jacks) and pickerel			20	2	398	25			530	50
Pilchard	342,275	1,827							342,275	1,827
Pilotfish									11	(3)
Pinfish									347	11
Pollock									8,421	227

[3] Less than 500 pounds or dollars.

Fisheries of the United States and Alaska—Continued

CATCH: BY DISTRICTS—Continued

[Expressed in thousands of pounds and thousands of dollars; that is, 000 omitted]

Species	Pacific, 1927		Mississippi River and tributaries, 1922		Lakes, 1927		Alaska, 1928		Total for the various years	
FISH										
Pompano	55	$6							754	$143
Porgies									96	4
Porkfish									12	1
Quillback			765	$59					765	59
Rock bass	526	37	3	(1)					529	37
Rockfishes	6,898	315					4	(1)	6,902	315
Sablefish	4,113	242					387	$12	4,500	254
Salmon:										
Atlantic									13	4
Pacific—										
King, chinook, or spring	44,883	5,098					13,131	463	58,014	5,561
Red or sockeye	8,050	1,129					192,812	4,977	200,862	6,106
Coho or silver	22,665	1,699					29,852	724	52,517	2,423
Humpback or pink	41,370	1,363					190,075	4,952	231,445	6,315
Chum or keta	14,825	404					91,199	1,674	106,024	2,078
Sauger pike			5	1	1,246	$98			1,251	99
Sculpin	114	10							114	10
Scup									5,319	323
Sea bass	468	21							8,597	291
Sea bass, white (California)	2,278	218							2,278	218
Sea gar									10	1
Sea robin									103	1
Shad	5,945	176							17,881	2,706
Sharks									1,340	14
Sheepshead (salt-water)									1,178	68
Sheepshead (fresh-water)			5,261	290	4,361	95			9,622	385
Sheepshead (Pacific coast)	159	6							159	6
Silversides									68	5
Skates	264	5							432	9
Skipjack	33,808	1,261							33,808	1,261
Smelt	2,718	90					32	2	3,433	245
Snapper, mangrove									228	9
Snapper, red									12,023	966
Snook									697	29
Spanish mackerel									7,086	529
Splittail	11	1							11	1
Spot									6,586	285
Squawfish	8	1							8	1
Squeteague									34,731	2,224
Steelhead trout	4,363	312					25	2	4,388	314
Striped bass	649	92							3,897	667
Sturgeon and sturgeon roe	215	18	11	1	41	17			461	82
Sturgeon, shovel-nosed			229	23					229	23
Sucker	1	(1)	700	68	4,765	298			5,958	418
Sunfish			375	25					1,644	66
Swellfish									48	(1)
Swordfish	130	12							3,078	551
Tang									1	(1)
Tautog									480	41
Ten pounder									2	(1)
Thimble-eyed mackerel									141	6
Tilefish									2,040	128
Tomcod and tomcod roe	1	(1)							158	4
Tripletail									180	5
Tuna	4,898	312							5,275	336
Turbot									1	(1)
White bass			65	5	126	13			191	18
Whitebait	134	11							152	12
Whitefish	313	28			5,463	1,011			5,776	1,039
Whiting									15,758	243
Yellow bass			8	1					8	1
Yellow pike			25	4	3,025	540			3,050	544
Yellowfin tuna	25,934	1,304							25,934	1,304
Yellowtail	4,225	195							4,411	208
Miscellaneous fish	230	11	73	5	2,290	125			8,861	178
Total	627,512	20,341	53,466	3,310	81,327	6,795	688,576	17,255	2,483,851	78,568

[1] Less than 500 pounds or dollars.

Fisheries of the United States and Alaska—Continued

CATCH: BY DISTRICTS—Continued

[Expressed in thousands of pounds and thousands of dollars; that is, 000 omitted]

Species	Pacific, 1927		Mississippi River and tributaries, 1922		Lakes,[3] 1927		Alaska, 1928		Total for the various years	
SHELLFISH, ETC.										
Abalone	563	$113							563	$113
Clams:										
Hard	250	37							5,722	1,758
Cockle	1	1							14	6
Surf or skimmers									59	15
Soft	25	13							6,693	651
Razor	2,023	309					367	$21	2,413	333
Pismo	33	15							33	15
Mixed	28	12							28	12
Conchs									5	(2)
Crabs:										
Stone									64	11
Soft									4,325	564
Hard	5,271	378					311	26	38,470	1,465
King									2,888	13
Sand									10	(2)
Crawfish	138	17	8	$1	82	$3			228	21
Lobsters:										
Common									10,835	3,403
Spiny	1,491	276							1,883	308
Mussels	3	(2)							260	11
Mussel shells, fresh-water			51,768	1,051	6,246	218			58,014	1,269
Octopus	139	10							141	10
Oysters:										
Eastern	169	77							157,706	16,967
Western	619	287							619	287
Pearls				46		9				55
Periwinkles									3	1
Scallops:										
Sea									1,454	388
Bay	11	3							2,449	598
Shrimp	1,736	34	147	15			917	41	101,718	3,614
Slugs				55		7				62
Squid	6,014	56							11,121	258
Frogs			232	20					234	20
Sponges									600	1,035
Terrapin									119	36
Turtles			97	3	1	(2)			200	10
Miscellaneous shellfish, etc.	5	(2)	16	3	3	(2)			6,055	60
Total	18,519	1,638	52,268	1,194	6,332	237	1,595	88	414,926	33,369
WHALE PRODUCTS [4]										
Oil, sperm							703	37	802	43
Oil, whale	5,166	327					5,480	343	10,646	670
Whale meal and scrap							2,652	74	2,652	74
Total	5,166	327					8,835	454	14,100	787
Grand total	651,197	22,306	105,734	4,504	87,659	7,032	699,006	17,797	2,912,377	112,724

[3] Figures are for 1927, except those for shellfish, etc., which are for 1922.
[2] Less than 500 pounds or dollars.
[4] The weight of the whales caught was not determined; therefore, the weight of the manufactured products is shown.

Fisheries of the United States and Alaska—Continued

CATCH: BY STATES [1]

[Expressed in thousands of pounds and thousands of dollars; that is, 000 omitted]

State	Marine and coastal rivers		Mississippi River and tributaries		Lakes [2]		Total	
Alabama	10,076	$437	1,243	$28			11,319	$465
Arkansas			22,795	760			22,795	760
California	491,347	10,059					491,347	10,059
Connecticut	25,770	2,007					25,770	2,007
Delaware	33,258	1,030					33,258	1,030
Florida	134,057	6,222			4,366	$201	138,423	6,423
Georgia	47,607	697					47,607	697
Illinois			22,598	1,079	388	58	22,986	1,137
Indiana			12,577	437	1,197	126	13,774	563
Iowa			6,761	326			6,761	326
Kansas			615	26			615	26
Kentucky			2,893	167			2,893	167
Louisiana	56,208	2,863	10,486	573			66,694	3,436
Maine	116,707	4,137					116,707	4,137
Maryland	56,978	4,863					56,978	4,863
Massachusetts	243,363	10,801					243,363	10,801
Michigan					37,328	3,273	37,328	3,273
Minnesota			5,660	230	12,167	584	17,827	814
Mississippi	34,503	1,259	3,328	191			37,831	1,450
Missouri			1,566	104			1,566	104
Nebraska			135	15			135	15
New Hampshire	447	56					447	56
New Jersey	73,299	6,254					73,299	6,254
New York	60,721	5,129			2,020	258	62,741	5,387
North Carolina	144,466	2,777					144,466	2,777
Ohio			702	30	17,629	1,090	18,331	1,120
Oklahoma			363	31			363	31
Oregon	34,195	3,103					34,195	3,103
Pennsylvania	735	43	49	2	4,408	512	5,192	557
Rhode Island	20,535	1,819					20,535	1,819
South Carolina	8,374	350					8,374	350
South Dakota			101	4			101	4
Tennessee			5,494	188			5,494	188
Texas	21,083	1,054	184	19			21,267	1,073
Virginia	276,228	9,085					276,228	9,085
Washington	125,655	9,146					125,655	9,146
West Virginia			95	8			95	8
Wisconsin			8,089	286	12,522	1,130	20,611	1,416
Alaska	699,006	17,797					699,006	17,797
Total	2,714,618	100,988	105,734	4,504	92,025	7,232	2,912,377	112,724

TRANSPORTING UNITS: BY DISTRICTS

Items	New England, 1924	Middle Atlantic, 1926	Chesapeake, 1925	South Atlantic, 1927	Gulf, 1927	Pacific, 1922	Mississippi River and tributaries, 1922	Lakes, 1922	Alaska, 1928	Total for the various years
Persons engaged	278	89	985	208	136	474	30	162	1,755	4,117
Vessels:										
Steam	3	1	1			5		6	27	43
Net tonnage	59	36	76			138		126	30,343	30,778
Motor	154	62	433	75	63	148	13	97	441	1,486
Net tonnage	1,831	924	5,180	822	795	2,301	214	831	13,551	26,449
Sail	5		89	40	5	5			5	149
Net tonnage	437		2,907	369	77	1,235			10,214	15,239
Barges						14			1	15
Net tonnage						989			225	1,214
Total vessels	162	63	523	115	68	172	13	103	474	1,693
Total net tonnage	2,327	960	8,163	1,191	872	4,663	214	957	54,333	73,680

[1] Statistics for the New England States are for 1924; Middle Atlantic States, 1926; Chesapeake Bay States, 1925; South Atlantic and Gulf States, 1927; Pacific Coast States, 1927; Mississippi River and tributaries, 1922; Lake States, 1927, except that the fisheries for shellfish, etc., are for 1922; and Alaska, 1928.

[2] Includes Lake Ontario, Lake Erie, Lake Huron, Lake Michigan, Lake Superior, Rainy Lake, Namakan Lake, Lake of the Woods, Lake Okeechobee, and several mussel streams tributary to Lakes Erie and Michigan.

CANNED FISHERY PRODUCTS AND BY-PRODUCTS

The output of canned fishery products and by-products in the United States and Alaska in 1928 was valued at $110,752,811, which was greater than for any year for which there are records. Larger packs were reported for almost every commodity. Of the total, canned products comprised $95,871,855 and by-products $14,880,956, an increase of 18 per cent in the value of canned products and 16 per cent in the value of by-products, when compared with the respective values of the previous year.

Fishery products were canned at 481 establishments in the United States and Alaska in 1928. The combined output of these canneries amounted to 15,629,980 standard cases. The net weight of the products canned amounted to 617,327,527 pounds.

Canned fishery products and by-products were prepared in 24 States and Alaska in 1928. Alaska ranked first in value of these products, accounting for 43 per cent of the total. Salmon was the leading product canned there. California, with her important sardine and tuna canning industries, ranked second with 22 per cent of the total value; while Maine, where canned sardines are the most important commodity, ranked third with 9 per cent of the total value. Considering the output by geographical sections, the Pacific coast and Alaska accounted for 74 per cent of the total value of canned products and by-products.

Canned fishery products and by-products of the United States and Alaska, 1928

SUMMARY OF PRODUCTION: BY COMMODITIES

Products	Number of plants	Standard cases	Pounds	Value
Canned products:				
Salmon—				
United States	54	842,903	40,459,344	$9,254,258
Alaska	153	6,083,903	292,027,344	45,383,885
Sardines—				
Maine	38	2,055,763	51,894,075	8,076,546
California	28	2,771,527	133,033,296	9,658,822
Tuna and tunalike fishes	16	1,216,222	29,189,328	8,374,030
Mackerel	22	398,903	19,147,344	1,714,020
Alewives	28	50,674	2,432,352	150,878
Alewife roe	28	56,392	2,706,816	288,592
Shad	18	23,447	1,125,456	110,006
Shad roe	17	4,130	198,240	123,840
Miscellaneous fish, caviar, roe, and eggs	38	228,103	10,948,944	1,997,732
Oysters	62	503,952	7,559,280	2,760,576
Clam products	54	531,640	[1] 12,746,700	2,623,598
Shrimp	71	851,831	13,350,688	5,181,547
Crabs	3	1,624	77,952	44,536
Miscellaneous shellfish	9	8,966	430,368	128,989
Total	[2] 481	15,629,980	617,327,527	95,871,855

		Quantity	Value
By-products:			
Shell products	tons	306,013	$2,459,424
Scrap, meal and bran	do	104,519	5,382,143
Fish and whale oils	gallons	12,145,577	5,149,618
Miscellaneous by-products			1,889,771
Total			14,880,956
Grand total			110,752,811

[1] "Cutout" or "drained" weights of can contents are included for whole and minced clams and gross can contents for chowder, soup, bouillon, broth, and juice.
[2] Exclusive of duplication.

Canned fishery products and by-products of the United States and Alaska, 1928—Continued

VALUE OF PRODUCTION: BY STATES

State	Canned products	By-products (including menhaden)	Total
Maine	$9,030,205	$387,351	$9,417,556
Massachusetts	1,452,031	1,805,103	3,257,134
Rhode Island, Connecticut, New York, New Jersey, Indiana, Wisconsin, and Minnesota	992,525	571,694	1,564,219
Pennsylvania and Delaware		423,964	423,964
Maryland	402,581	445,509	848,090
Virginia	300,744	1,600,005	1,900,749
North Carolina	158,483	927,039	1,085,522
South Carolina	839,623	85,125	924,748
Georgia and Florida	1,555,759	911,280	2,467,039
Alabama	577,408	43,149	620,557
Mississippi	1,746,261	132,859	1,879,120
Louisiana	2,754,112	1,202,091	3,956,203
Texas	304,486	25,522	330,008
Washington	6,008,603	65,970	6,074,573
Oregon	4,371,591	43,815	4,415,406
California	19,878,945	4,022,642	23,901,587
Alaska	45,498,498	2,187,838	47,686,336
Total	95,871,855	14,880,956	110,752,811

Value of canned fishery products and by-products of the United States and Alaska, 1921 to 1928

Year	Canned products	By-products (including menhaden)	Total
1921	$46,634,706	$8,351,827	$54,986,533
1922	60,464,947	11,390,693	71,855,640
1923	72,445,205	12,634,590	85,079,795
1924	72,164,589	10,308,990	82,473,579
1925	80,577,138	14,600,198	95,177,836
1926	86,193,240	12,133,110	98,326,350
1927	81,384,133	12,793,256	94,177,389
1928	95,871,855	14,880,956	110,752,811

CANNED PRODUCTS

The value of fishery products canned in 1928 was 18 per cent greater than in the previous year. Salmon was the most important item and contributed 57 per cent of the total value; sardines were next, with 18 per cent; and tuna followed, with 9 per cent. The remainder of the total value was made up mainly by shrimp, oysters, and clam products.

Value of canned fishery products, 1921 to 1928

Year	Salmon	Sardine	Tuna	Oyster	Shrimp	Clam	Other	Total
1921	$28,867,169	$6,307,362	$3,074,626	$2,179,271	$3,804,781	$1,166,507	$1,234,990	$46,634,706
1922	38,420,717	9,111,589	4,511,873	2,423,616	3,064,087	1,716,365	1,216,700	60,464,947
1923	45,533,573	9,896,796	6,914,760	2,720,073	4,381,534	1,710,616	1,287,853	72,445,205
1924	42,401,602	12,636,599	5,756,586	2,478,044	4,608,950	2,161,389	2,121,419	72,164,589
1925	47,869,507	13,097,318	8,499,080	3,721,159	3,782,819	1,850,378	2,256,877	80,577,138
1926	56,219,806	14,534,792	5,282,283	2,026,569	4,122,092	2,004,650	2,003,548	86,193,240
1927	45,728,761	14,517,814	8,368,227	2,367,949	5,321,652	2,744,954	2,334,776	81,384,133
1928	54,638,143	17,785,368	8,374,030	2,760,576	5,181,547	2,623,598	4,558,593	95,871,855

Salmon.—In 1928 salmon were canned at 153 plants in Alaska, 35 in Washington, 17 in Oregon, and 2 in California. Compared with the previous year, there was an increase of 18 plants in Alaska and a decrease of 5 in Washington, 2 in Oregon, and 3 in California. The combined output of the 207 plants amounted to 6,926,806 standard cases of forty-eight 1-pound cans, valued at $54,638,143. Of the total, 842,903 cases, valued at $9,254,258, were packed in the Pacific Coast States and 6,083,903 cases, valued at $45,383,885, in Alaska. The pack for the Pacific Coast States was 44 per cent less than a year ago, due mainly to the smaller pack in Puget Sound of humpback or pink salmon, as 1928 was the "off year." Compared with 1926, the previous "off year," there was an increase of 1 per cent in the pack. The pack in Alaska was 70 per cent greater than in the previous year and was occasioned by larger packs of virtually every species.

The world pack of canned salmon in 1928 amounted to 10,654,781 cases, which was an increase of 44 per cent over that of the previous year. Of the total, 6,926,806 cases, or 65 per cent, were packed in the United States and Alaska; 2,035,637 cases, or 19 per cent, in British Columbia; 1,472,969 cases in Siberia; and 219,369 cases (estimated) in Japan. Compared with 1927, there was an increase of 36 per cent in the pack in the United States and Alaska, 50 per cent in British Columbia, and 80 per cent in Siberia.

Pack of canned salmon, Pacific Coast States and Alaska, 1928, standard cases

Products	Alaska							
	Southeastern		Central		Western		Total	
	Cases	*Value*	*Cases*	*Value*	*Cases*	*Value*	*Cases*	*Value*
King, chinook, or spring:								
1-pound tall	2,301	$17,895	12,203	$97,976	13,019	$103,062	27,523	$218,933
1-pound flat	2,465	25,074	11,807	163,026	582	7,756	14,854	195,856
½-pound flat	756	10,636	11,026	177,383			11,782	188,019
Total	5,522	53,605	35,036	438,385	13,601	110,818	54,159	602,808
Red or sockeye:								
1-pound tall	65,326	606,538	331,083	3,032,788	1,375,522	12,468,807	1,771,931	16,108,133
1-pound flat	15,071	168,300	58,661	664,864	13,368	129,986	87,100	968,150
½-pound flat	26,401	361,576	40,828	592,858	21,834	308,075	89,063	1,262,509
Total	106,798	1,136,414	430,572	4,290,510	1,410,724	12,906,868	1,948,094	18,333,792
Coho or silver:								
1-pound tall	130,249	918,275	148,543	1,025,447	493	3,436	279,285	1,947,158
1-pound flat	5,840	44,864					5,840	44,864
½-pound flat	9,681	93,095	3,817	40,172			13,498	133,267
Total	145,770	1,056,234	152,360	1,065,619	493	3,436	298,623	2,125,289
Humpback or pink:								
1-pound tall	2,099,684	13,681,839	639,822	4,210,523	1,074	6,685	2,740,580	17,899,047
1-pound flat	6,189	43,051					6,189	43,051
½-pound flat	36,965	312,561	3,508	30,871			40,473	343,432
Total	2,142,838	14,037,451	643,330	4,241,394	1,074	6,685	2,787,242	18,285,530
Chum or keta:								
1-pound tall	565,252	3,261,527	377,763	2,445,373	47,709	289,936	990,724	5,996,836
1-pound flat	4	20					4	20
½-pound flat	4,963	38,834	94	776			5,057	39,610
Total	570,219	3,300,381	377,857	2,446,149	47,709	289,936	995,785	6,036,466
Grand total	2,971,147	19,584,085	1,639,155	12,482,057	1,473,601	13,317,743	6,083,903	45,383,885

Pack of canned salmon, Pacific Coast States and Alaska, 1928, standard cases—Con.

Products	United States						Grand total, Alaska and United States	
	Washington		Oregon and California		Total			
	Cases	*Value*	*Cases*	*Value*	*Cases*	*Value*	*Cases*	*Value*
King, chinook, or spring:								
1-pound tall	13, 358	$109, 196	6, 955	$50, 035	20, 313	$159, 231	47, 836	$378, 164
1-pound oval	1, 614	37, 122	3, 338	76, 774	4, 952	113, 896	4, 952	113, 896
1-pound flat	19, 836	280, 929	47, 614	702, 895	67, 450	983, 824	82, 304	1, 179, 680
½-pound oval	219	4, 993	491	11, 195	710	16, 188	710	16, 188
½-pound flat	75, 580	1, 315, 796	113, 862	2, 056, 431	189, 442	3, 372, 227	201, 224	3, 560, 246
Total	110, 607	1, 748, 036	172, 260	2, 897, 330	282, 867	4, 645, 366	337, 026	5, 248, 174
Red or sockeye:								
1-pound tall	823	7, 736			823	7, 736	1, 772, 754	16, 115, 869
1-pound flat	15, 005	189, 063			15, 005	189, 063	102, 105	1, 152, 213
½-pound flat	54, 460	818, 374	2, 916	60, 653	57, 376	879, 027	146, 439	2, 141, 536
Total	70, 288	1, 015, 173	2, 916	60, 653	73, 204	1, 075, 826	2, 021, 298	19, 409, 618
Coho or silver:								
1-pound tall	40, 085	280, 595	2, 743	19, 138	42, 828	299, 733	322, 113	2, 246, 891
1-pound flat	35, 231	281, 848	13, 982	111, 856	49, 213	393, 704	55, 053	438, 568
½-pound flat	34, 708	374, 846	[1] 25, 388	276, 513	60, 096	651, 359	73, 594	784, 626
Total	110, 024	937, 289	42, 113	407, 507	152, 137	1, 344, 796	450, 760	3, 470, 085
Humpback or pink:								
1-pound tall	3, 716	24, 526			3, 716	24, 526	2, 744, 296	17, 923, 573
1-pound flat	28	196			28	196	6, 217	43, 247
½-pound flat	2, 357	20, 742			2, 357	20, 742	42, 830	364, 174
Total	6, 101	45, 464			6, 101	45, 464	2, 793, 343	18, 330, 994
Chum or keta:								
1-pound tall	177, 820	1, 060, 476	85, 405	478, 268	263, 225	1, 538, 744	1, 253, 949	7, 535, 580
1-pound flat	79	521	10, 222	67, 465	10, 301	67, 986	10, 305	68, 006
½-pound flat	15, 448	117, 404	20, 562	156, 271	36, 010	273, 675	41, 067	313, 285
Total	193, 347	1, 178, 401	116, 189	702, 004	309, 536	1, 880, 405	1, 305, 321	7, 916, 871
Steelhead:								
1-pound tall	13	109			13	109	13	109
1-pound oval	103	1, 442	21	294	124	1, 736	124	1, 736
1-pound flat	1, 276	14, 036	3, 282	36, 102	4, 558	50, 138	4, 558	50, 138
½-pound oval	1, 268	22, 824	1, 066	19, 188	2, 334	42, 012	2, 334	42, 012
½-pound flat	4, 373	61, 222	7, 656	107, 184	14, 029	168, 406	12, 029	168, 406
Total	7, 033	99, 633	12, 025	162, 768	19, 058	262, 401	19, 058	262, 401
Grand total	497, 400	5, 023, 996	345, 503	4, 230, 262	842, 903	9, 254, 258	6, 926, 806	54, 638, 143

[1] Includes a few cases packed in quarter-pound cans.

NOTE.—"Standard cases" represent the various sized cases converted to the equivalent of forty-eight 1-pound cans to the case.

Pack of canned salmon in the Pacific Coast States, 1921 to 1928

Year	King, chinook, or spring		Red or sockeye		Coho or silver		Humpback or pink	
	Cases	*Value*	*Cases*	*Value*	*Cases*	*Value*	*Cases*	*Value*
1921	335, 854	$4, 527, 711	104, 954	$1, 905, 647	111, 643	$806, 678	402, 846	$1, 732, 847
1922	314, 126	4, 572, 607	97, 927	1, 816, 901	204, 252	1, 583, 173	3, 551	18, 546
1923	384, 705	5, 790, 419	105, 836	1, 955, 549	245, 548	1, 608, 627	445, 175	2, 211, 742
1924	349, 014	4, 599, 759	85, 800	1, 478, 698	231, 139	1, 774, 078	12, 778	79, 436
1925	432, 638	5, 990, 019	118, 387	2, 065, 975	307, 567	3, 313, 060	551, 375	3, 152, 342
1926	349, 600	5, 281, 404	75, 711	1, 474, 722	228, 141	2, 228, 499	2, 608	19, 609
1927	405, 319	6, 192, 368	123, 826	2, 170, 385	210, 537	2, 212, 763	586, 598	3, 865, 797
1928	282, 867	4, 645, 366	73, 204	1, 075, 826	152, 137	1, 344, 796	6, 101	45, 464

Year	Chum or keta		Steelhead		Total	
	Cases	*Value*	*Cases*	*Value*	*Cases*	*Value*
1921	85, 132	$127, 659	12, 519	$133, 883	1, 002, 948	$9, 234, 425
1922	87, 583	365, 303	25, 797	326, 994	733, 246	8, 633, 524
1923	154, 342	769, 839	32, 157	324, 390	1, 367, 263	12, 660, 566
1924	247, 858	1, 192, 156	32, 073	270, 340	958, 662	9, 394, 467
1925	133, 368	641, 310	15, 278	217, 270	1, 558, 613	15, 379, 976
1926	148, 732	758, 843	30, 946	381, 225	835, 738	10, 139, 302
1927	145, 356	852, 120	32, 815	419, 064	1, 504, 451	15, 712, 497
1928	309, 536	1, 880, 405	19, 058	262, 401	842, 903	9, 254, 258

NOTE.—Shown in standard cases of forty-eight 1-pound cans.

Pack of canned salmon in Alaska, 1921 to 1928

Year	King, chinook, or spring		Red or sockeye		Coho or silver	
	Cases	*Value*	*Cases*	*Value*	*Cases*	*Value*
1921	44, 994	$459, 897	1, 765, 798	$15, 841, 404	106, 555	$600, 140
1922	30, 660	247, 673	2, 070, 658	19, 135, 696	175, 993	962, 790
1923	38, 343	328, 270	1, 859, 496	17, 253, 792	164, 107	943, 318
1924	33, 648	299, 009	1, 447, 895	13, 803, 932	183, 601	1, 254, 551
1925	49, 978	595, 041	1, 069, 676	13, 904, 599	161, 010	1, 565, 759
1926	52, 476	544, 246	2, 157, 087	21, 328, 739	202, 527	1, 700, 563
1927	70, 391	791, 653	1, 320, 195	15, 954, 485	253, 044	2, 153, 956
1928	54, 159	602, 808	1, 948, 094	18, 833, 792	298, 623	2, 125, 289

Year	Humpback or pink		Chum or keta		Total	
	Cases	*Value*	*Cases*	*Value*	*Cases*	*Value*
1921	423, 984	$1, 788, 778	255, 495	$942, 525	2, 596, 826	$19, 632, 744
1922	1, 658, 423	7, 189, 494	565, 918	2, 251, 540	4, 501, 662	29, 787, 193
1923	2, 448, 129	11, 899, 956	525, 622	2, 447, 671	5, 035, 697	32, 873, 007
1924	2, 601, 283	12, 837, 346	1, 028, 488	4, 812, 297	5, 294, 915	33, 007, 135
1925	2, 110, 593	11, 137, 102	1, 078, 680	4, 787, 030	4, 459, 937	31, 989, 531
1926	3, 338, 349	17, 987, 527	902, 443	4, 518, 929	6, 652, 882	46, 080, 004
1927	1, 420, 775	8, 338, 690	507, 723	2, 777, 480	3, 572, 128	30, 016, 264
1928	2, 787, 242	18, 285, 530	995, 785	6, 036, 466	6, 083, 903	45, 383, 885

NOTE.—Shown in standard cases of forty-eight 1-pound cans.

Pack of canned salmon in the United States and Alaska, 1921 to 1928

Year	Pacific Coast States		Alaska		Total	
	Cases	*Value*	*Cases*	*Value*	*Cases*	*Value*
1921	1, 002, 948	$9, 234, 425	2, 596, 826	$19, 632, 744	3, 599, 774	$28, 867, 169
1922	733, 246	8, 633, 524	4, 501, 662	29, 787, 193	5, 234, 898	38, 420, 717
1923	1, 367, 263	12, 660, 566	5, 035, 697	32, 873, 007	6, 402, 960	45, 533, 573
1924	958, 662	9, 394, 467	5, 294, 915	33, 007, 135	6, 253, 577	42, 401, 602
1925	1, 558, 613	15, 379, 976	4, 459, 937	31, 989, 531	6, 018, 550	47, 369, 507
1926	835, 738	10, 139, 302	6, 652, 882	46, 080, 004	7, 488, 620	56, 219, 306
1927	1, 504, 451	15, 712, 497	3, 572, 128	30, 016, 264	5, 076, 579	45, 728, 761
1928	842, 903	9, 254, 258	6, 083, 903	45, 383, 885	6, 926, 806	54, 638, 143

NOTE.—Shown in standard cases of forty-eight 1-pound cans.

Sardines.—In 1928 packs of sardines were reported by 38 plants in Maine and 28 in California. This is an increase of one plant in Maine and a decrease of one in California, as compared with last year. There was also one plant operating in Massachusetts in 1927, which was inactive in 1928. The production of Maine sardines amounted to 2,055,763 standard cases of one hundred ¼-pound cans, valued at $8,076,546, which is an increase of 63 per cent in quantity and 54 per cent in value, as compared with the pack of the previous year. In California the production amounted to 2,771,527 standard cases of forty-eight 1-pound cans, valued at $9,658,822, which is an increase of 8 per cent in quantity and 4 per cent in value. The production in both Maine and California was far above the average for the period 1921 to 1927.

Pack of canned sardines, 1928

Sardines (herring)	Maine	
	Cases	*Value*
In olive oil: Quarters, ¼-pound (100 cans)	32,677	$192,754
In cottonseed oil: Quarters, ¼-pound (100 cans)	1,683,895	6,682,194
In mustard:		
Quarters, ¼-pound (100 cans)	135,708	604,781
Three-quarters. ¾-pound (48 cans)	129,451	515,753
In other sauces: Quarters, ¼-pound (100 cans)	[1] 17,073	81,064
Total	1,998,804	8,076,546
Total (standard cases)	2,055,763	----------

Sardines (pilchard)	California	
	Cases	*Value*
½-pound oval (48 cans)[2]	44,468	$131,276
1-pound oval (48 cans):		
In tomato sauce	2,374,227	7,939,509
In mustard	137,874	478,434
In cottonseed oil	4,365	14,063
In natural oil	14,530	46,806
Soused	2,495	8,429
In other sauces	7,146	24,183
¼-pound square (100 cans):		
In olive oil	26,194	247,983
In other oils and sauces	6,606	42,544
½-pound square (100 cans)	[3] 170,080	683,238
1-pound tall (48 cans)	[4] 14,417	42,357
Total	2,802,404	9,658,822
Total (standard cases)	2,771,527	----------

[1] Principally in tomato sauce. Includes a few cases packed in half-pound oval cans, 100 to the case, which have been converted to the equivalent of quarter-size cans, 100 to the case.
[2] Principally in tomato sauce.
[3] Includes the pack in 8-ounce square cans, 48 to the case; 8-ounce glass jars, 24 to the case; and 6-ounce cans, 100 to the case, which have been converted to the equivalent of ½-pound cans, 100 to the case.
[4] Includes the pack in 102-ounce cans, 6 to the case, which have been converted to the equivalent of 1-pound cans, 48 to the case.

NOTE.—"Standard cases" represent the various sized cases converted to the equivalent of one hundred ¼-pound cans to the case of sardines (herring) and forty-eight 1-pound cans to the case of sardines (pilchard).

Pack of canned sardines, 1921 to 1928

Year	Maine and Massachusetts		California	
	Cases	*Value*	*Cases*	*Value*
1921	1,399,507	$3,960,916	398,668	$2,346,446
1922	1,869,719	5,750,109	715,364	3,361,480
1923	1,272,277	5,288,865	1,100,162	4,607,931
1924	1,899,925	7,191,026	1,367,139	5,445,578
1925	1,870,786	6,716,701	1,714,913	6,380,617
1926	1,717,537	6,727,388	2,093,278	7,807,404
1927	1,262,124	5,249,030	2,563,146	9,268,784
1928	[1] 2,055,763	8,076,546	2,771,527	9,658,822

[1] Maine only. None packed in Massachusetts.

NOTE.—Shown in standard cases of one hundred ¼-pound cans for Maine and Massachusetts and forty-eight 1 pound cans for California.

Tuna and tunalike fishes.—In 1928 these fishes were canned at 16 plants in California. This is a decrease of 3 plants, as compared with last year. The total production was 1,216,222 standard cases of forty-eight ½-pound cans, valued at $8,374,030. This is a decrease of 3 per cent in quantity and an increase of less than 1 per cent in value, as compared with the pack of the previous year. With the exception of that in 1927, the pack was larger than in any year during the period 1921 to 1927.

Pack of canned tuna and tunalike fishes in California, 1928

Sizes	Albacore		Yellowfin		Bluefin	
	Cases	*Value*	*Cases*	*Value*	*Cases*	*Value*
¼-pound round (48 cans) [1]	14,280	$81,327	62,803	$275,879	28,337	$101,077
½-pound round (48 cans) [2]	71,744	744,615	431,356	3,018,250	78,690	471,221
1-pound round (48 cans) [3]	6,989	134,121	54,912	703,965	10,515	108,196
Flakes [4]	12,860	67,226	22,390	94,553	281	1,191
Total	105,873	1,027,289	571,461	4,092,647	117,823	681,685
Total (standard cases)	105,722		594,972		114,169	

Sizes	Striped		Mixed yellowfin and bluefin		"Tonno"[6]	
	Cases	*Value*	*Cases*	*Value*	*Cases*	*Value*
¼-pound round (48 cans) [1]	32,648	$110,924	1,570	$6,672	210,950	$898,865
½-pound round (48 cans) [2]	145,985	795,934	23,542	153,023	19,588	154,121
1-pound round (48 cans) [3]	18,337	181,462	664	7,968	948	15,313
Flakes [4]	2,833	10,502	8,740	34,860		
Total	199,803	1,098,822	[5] 34,516	202,523	231,486	1,068,299
Total (standard cases)	201,816		34,395		126,959	

Sizes	Bonito		Yellowtail		Total	
	Cases	*Value*	*Cases*	*Value*	*Cases*	*Value*
¼-pound round (48 cans) [1]	2,507	$9,170	5,752	$21,332	358,847	$1,505,246
½-pound round (48 cans) [2]	18,442	94,164	5,871	32,947	795,218	5,464,275
1-pound round (48 cans) [3]	2,208	19,908	2,665	25,244	97,238	1,196,177
Flakes [4]					47,104	208,332
Total	23,157	123,242	14,288	79,523	1,298,407	8,374,030
Total (standard cases)	24,112		14,077		1,216,222	

[1] Includes the pack in ½-pound cans, 96 to the case, and ¼-pound cans, 100 to the case, which have been converted to the equivalent of ¼-pound round cans, 48 to the case.
[2] Includes the pack of ½-pound square cans, 48 to the case, and ½-pound cans, 50 to the case, which have been converted to the equivalent of ½-pound round cans, 48 to the case.
[3] Includes the pack of 4-pound cans, 12 to the case, which have been converted to the equivalent of 1-pound round cans, 48 to the case.
[4] Flakes have been converted to the equivalent of standard cases.
[5] Includes a few cases of mixed striped and yellowfin tuna.
[6] Manufactured chiefly from bluefin tuna.

NOTE.—"Standard cases" represent the various sized cases converted to the equivalent of forty-eight ½-pound cans to the case.

Pack of canned tuna and tunalike fishes, 1921 to 1928

Year	Albacore		Bluefin and yellowfin tuna		Striped tuna		"Tonno"	
	Cases	*Value*	*Cases*	*Value*	*Cases*	*Value*	*Cases*	*Value*
1921	456,152	$2,657,266	64,816	$306,486	27,972	$109,929		
1922	296,210	2,304,935	168,874	1,047,621	177,995	942,356	13,714	$139,067
1923	310,037	3,106,329	261,773	1,959,812	96,452	578,254	124,416	1,136,814
1924	416,820	4,024,509	65,941	455,048	43,159	239,198	97,304	861,861
1925	[1] 518,079	4,412,655	261,482	1,745,338	168,177	997,697	131,159	1,212,024
1926 [2]	61,197	471,502	287,699	1,718,744	290,278	1,525,146	137,720	1,209,041
1927	131,157	1,118,985	533,691	3,594,195	414,314	2,362,587	116,335	979,860
1928	105,722	1,027,289	[3] 743,536	4,976,855	201,816	1,098,822	126,959	1,068,299

Year	Bonito		Yellowtail		Total	
	Cases	*Value*	*Cases*	*Value*	*Cases*	*Value*
1921			210	$945	549,150	$3,074,626
1922	10,810	$58,900	4,718	18,994	672,321	4,511,873
1923	15,099	77,906	10,059	55,645	817,836	6,914,760
1924	12,899	94,806	16,293	81,164	652,416	5,756,586
1925	10,090	61,207	13,484	70,159	1,102,471	8,499,080
1926	48,113	259,204	26,192	98,646	851,199	5,282,283
1927	18,587	111,253	41,734	201,347	1,255,818	8,368,227
1928	24,112	123,242	14,077	79,523	1,216,222	8,374,030

[1] Includes 27,489 cases of tuna flakes, valued at $120,637.
[2] Includes 25,353 cases of tuna flakes, valued at $102,129, which have been credited to the various species as packed.
[3] Includes a few cases of mixed striped and yellowfin tuna.

NOTE.—Shown in standard cases of forty-eight ½-pound cans.

Mackerel.—In 1928 mackerel were canned at 18 plants in California and 4 in Massachusetts. The present popularity of canned mackerel is evidenced by the production in 1928 of 398,903 standard cases of forty-eight 1-pound cans, valued at $1,714,020. This is by far the largest pack of mackerel on record. A considerable portion of the pack finds outlet in the export trade.

Pack of canned mackerel, 1928

Sizes	Massachusetts		California		Total	
	Cases	*Value*	*Cases*	*Value*	*Cases*	*Value*
8-ounce (24 cans)	3,103	$8,201			3,103	$8,201
8-ounce (48 cans)			[1] 7,799	$23,832	7,799	23,832
14-ounce (24 cans)	[2] 21,956	84,224			21,956	84,224
16-ounce (48 cans)			384,622	1,597,763	384,622	1,597,763
Total	25,059	92,425	392,421	1,621,595	417,480	1,714,020
Total (standard cases)	10,382		388,521		398,903	

[1] Includes a few cases packed in 4-ounce cans, 100 to the case, which have been converted to the equivalent of 8-ounce cans, 48 to the case.
[2] Includes a few cases packed in 16-ounce cans, 24 to the case, which have been converted to the equivalent of 14-ounce cans, 24 to the case.

NOTE.—"Standard cases" represent the various sized cases converted to the equivalent of forty-eight 1-pound cans to the case.

Alewife products.—In 1928 alewives and alewife roe were canned at 7 plants in Maryland, 19 in Virginia, and 2 in North Carolina, a total of 28 plants or 13 less than in 1927. Their output consisted of 50,674 standard cases of canned alewives, valued at $150,878, and 56,392 cases of alewife roe, valued at $288,592, a total of 107,066 standard cases of forty-eight 1-pound cans, valued at $439,470. Considering the total production, there was an increase of 61 per cent in quantity and 39 per cent in value as compared with the previous year. This is greater in both quantity and value than the production of any year from 1921 to 1927.

Pack of canned alewife products, 1928, standard cases

Products	Maryland		Virginia and North Carolina		Total	
	Cases	*Value*	*Cases*	*Value*	*Cases*	*Value*
Alewives	33,956	$97,523	16,718	$53,355	50,674	$150,878
Alewife roe	15,941	71,750	40,451	216,842	56,392	288,592
Total	49,897	169,273	57,169	270,197	107,066	439,470

NOTE.—"Standard cases" represent the various sized cases converted to the equivalent of forty-eight 1-pound cans to the case.

Pack of canned alewives and alewife roe, 1921 to 1928

Year	Alewives		Alewife roe		Total	
	Cases	*Value*	*Cases*	*Value*	*Cases*	*Value*
1921	156	$813	20,304	$157,841	20,460	$158,654
1922	489	1,994	18,099	137,514	18,588	139,508
1923	537	1,915	20,404	169,435	20,941	171,350
1924	1,550	5,118	41,642	332,245	43,192	337,363
1925	4,449	15,045	35,183	240,461	39,632	255,506
1926	19,920	65,405	33,886	201,278	53,806	266,683
1927	21,327	64,577	45,168	252,120	66,495	316,697
1928	50,674	150,878	56,392	288,592	107,066	439,470

NOTE.—Shown in standard cases of forty-eight 1-pound cans.

Shrimp.—In 1928 shrimp were canned at 4 plants in South Carolina, 9 in Georgia, 9 in Florida, 4 in Alabama, 16 in Mississippi, 24 in Louisiana, and 5 in Texas, making a total of 71 plants, or 3 less than a year ago. Louisiana is by far the most important State in the production of canned shrimp. The total pack amounted to 851,831 standard cases of 48 No. 1 cans (5-ounce cans, dry pack, and 5¾-ounce cans, wet pack), valued at $5,181,547. This is a decrease of less than 1 per cent in quantity and 3 per cent in value, compared with the pack for 1927, but is still one of the largest packs during the period 1921 to 1928.

Pack of canned shrimp, 1928

STANDARD CASES

States	Dry pack (in tins)		Wet pack (in tins)		Wet pack (in glass)		Total	
	Cases	*Value*	*Cases*	*Value*	*Cases*	*Value*	*Cases*	*Value*
South Carolina	3,603	$21,162	17,039	$89,591			20,642	$110,753
Georgia	30,074	184,671	61,858	349,211	2,871	$29,919	94,803	563,801
Florida	7,451	44,563	46,559	272,400	25,207	268,447	79,217	585,410
Alabama	51,911	311,267	15,117	89,811			67,028	401,078
Mississippi	54,429	302,681	52,259	291,863	3,228	32,406	109,916	626,950
Louisiana	220,690	1,336,208	217,113	1,256,811			437,803	2,593,019
Texas	6,685	39,315	26,144	156,719			32,829	196,034
Louisiana and Texas					9,598	104,502	9,598	104,502
Total	374,843	2,239,867	436,089	2,506,406	40,899	435,274	851,831	5,181,547

ACTUAL CASES

Sizes	Total		Sizes	Total	
	Cases	*Value*		*Cases*	*Value*
In tins, dry:			In glass, wet:		
No. 1, 4-ounce (4 dozen)	19,945	$88,534	5¼-ounce (2 dozen)	66,381	$323,287
No. 1, 4½-ounce (4 dozen)	11,750	66,169	6¼-ounce (2 dozen)	18,681	102,017
No. 1, 5-ounce (4 dozen)	305,825	1,787,426	Wet, other sizes, in tins and glass (standard cases)	2,117	15,557
No. 1½, 8¼-ounce (2 dozen)	49,517	286,368	Total		5,181,547
Other sizes (standard cases)	1,636	11,370			
In tins, wet:					
No. 1, 5¾-ounce (4 dozen)	430,965	2,472,699			
No. 1½, 9¾-ounce (2 dozen)	4,960	28,120			

NOTE.—"Standard cases" represent the various sized cases converted to the equivalent of 48 No. 1, 5-ounce cans to the case in the dry pack, and 48 No. 1, 5¾-ounce cans to the case in the wet pack.

Pack of canned shrimp, 1921 to 1928

Year	Cases	Value	Year	Cases	Value
1921	655,364	$3,804,781	1925	735,714	$3,782,819
1922	579,797	3,064,087	1926	732,365	4,122,092
1923	700,429	4,381,534	1927	852,764	5,321,652
1924	718,517	4,608,950	1928	851,831	5,181,547

NOTE.—Shown in standard cases of 48 No. 1 cans.

Oysters.—In 1928 oysters were canned at 3 plants in Maryland, 3 in North Carolina, 14 in South Carolina, 6 in Georgia, 6 in Florida, 4 in Alabama, 18 in Mississippi, 7 in Louisiana, and 1 in Texas—a total of 62 plants, or 7 more than in 1927. The output of these plants amounted to 503,952 standard cases of forty-eight 5-ounce cans, valued at $2,760,576. This is an increase of 13 per cent in quantity and 17 per cent in value, as compared with the previous year, and is above the average for the period 1921 to 1927. Mississippi and South Carolina accounted for 67 per cent of the total value of the production.

Pack of canned oysters, 1928

STANDARD CASES

States	Cases	Value	States	Cases	Value
Maryland	37,892	$233,218	Alabama	32,978	$176,330
North Carolina	29,161	145,102	Mississippi	205,115	1,119,123
South Carolina	133,202	728,870	Louisiana and Texas	29,537	165,043
Georgia	22,100	119,730			
Florida	13,967	73,160	Total	503,952	2,760,576

ACTUAL CASES

Sizes	Cases	Value	Sizes	Cases	Value
4-ounce (4 dozen)	54,622	$271,114	10-ounce (2 dozen)	75,547	$403,307
5-ounce (4 dozen)	354,237	1,888,795	Other sizes (standard cases)	537	4,012
6-ounce (4 dozen)	7,154	60,681			
8-ounce (2 dozen)	26,685	132,667	Total		2,760,576

NOTE.—"Standard cases" represent the various sized cases converted to the equivalent of 48 No. 1 5-ounce cans to the case.

Pack of canned oysters, 1921 to 1928

Year	Cases	Value	Year	Cases	Value
1921	442,086	$2,179,271	1925	654,755	$3,721,159
1922	505,973	2,423,616	1926	413,834	2,026,569
1923	524,544	2,720,073	1927	447,297	2,367,949
1924	447,481	2,476,044	1928	503,952	2,760,576

NOTE.—Shown in standard cases of 48 No. 1 5-ounce cans to the case.

Clam products.—In 1928 razor-clam products were canned at 14 plants in Washington, 6 in Oregon, and 3 in Alaska; hard-clam products at 1 plant in Rhode Island, 1 in New Jersey, 1 in Georgia, 2 in Florida, and 3 in Washington; and soft-clam products at 21 plants in Maine and 2 in Massachusetts—a total of 54 plants. In standard cases of 48 No. 1 cans, the pack of whole and minced clams was as follows: Razor clams, 106,280 standard cases, valued at $936,394; hard clams, 32,675 cases, valued at $203,959; and soft clams, 74,545 cases, valued at $318,510. The combined pack, in standard cases, of other clam products derived from razor, hard, and soft clams (chowder, soup, bouillón, broth, and juice), amounted to 318,140 cases, valued at $1,164,735. The total pack of 531,640 standard cases, valued at $2,623,598 in 1928, represents an increase of 1 per cent in quantity and a decrease of 4 per cent in value when compared with the pack of the previous year.

Pack of canned clam products, 1928

Items and States	Cases	Value
Razor clams (Washington, Oregon, and Alaska):		
Whole—		
No. 1, 5-ounce (4 dozen)	3,643	$36,430
1-pound 8-ounce (4 dozen)	1,472	16,324
No. 2, 10-ounce (2 dozen)	352	3,016
Minced—		
½-pound flat, 4-ounce (4 dozen)	92,810	647,132
No. 1, 5-ounce (4 dozen)	22,415	207,626
No. 2, 10-ounce (2 dozen)	2,480	20,159
Other sizes (standard cases)	787	5,707
Total	123,959	936,394
Total (standard cases)	106,280	
Hard clams (Washington and Florida):		
Whole and minced—		
No. 1, 5-ounce (4 dozen)	8,159	66,863
1-pound, 8-ounce (4 dozen)	1,561	11,239
No. 2, 10-ounce (2 dozen)	13,544	84,488
No. 10, 52-ounce (½ dozen)	6,519	41,369
Total	29,783	203,959
Total (standard cases)	32,675	
Soft clams (Maine and Massachusetts):		
Whole—		
5-ounce (4 dozen)	45,825	204,683
8-ounce (4 dozen)	7,894	53,055
Soft clams (Maine and Massachusetts)—Continued.		
Whole—Continued.		
10-ounce (2 dozen)	12,009	$42,476
Other sizes (standard cases)	4,080	18,296
Total	69,808	318,510
Total (standard cases)	74,545	
Other hard, soft, and razor clam products (Maine, Massachusetts, Rhode Island, New Jersey, Georgia, Florida, Washington, and Oregon):		
Chowder and soup—		
No. 1, 10-ounce (4 dozen) [1]	161,883	613,684
No. 2, 20-ounce (2 dozen) [2]	56,527	224,560
No. 3, 33-ounce (2 dozen) [3]	39,592	206,314
No. 10, 102-ounce (½ dozen) [4]	4,424	15,380
Bouillon, broth, and juice—		
Miscellaneous sizes in tins and glass (standard cases)	28,771	104,797
Total	291,197	1,164,735
Total (standard cases)	318,140	
Grand total (standard cases)	531,640	2,623,598

[1] Includes the pack in 11-ounce cans, 48 to the case, and 10½-ounce cans, 24 and 48 to the case, which have been converted to the equivalent of 10-ounce cans, 48 to the case.
[2] Includes the pack in 19-ounce cans, 24 to the case, and 15-ounce cans, 24 to the case, which have been converted to the equivalent of 20-ounce cans, 24 to the case.
[3] Includes the pack in 32-ounce cans, 12 to the case, which have been converted to the equivalent of 33-ounce cans, 24 to the case.
[4] Includes the pack in 108-ounce cans, 6 to the case, which have been converted to the equivalent of 102-ounce cans, 6 to the case.

NOTE.—"Standard cases" represent the various sized cases converted to the equivalent of 48 No. 1, 5-ounce, cans to the case, for whole and minced clams; and 48 No. 1, 10-ounce, cans to the case, for other clam products.

Value of canned clams and clam products, 1921 to 1928

Year	Razor clams	Hard clams	Soft clams	Clam chowders, juices, etc.	Total
1921	$506,591	$138,699	$338,775	$182,442	$1,166,507
1922	876,364	201,270	327,287	311,444	1,716,365
1923	883,535	194,937	308,560	323,584	1,710,616
1924	863,126	271,911	459,882	566,470	2,161,389
1925	860,002	218,601	287,073	484,702	1,850,378
1926	795,256	191,044	279,998	738,354	2,004,660
1927	1,046,797	231,526	270,747	1,195,884	2,744,954
1928	936,394	203,959	318,510	1,164,735	2,623,598

Miscellaneous canned fishery products.—In addition to those products not tabulated separately, there were 266,270 standard cases of forty-eight 1-pound cans of various miscellaneous canned fishery products, valued at $2,405,103. Of these products, shad were canned at 18 plants, shad roe at 17 plants, miscellaneous fish, roe, caviar, and salmon eggs at 38 plants, crabs at 3 plants, and miscellaneous shellfish at 9 plants. Compared with the pack a year ago, the pack of shad and shad roe, which amounted to 27,577 standard cases, valued at $233,846, increased 124 per cent in quantity and 179 per cent in value, and the pack of crabs, which amounted to 1,624 cases, valued at $44,536, increased 61 per cent in quantity and 65 per cent in value.

Pack of miscellaneous canned fishery products in the United States and Alaska, 1928, standard cases

Items	Cases	Value	Items	Cases	Value
Shad	23,447	$110,006	Crabs	1,624	$44,536
Shad roe	4,130	123,840	Other shellfish [1]	8,966	128,989
Other fish	210,231	1,729,014			
Roe and caviar	12,584	144,384	Total	266,270	2,405,103
Salmon eggs (for bait)	5,288	124,334			

[1] Includes canned terrapin products, turtle products, mussels, squid, scallops, abalone, and clam cakes.

NOTE.—"Standard cases" represent the various sized cases converted to the equivalent of forty-eight 1-pound cans to the case.

Pack of canned shad and shad roe, 1921 to 1928

Year	Shad		Shad roe		Total	
	Cases	*Value*	*Cases*	*Value*	*Cases*	*Value*
1921	641	$2,455	38	$142	679	$2,597
1922	1,781	9,961	292	8,517	2,073	18,478
1923	2,162	37,165	536	16,288	2,698	53,453
1924	6,470	20,461	1,164	72,932	7,634	93,393
1925	12,569	53,875	2,430	100,571	14,999	154,446
1926	14,275	63,334	1,121	39,422	15,396	102,756
1927	11,569	61,842	767	21,890	12,336	83,732
1928	23,447	110,006	4,130	123,840	27,577	233,846

NOTE.—Shown in standard cases of forty-eight 1-pound cans.

Value of canned crabs 1921 to 1928

Year	Value	Year	Value
1921	$115,800	1925	$52,499
1922	104,171	1926	25,223
1923	47,023	1927	26,986
1924	35,944	1928	44,536

BY-PRODUCTS

In 1928 the total value of by-products, including the products of the menhaden and whaling industries, amounted to $14,880,956. This is an increase over the previous year's value of 16 per cent. Considered by groups, scrap, meal, and bran were most important and accounted for 36 per cent of the total value. The fish and whale oil group follows, accounting for 35 per cent, while shell products ranked third, accounting for 16 per cent. The remainder of the value, or 13 per cent, was made up by liquid glue, herring skins and scales, isinglass, shark skins and fins, fish flour, agar, and kelp products.

Oils.—In 1928 the production of fish and marine-animal oils amounted to 12,145,577 gallons, valued at $5,149,618, which is an increase of 12 per cent in the amount and 5 per cent in value compared with the preceding year. Of the total production, 30 per cent consisted of menhaden oil, 23 per cent herring oil (from Maine and

Alaska herring and alewives), 31 per cent sardine or pilchard oil, 12 per cent whale and sperm oil, and 4 per cent other fish oils, including salmon, tuna, cod-liver, blackfish, porpoise, shark, lake-herring and trout, mackerel, and oil from miscellaneous fish cuttings and waste. The production and value in 1928 were greater than for any year for which there are records except 1925.

Production of miscellaneous by-products, 1928

Products	Atlantic and Gulf coast		Pacific coast (including Alaska)		Total	
	Quantity	*Value*	*Quantity*	*Value*	*Quantity*	*Value*
Fish and whale scrap and meal:						
Dried ... tons	15,053	$887,765	39,964	$2,451,119	55,017	$3,318,884
Crude or green ... do	3,067	20,290			3,067	20,290
Shrimp bran ... do	1,726	58,080			1,726	58,080
Oil:						
Salmon ... gallons			171,590	64,930	171,590	64,930
Pilchard or sardine ... do			3,825,786	1,621,531	3,825,786	1,621,531
Tuna ... do			22,834	5,102	22,834	5,102
Herring ... do	199,465	70,244	2,543,600	1,015,555	2,743,065	1,085,799
Whale ... do			1,364,498	639,786	1,364,498	639,786
Sperm ... do			93,750	36,748	93,750	36,748
Cod-liver, crude ... do	267,882	212,036			267,882	212,036
Miscellaneous ... do	[1] 26,371	11,684	44,232	16,626	70,603	28,310
Liquid glue ... do	[2] 510,587	1,254,082			510,587	1,254,082
Miscellaneous by-products [3] ... pounds	4,866,488	254,667	2,598,000	381,022	7,464,488	635,689
Total		2,748,848		6,232,419		8,981,267

[1] Includes the production in Wisconsin and Indiana.
[2] Includes the production of 1 plant in California.
[3] Includes herring skins and scales, isinglass, shark skins and fins, fish flour, agar, and kelp.

NOTE.—The oils produced on the Pacific coast are reported in "trade" gallons (7½ pounds), and those produced on the Atlantic and Gulf coasts are reported in United States gallons (about 7.74 pounds).

Production of fish and marine-animal oils, 1921 to 1928

Year	Menhaden		Herring		Pilchard or sardine	
	Gallons	*Value*	*Gallons*	*Value*	*Gallons*	*Value*
1921	6,260,478	$1,719,892	112,838	$26,735	170,977	$35,760
1922	7,102,677	2,904,833	450,362	150,144	428,859	145,668
1923	7,461,365	3,316,277	945,424	384,053	966,247	424,103
1924	3,923,904	1,817,626	1,324,002	571,399	2,338,711	1,076,903
1925	6,023,108	3,001,106	2,442,527	1,034,071	3,120,048	1,568,753
1926	3,942,821	1,729,160	3,116,936	1,382,763	2,113,028	932,651
1927	3,957,068	1,716,474	2,291,687	960,250	2,514,562	1,116,725
1928	3,585,569	1,455,376	2,743,065	1,085,799	3,825,786	1,621,531

Year	Other fish oils		Whale and sperm		Total	
	Gallons	*Value*	*Gallons*	*Value*	*Gallons*	*Value*
1921	[1] 733,259	$201,516	[1] 168,729	$94,767	7,446,281	$2,078,670
1922	306,430	145,401	2,247,145	884,714	10,535,473	4,230,760
1923	443,935	187,877	1,556,830	791,884	11,373,801	5,104,194
1924	381,832	184,534	1,242,836	661,271	9,211,285	4,311,733
1925	480,195	211,250	1,221,198	685,011	13,287,076	6,500,191
1926	439,252	234,832	1,276,009	748,075	10,888,046	5,027,491
1927	579,396	355,607	1,531,400	755,965	10,874,113	4,905,021
1928	532,909	310,378	1,458,248	676,534	12,145,577	5,149,618

[1] Whale oil included with "Other fish oils" in 1921.

Scrap, meal, and bran.—In 1928 the production of fish and marine-animal scrap, meal, and bran amounted to 104,519 tons, valued at $5,382,143. This is an increase of 14 per cent in the amount and 25 per cent in the value, compared with the production for 1927. The value in 1928 was greater than for any year during the period 1921 to 1927. Of the total production 24 per cent consisted of dried menhaden scrap and meal; 19 per cent, acidulated menhaden scrap; 52 per cent, miscellaneous dried scrap and meal (other than menhaden); 3 per cent, crude or green scrap; and 2 per cent, shrimp bran. All of the above groups increased over 1927, except dried menhaden scrap and meal, which showed a slight decline.

Production of fish and marine-animal meal and scrap, 1921 to 1928

Year	Dried menhaden scrap and meal		Acidulated menhaden scrap		Other dried scrap and meal	
	Tons	*Value*	*Tons*	*Value*	*Tons*	*Value*
1921	37,858	$1,380,455	44,804	$905,640	22,173	$1,232,906
1922	67,821	2,665,441	25,755	556,317	21,638	1,090,346
1923	43,452	2,029,406	44,935	1,064,870	22,636	1,257,098
1924	21,008	996,866	24,409	495,684	30,847	1,373,351
1925	30,167	1,519,458	41,463	1,102,051	39,566	1,981,038
1926	24,226	1,164,396	23,553	548,204	37,703	1,892,010
1927	26,417	1,406,915	19,984	566,590	42,078	2,293,919
1928	24,681	1,453,651	20,028	531,238	55,017	3,318,884

Year	Crude or green scrap		Shrimp bran		Total	
	Tons	*Value*	*Tons*	*Value*	*Tons*	*Value*
1921	1,810	$21,327	628	$16,814	107,273	$3,557,142
1922	390	9,175	562	15,398	116,166	4,336,677
1923	1,593	13,721	1,269	48,290	113,885	4,413,385
1924	4,097	15,217	936	31,580	81,297	2,912,698
1925	5,787	16,430	1,079	31,658	118,062	4,650,635
1926	6,456	12,692	1,036	33,775	92,974	3,651,077
1927	1,960	8,942	1,427	44,716	91,866	4,321,082
1928	3,067	20,290	1,726	58,080	104,519	5,382,143

Glue.—In 1928 liquid fish glue was manufactured at four plants in Massachusetts and one in California. The production amounted to 510,587 gallons, valued at $1,254,082. This is a decrease of less than 1 per cent in amount and an increase of 46 per cent in value compared with the previous year. The value in 1928 was larger than for any year during the period 1921 to 1927, while the production has remained fairly constant during these years.

Production of fish glue, 1921 to 1928

Year	Gallons	Value	Year	Gallons	Value
1921	347,048	$364,415	1925	510,816	$589,064
1922	323,003	278,424	1926	520,622	732,109
1923	465,814	680,054	1927	512,136	860,396
1924	502,940	550,391	1928	510,587	1,254,082

Oyster-shell products.—In 1928 oyster-shell products were manufactured at 2 plants in Rhode Island, 4 in New Jersey, 2 in Pennsylvania, 7 in Maryland, 7 in Virginia, 2 in North Carolina, 3 in South Carolina, 2 in Florida, 3 in Alabama, 5 in Mississippi, 5 in Louisiana, and 5 in Texas, making a total of 47 plants, or the same number as operated in 1927. These plants produced 237,305 tons of crushed oyster shell for poultry feed, valued at $2,155,985, and 68,708 tons of oyster-shell lime, valued at $303,439, making a total of 306,013 tons of crushed oyster-shell products, valued at $2,459,424. Compared with the total production of these products in 1927, there was a decrease in quantity of 1 per cent and 5 per cent in value.

Louisiana, as in 1927, ranked as the most important State in the production of oyster-shell products and accounted for 44 per cent of the total production and 47 per cent of the total value. The shells in Louisiana are taken with large dredges, mainly from reefs containing deposits of many thousands of tons of dead oyster shells.

Whole and crushed oyster shells are often used for road-building purposes, although crushed shells are used mainly for poultry feed, and the shell dust resulting from the crushing operation is sold as lime.

Production of oyster-shell products, 1928

States	Crushed oyster shell for poultry feed		Oyster-shell lime		Total	
	Tons	*Value*	*Tons*	*Value*	*Tons*	*Value*
Rhode Island and Pennsylvania	6,326	$65,202	1,350	$6,113	7,676	$71,315
New Jersey	7,899	78,308	2,089	8,901	9,988	87,209
Maryland	43,755	375,466	21,092	57,758	64,847	433,224
Virginia	17,784	169,272	[1] 28,357	189,388	46,141	358,660
North Carolina and South Carolina	7,561	82,186	2,017	13,589	9,578	95,775
Florida and Alabama	12,053	102,424	2,425	8,425	14,478	110,849
Mississippi and Texas	18,573	156,508	1,248	1,873	19,821	158,381
Louisiana	123,354	1,126,619	10,130	17,392	133,484	1,144,011
Total	237,305	2,155,985	68,708	303,439	306,013	2,459,424

[1] Of this amount, 15,371 tons, valued at $126,844, were reported as "burned" lime.

Production of oyster-shell products, 1921 to 1928

Year	Crushed oyster shell for poultry feed		Oyster-shell lime		Total
	Tons	*Value*	*Tons*	*Value*	*Value*
1921	185,474	$1,759,120	73,764	$502,634	$2,261,754
1922	236,021	2,005,838	93,168	431,218	2,437,051
1923	224,983	1,986,249	83,808	372,286	2,358,535
1924	219,211	2,019,254	70,269	336,384	2,355,638
1925	226,971	2,075,057	67,818	303,261	2,378,318
1926	251,166	2,379,141	57,232	207,019	2,586,160
1927	249,959	2,332,065	60,560	268,985	2,601,050
1928	237,305	2,155,985	68,708	303,439	2,459,424

Menhaden industry.—In 1928 one menhaden factory was operated in Connecticut, 1 in New York, 2 in New Jersey, 3 in Delaware, 11 in Virginia, 12 in North Carolina, 1 in Georgia, and 3 in Florida, making a total of 34 factories, or 5 less than in 1927. These plants utilized 540,617,000 fish for the manufacture of 44,709 tons of scrap and meal, valued at $1,984,889, and 3,585,569 gallons of oil, valued at $1,455,376, making a total value for these products of $3,440,265. This is a decrease in total value of 7 per cent under the previous year and is considerably under the value of the production as recorded for 1922 and 1923.

Virginia, as in the previous year, ranked first in the menhaden industry and accounted for 31 per cent of the total value of all menhaden products, while North Carolina accounted for 27 per cent, Georgia and Florida 24 per cent, and Connecticut, New York, New Jersey, and Delaware the remainder, or 18 per cent.

Fish utilized and products of the menhaden industry, 1928

States	Quantity of menhaden utilized	Products				
		Scrap and meal		Oil		Total
	Number	*Tons*	*Value*	*Gallons*	*Value*	*Value*
Connecticut, New York, New Jersey, and Delaware	75,595,000	[1] 6,593	$209,749	1,031,965	$427,829	$637,578
Virginia	113,687,000	8,294	531,009	1,308,886	538,806	1,069,815
North Carolina	170,997,000	[2] 15,679	667,256	633,806	248,897	916,153
Georgia and Florida	180,338,000	14,143	576,875	610,912	239,844	816,719
Total	[3] 540,617,000	[4] 44,709	1,984,889	3,585,569	1,455,376	3,440,265

[1] Of this quanity, 820 tons, valued at $49,420, were reported as dry scrap, and 5,773 tons, valued at $160,329, as acidulated scrap.
[2] Of this quantity, 4,492 tons, valued at $240,355, were reported as dry scrap; 7,333 tons, valued at $186,476, as acidulated scrap; and 3,854 tons, valued at $240,425, as fish meal.
[3] 324,370,200 pounds.
[4] Of this quantity, 16,693 tons, valued at $970,109, were reported as dry scrap; 20,028 tons, valued at $531,238, as acidulated scrap; and 7,988 tons, valued at $483,542, as fish meal.

NOTE.—Menhaden oil is reported in United States gallons (about 7.74 pounds).

Products of the menhaden industry, 1921 to 1928

Year	Dried scrap and meal		Acidulated scrap		Oil		Total
	Tons	*Value*	*Tons*	*Value*	*Gallons*	*Value*	*Value*
1921	37,858	$1,380,455	44,804	$905,640	6,260,478	$1,719,892	$4,005,987
1922	67,821	2,665,441	25,755	556,317	7,102,677	2,904,833	6,126,591
1923	43,452	2,029,406	44,935	1,064,870	7,461,365	3,316,277	6,410,553
1924	21,008	996,866	24,409	495,684	3,923,904	1,817,626	3,310,176
1925	30,167	1,519,458	41,463	1,102,051	6,023,108	3,001,106	5,622,615
1926	24,226	1,164,396	23,553	548,204	3,942,821	1,729,160	3,441,760
1927	26,417	1,406,915	19,984	566,590	3,957,068	1,716,474	3,689,979
1928	24,681	1,453,651	20,028	531,238	3,585,569	1,455,376	3,440,265

PACKAGED-FISH TRADE

Fresh and frozen packaged fishery products were prepared in 1928 at 5 plants in Maine, 45 in Massachusetts, 1 in Connecticut, 14 in New York, 9 in Virginia, 1 in North Carolina, 4 in Florida, 1 in Alabama, 1 in Pennsylvania, 3 in Washington, and 1 in Oregon, making a total of 85 plants. In addition, fish were packaged by fishermen in California, the number of whom was not determined. The production amounted to 65,245,376 pounds, valued at $9,790,024. It has been estimated that to produce this amount of packaged products 160,000,000 pounds of whole fish were utilized.

Haddock was by far the most important fish packaged, accounting for 87 per cent of the total products prepared. Following, in order, were cod with 3 per cent of the total, squeteague 2 per cent, hake 2 per cent, and croaker 1 per cent. About 17 other species were packaged in smaller quantities. Predominating among these were flounders (including sole), cusk, and halibut.

Massachusetts accounted for 65 per cent of the production; Connecticut and New York, combined, 28 per cent; Virginia and North Carolina, combined, 4 per cent; and Maine, 2 per cent. The remaining 1 per cent was packaged in the Gulf and Pacific Coast States.

Considered according to the method of preparation, fish fillets accounted for 89 per cent of the product, dressed fish 4 per cent, pan-dressed fish 3 per cent, fish sticks 3 per cent, and the remainder consisted of fish steaks and fish tenderloins.

Production of fresh and frozen packaged fish in the United States, 1928

Species	Maine		Massachusetts		Connecticut and New York	
	Pounds	*Value*	*Pounds*	*Value*	*Pounds*	*Value*
Cod	313,800	$49,586	684,863	$96,183	[1] 1,057,581	$154,697
Cusk	213,400	34,158	268,250	32,758		
Flounders, including "sole"	8,400	1,428	258,812	108,838	182,000	36,400
Haddock	552,799	88,868	39,423,920	5,664,549	16,800,709	2,689,293
Hake	306,025	47,539	752,708	86,146	85,000	10,200
Mackerel			89,417	19,936		
Miscellaneous [2]			915,800	141,829		
Total	1,394,424	221,579	42,393,770	6,150,239	18,125,290	2,890,590

Species	Virginia and North Carolina		Florida, Alabama, and Pennsylvania		Washington, Oregon, and California		Total	
	Pounds	*Value*	*Pounds*	*Value*	*Pounds*	*Value*	*Pounds*	*Value*
Cod	(1)						2,056,244	$300,466
Croaker	786,069	$101,486					786,069	101,486
Cusk							481,650	66,916
Flounders, including "sole"	95,323	13,537					544,535	160,203
Grouper			41,500	$8,045			41,500	8,045
Haddock	281,465	48,285					57,058,893	8,490,995
Hake							1,143,733	143,885
Halibut					232,000	$46,400	232,000	46,400
Mackerel							89,417	19,936
Rockfish					125,000	30,000	125,000	30,000
Sablefish					8,000	960	8,000	960
Salmon					75,000	15,000	75,000	15,000
Sea bass					75,000	18,000	75,000	18,000
Snapper, red			58,000	12,600			58,000	12,600
Spot	12,000	2,130					12,000	2,130
Squeteague	1,293,835	163,441					1,293,835	163,441
Miscellaneous [2]	52,000	6,267	138,700	48,185	58,000	13,280	1,164,500	209,561
Total	2,520,692	335,146	238,200	68,830	573,000	123,640	[3] 65,245,376	9,790,024

[1] Cod packaged in Virginia is included with Connecticut and New York.
[2] Includes blue pike, butterfish, pollock, whiting, yellow perch, and other species.
[3] Of this amount 58,217,881 pounds, valued at $8,818,324, were fillets; 2,733,535 pounds, valued at $346,022, were dressed fish; 2,193,425 pounds, valued at $279,128, were pan-dressed fish; 1,717,035 pounds, valued at $269,515, were sticks; 333,000 pounds, valued at $65,960, were steaks; and 50,500 pounds, valued at $11,075, were tenderloins.

FROZEN-FISH TRADE

In 1928 there were 155 freezers and cold-storage warehouses in the United States and Alaska devoted wholly or in part to the storage of frozen and cured fishery products that reported their operations to the Government. This is six more than operated during 1927. Of the total, 23 were in New York, 20 in Ohio, 15 in Massachusetts, 12 in Pennsylvania, and 11 in Washington. The rest were in 21 other States and Alaska.

Fish, frozen.—In 1928 there were 113,637,898 pounds of fishery products frozen in the United States and Alaska. This is greater than the amount frozen in any previous year for which there are records, exceeding the amount frozen in 1925 by 25 per cent. Six species of fishery products constituted nearly one-half of the total amount of fish frozen. Listed in order of importance, these were salmon, which accounted for 13 per cent; halibut, 11 per cent; mackerel, 10 per cent; whiting, 9 per cent; and squid, 6 per cent. Other species of importance were sea herring, shellfish, and fishes in the groundfish group. During June, July, August, and November over one-half of the year's total was frozen. The amount frozen during June was largest, accounting for 16 per cent of the year's total. August ranked second, accounting for 15 per cent; July third, with 14 per cent; and November fourth, with 12 per cent. Other months in which considerable quantities of fish were frozen were September, December, and October. As a general rule a comparatively small amount of fish is frozen from January to May, inclusive. The smallest number of pounds was frozen in April.

During 1928 about 64,000,000 pounds of halibut were caught by American and Canadian fishermen in the North Atlantic and Pacific oceans and landed at ports in these countries. During the same year about 17,000,000 pounds of halibut were frozen in Canada, the United States, and Alaska, or 27 per cent of the commercial catch.

Halibut is considered one of our most staple fish products and can be purchased in virtually every fish market in the United States. Undoubtedly this is due to the fact that stocks of halibut are put away in times when the catch exceeds market demand and then drawn upon when the catch is small, or during the closed season, as well as the fact that halibut is a most palatable fish.

A condition similar to that in the halibut fishery exists with mackerel, although the merits of this fish when frozen have not been learned to as great extent as with halibut, and therefore distribution is confined largely to our Eastern States. In 1928, 31,000,000 pounds of mackerel were taken by American fishing vessels along our North Atlantic coast and landed at American ports. In addition, it is estimated that the catch along the California coast by American vessels amounted to about 30,000,000 pounds, of which about 25,000,000 pounds were canned. During 1928 about 12,000,000 pounds of mackerel were frozen, or about 20 per cent of the catch by American vessels.

In 1928 about 287,000,000 pounds of ground fish (cod, haddock, hake, pollock, and cusk), were landed fresh at Boston and Gloucester, Mass., Portland, Me., New York City, and Groton, Conn., of which about 205,000,000 pounds were haddock. While this does not represent the entire catch of these fish during the year, it is believed that it represents a goodly portion of the total catch by American fishermen in North Atlantic waters. From these landings are selected nearly all of the fish of these species that are frozen and held in cold-storage warehouses in the United States, the amount of which during 1928 amounted to nearly 5,000,000 pounds. This figure does not represent the entire amount of ground fish frozen during 1928, for it must be borne in mind that our figures are mainly for the public freezers and cold-storage warehouses. During late years an increasing number of establishments have been preparing frozen package fishery products, and usually these firms operate a private freezer and cold-storage warehouse. The stocks of most of these products are held in private warehouses and do not enter into our statistics of the holdings unless they are later stored in a public warehouse. In considering the duplication that might occur in discussing the amount of ground fish frozen, it is estimated that about 35,000,000 pounds of ground fish, in the landed weight, were used in 1928 in preparing products that were later frozen, or about 12 per cent of the ground fish landed at the important North Atlantic ports. From this it readily can be seen that only a fraction of the catch of ground fish is now being frozen. With the more general adaptation of rapid freezing methods, which are recognized to produce a superior frozen fishery product, and greater consideration of the scheme of marketing frozen fish products it is believed that in a few years a larger proportion of the catch of ground fish will enter the trade in a frozen condition.

The Pacific section, including Washington, Oregon, California, and Alaska, was most important in the frozen-fish trade in 1928. There, 32,718,000 pounds of fish, or 29 per cent of the total, were frozen, consisting almost entirely of salmon and halibut, although there was a considerable quantity of sablefish and sea herring. The New England section, comprising the States in that area, ranked second in importance, 30,802,000 pounds of fish, or 27 per cent of the total, being frozen there, consisting largely of mackerel and whiting, although considerable quantities of squid, groundfish, and sea herring also were frozen. Third in importance was the Middle Atlantic section, which includes the States of New York, New Jersey, and Pennsylvania. There, 28,909,000 pounds of fish, or 25 per cent of the total, were frozen. Virtually every species of fish frozen in the United States was frozen in this section in 1928, although whiting, mackerel, squid, weakfish, and shellfish made up a large portion of the amount frozen. The North Central-East section, including some States bordering on the Great Lakes, ranked fourth. There, 11,494,000 pounds of fish, or 10 per cent of the total, were frozen, the important species being lake trout, species of shellfish shipped from the seacoast, ciscoes, and whitefish. The South Atlantic, North Central-West, and South Central sections ranked in the order named and accounted for the remaining quantities frozen.

In the Pacific section most of the fish were frozen from June to November, inclusive; in the New England section during June, July, and August; and in the Middle Atlantic section during June, July, and August, a considerable quantity being frozen in November and December. In the other sections there was a tendency to freeze most of the fish during the summer and fall.

Fish frozen, 1928

BY SPECIES AND MONTHS

Species	Month ended—						
	Jan. 15	Feb. 15	Mar. 15	Apr. 15	May 15	June 15	July 15
	Pounds	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*
Bluefish (all trade sizes)	9,113	1,623	2,896	1,348	365	65,108	88,444
Butterfish (all trade sizes)	43	7,019	14,464	--------	28,280	270,543	122,975
Catfish	17,184	25,505	6,389	21,655	38,376	57,667	86,678
Cisco (Lake Erie)	5,424	--------	69,587	--------	45,328	43,786	55,968
Cisco (lake herring), including bluefin, blackfin, and chub	76,564	39,961	33,578	6,518	12,895	130,381	93,946
Cisco (tullibees, Canadian lakes)	44,274	46,070	228,812	56,777	11,052	13,266	13,811
Cod, haddock, hake, pollock	195,102	60,733	104,144	353,085	297,918	386,542	252,066
Croaker	4,644	--------	5,591	8,277	384,884	478,355	261,126
Flounders	23,137	46,225	23,190	135,635	295,711	384,546	91,747
Halibut (all trade sizes)	153,607	12,172	1,645,223	699,652	1,175,072	1,842,628	1,668,461
Herring, sea (including alewives and bluebacks)	603,295	723,234	754,279	97,469	242,281	107,496	153,221
Lake trout	12,772	12,887	26,706	8,416	34,259	185,431	77,433
Mackerel (except Spanish)	58,026	74,632	54,742	62,887	192,324	4,180,421	3,719,118
Pike, blue and sauger	693	--------	--------	3,415	6,915	298,483	392,913
Pike, yellow or wall-eyed	--------	16,711	72,268	--------	7,631	3,531	24,220
Pike (including pickerel, jacks, and yellow jack)	157,311	51,462	60,143	2,839	2,954	99,088	36,744

Fish frozen, 1928—Continued

BY SPECIES AND MONTHS—Continued

Species	Month ended—						
	Jan. 15	Feb. 15	Mar. 15	Apr. 15	May 15	June 15	July 15
	Pounds	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*
Sablefish (black cod)	31, 412	33, 335	24, 283	17, 643	37, 547	91, 033	121, 646
Salmon, chinook	2, 240	1, 000	1, 656	52, 565	43, 270	149, 390	426, 728
Salmon, silver	1, 692	119, 007	91, 253	7, 728	4, 566	71, 641	483, 717
Salmon, fall and pink	42, 074	40, 429	34, 141	10, 584	9, 536	55, 919	110, 624
Salmon, steelhead trout	1, 021	1, 264	6, 171		11, 129	14, 983	296, 816
Salmon, all other	13, 614	30, 622	51, 528	25, 233	89, 985	204, 604	356, 924
Scup (porgies)			92		86, 941	478, 886	444, 452
Shad and shad roe	965	1, 590	51, 587	7, 217	77, 459	168, 940	92, 457
Shellfish	232, 821	650, 672	142, 082	162, 705	167, 912	359, 403	157, 652
Smelts, eulachon, etc	9, 750	7, 211	408, 873	7, 763	1, 505	4, 467	510
Squid	3, 918		780		860, 947	3, 631, 697	1, 279, 855
Sturgeon and spoonbill cat	3, 617	2, 305	25, 108	8, 040	57, 644	86, 963	54, 357
Suckers	15, 208	15, 986	3, 910	230	9, 129	47, 852	20, 487
Weakfish (including southern "sea trout")	2, 896	2, 519	1, 669		104, 201	396, 444	159, 552
Whitefish	52, 022	17, 754	95, 913	24, 687	4, 524	150, 400	225, 894
Whiting	68, 050	200	246	830	85, 474	2, 651, 355	3, 620, 708
Miscellaneous frozen fish	506, 413	807, 837	500, 667	429, 047	1, 095, 310	1, 354, 212	1, 104, 461
Total	2, 348, 902	2, 849, 465	4, 541, 471	2, 202, 245	5, 518, 274	18, 415, 461	16, 045, 716

Species	Month ended—					Total	Per cent of total
	Aug. 15	Sept. 15	Oct. 15	Nov. 15	Dec. 15		
	Pounds	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	
Bluefish (all trade sizes)	219, 945	133, 937	69, 470	59, 074	36, 648	687, 966	0. 6
Butterfish (all trade sizes)	241, 542	395, 012	142, 992	245, 283	9, 252	1, 477, 405	1. 3
Catfish	48, 988	64, 113	48, 691	42, 732	54, 693	457, 666	. 4
Cisco (Lake Erie)	135, 132	146, 742	89, 353	45, 119	8, 996	645, 455	. 6
Cisco (lake herring), including bluefin, blackfin, and chub	106, 280	41, 480	67, 098	560, 188	892, 263	2, 061, 152	1. 8
Cisco (tullibees, Canadian lakes)	10, 697	42, 520	56, 035	606, 253	174, 342	1, 303, 409	1. 2
Cod, haddock, hake, pollock	814, 917	799, 366	864, 572	339, 877	385, 895	4, 854, 217	4. 3
Croaker	444. 477	58, 824	77, 472	24, 955	5, 899	1, 754, 454	1. 5
Flounders	112, 729	78, 591	73, 266	107, 710	92, 736	1, 465, 223	1. 3
Halibut (all trade sizes)	2, 433, 597	1, 215, 906	326, 027	426, 403	926, 697	12, 525, 445	11. 0
Herring, sea (including alewives and bluebacks)	669, 693	460, 993	880, 395	791, 337	668, 551	6, 152, 244	5. 4
Lake trout	160, 129	182. 699	212, 653	935, 860	743, 436	2, 537, 181	2. 2
Mackerel (except Spanish)	1, 170, 911	978, 740	400, 651	461, 952	196, 450	11, 550, 854	10. 2
Pike, blue and sauger	16, 924	13, 033	206. 889	468, 789	381, 602	1, 789, 656	1. 6
Pike, yellow or wall-eyed	6, 395	73, 596	25, 278	114, 712	4, 770	349, 112	. 3
Pike (including pickerel, jacks, and yellow jack)	63, 453	80, 879	83, 025	144, 063	93, 419	874, 880	. 8
Sablefish (black cod)	252, 768	424, 366	476, 010	463, 312	133, 059	2, 106, 414	1. 9
Salmon, chinook	242, 030	359, 001	259, 554	9, 146	142, 464	1, 689, 039	1. 5
Salmon, silver	1, 689, 003	1, 523, 104	1, 158, 106	771, 480	146, 001	6, 067, 298	5. 3
Salmon, fall and pink	964, 551	73, 077	390, 926	718, 564	88, 265	2, 538, 690	2. 2
Salmon, steelhead trout	194, 225	265, 544	136, 159	30, 549	179, 886	1, 137, 747	1. 0
Salmon, all other	757, 618	1, 108, 626	233, 881	158, 304	181, 072	3, 212, 011	2. 8
Scup (porgies)	183, 200	14, 793	5, 683	1, 613	3, 125	1, 218, 785	1. 1
Shad and shad roe	101, 725	79, 032	675	19, 915	2, 889	604, 451	. 5
Shellfish	229, 106	502, 584	870, 563	1, 509, 811	1, 110, 770	6, 096, 081	5. 4
Smelts, eulachon, etc	2, 637	16, 731	50, 765	142, 661	95, 878	748, 751	. 7
Squid	636, 023	227, 822	130, 998	3, 881	25, 278	6, 801, 199	6. 0
Sturgeon and spoonbill cat	67, 106	48, 383	76, 470	51, 154	50, 953	527, 100	. 5
Suckers	6, 847	2, 286	10, 562	26, 926	5, 394	164, 817	. 1
Weakfish (including southern "sea trout")	827, 319	252, 879	307, 267	1, 018, 201	149, 035	3, 221, 982	2. 8
Whitefish	81, 178	86, 114	38, 982	398, 696	440, 039	1, 616, 203	1. 4
Whiting	2, 164, 510	143, 954	108, 412	654, 285	1, 016, 667	10, 514, 686	9. 2
Miscellaneous frozen fish	2, 074, 302	1, 368, 587	1, 494, 443	2, 050, 020	2, 101, 076	14, 886, 875	13. 1
Total	17, 129, 957	11, 262, 764	9, 373, 323	13, 402, 825	10, 547, 495	113, 637, 898	100. 0

Fish frozen, 1928—Continued

BY GEOGRAPHICAL SECTIONS[1]

[Expressed in thousands of pounds; that is, 000 omitted]

Species	New England	Middle Atlantic	South Atlantic	North Central East	North Central West	South Central	Pacific	Total
Bluefish (all trade sizes)	18	528	2	132	8			688
Butterfish (all trade sizes)	189	1,103	177	8				1,477
Catfish	22	25	7	185	181	37		457
Cisco (Lake Erie)		645						645
Cisco (lake herring), including bluefin, blackfin, and chub		188		1,161	710	1		2,060
Cisco (tullibees, Canadian lakes)	34	903	4	191	171			1,303
Cod, haddock, hake, pollock	3,336	918	5	80	271	30	215	4,855
Croaker	1	784	809	161				1,755
Flounders	521	904		7			33	1,465
Halibut (all trade sizes)	301	674		657	65	1	10,828	12,526
Herring, sea (including alewives and bluebacks)	3,098	375	1	453	184		2,042	6,153
Lake trout	1	438		1,822	276			2,537
Mackerel (except Spanish)	7,910	3,050	7	93	33		456	11,549
Pike, blue and sauger		1,079		702	3	6		1,790
Pike, yellow or wall-eyed		166		158	25			349
Pike (including pickerel, jacks, and yellow jack)		61	8	662	143			874
Sablefish (black cod)		1		3	44		2,059	2,107
Salmon, chinook	6	35		34	20		1,595	1,690
Salmon, silver	55	331		18	8		5,656	6,068
Salmon, fall and pink	3	132	4	64	13		2,322	2,538
Salmon, steelhead trout	1	6					1,131	1,138
Salmon, all other	53	295		145	39		2,681	3,213
Scup (porgies)	193	1,022		1	3			1,219
Shad and shad roe	125	282	18	75	3		101	604
Shellfish	487	2,294	897	1,391	265	2	760	6,096
Smelts, eulachon, etc	44	593		6	4		102	749
Squid	4,136	2,639		14	12			6,801
Sturgeon and spoonbill cat		319	26	15	22	38	108	528
Suckers		3		161	1			165
Weakfish (including southern "sea trout")	1	2,570	649	2				3,222
Whitefish		710		826	80			1,616
Whiting	7,296	3,104	2	4	109			10,515
Miscellaneous frozen fish	2,971	2,732	1,939	2,263	1,208	1,144	2,629	14,886
Total	30,802	28,909	4,555	11,494	3,901	1,259	32,718	113,638

[1] New England includes the six States of that section; Middle Atlantic—New York, New Jersey, and Pennsylvania; South Atlantic—Delaware, Maryland, District of Columbia, Virginia, West Virginia, North Carolina, South Carolina, Georgia, and Florida; North Central East—Ohio, Indiana, Illinois, Michigan, and Wisconsin; North Central West—Minnesota, Iowa, Missouri, North Dakota, South Dakota, Nebraska, and Kansas; South Central—Kentucky, Tennessee, Alabama, Mississippi, Louisiana, Texas, Oklahoma, and Arkansas.

Fish frozen monthly, 1928

BY GEOGRAPHICAL SECTIONS[1]

[Expressed in thousands of pounds; that is, 000 omitted]

Month ended the 15th of—	New England	Middle Atlantic	South Atlantic	North Central East	North Central West	South Central	Pacific	Total
January	178	256	63	397	326	65	1,064	2,349
February	83	544	81	319	186	120	1,516	2,849
March	92	1,411	27	220	113	112	2,567	4,542
April	414	213	40	177	233	110	1,015	2,202
May	1,377	1,559	190	365	145	115	1,767	5,518
June	6,825	6,755	502	1,249	346	104	2,634	18,415
July	8,103	3,096	339	793	296	87	3,332	16,046
August	5,923	2,517	1,262	659	243	65	6,461	17,130
September	2,887	2,066	215	803	242	116	4,934	11,263
October	2,206	2,337	263	1,068	311	100	3,088	9,373
November	1,670	4,887	500	2,800	755	153	2,638	13,403
December	1,044	3,268	1,073	2,644	705	112	1,702	10,548
Total	30,802	28,909	4,555	11,494	3,901	1,259	32,718	113,638

[1] New England includes the six States of that section; Middle Atlantic—New York, New Jersey, and Pennsylvania; South Atlantic—Delaware, Maryland, District of Columbia, Virginia, West Virginia, North Carolina, South Carolina, Georgia, and Florida; North Central East—Ohio, Indiana, Illinois, Michigan, and Wisconsin; North Central West—Minnesota, Iowa, Missouri, North Dakota, South Dakota, Nebraska, and Kansas; South Central—Kentucky, Tennessee, Alabama, Mississippi, Louisiana, Texas, Oklahoma, and Arkansas.

Fish frozen in various years, 1920 to 1928

[Expressed in thousands of pounds; that is, 000 omitted]

Year	Month ended—						
	Jan. 15	Feb. 15	Mar. 15	Apr. 15	May 15	June 15	July 15
1920	2,291	2,274	2,630	2,465	3,688	10,094	12,762
1921	4,005	2,843	1,770	2,413	2,698	9,624	10,151
1922	2,442	1,453	1,364	1,497	1,980	5,850	7,376
1923	2,742	1,662	1,412	1,400	5,027	7,671	11,872
1924	3,179	2,440	2,417	2,729	6,040	8,282	11,996
1925	3,933	2,193	3,488	4,315	5,857	10,800	11,221
1928	2,349	2,849	4,542	2,202	5,518	18,415	16,046

Year	Month ended—					Total
	Aug. 15	Sept. 15	Oct. 15	Nov. 15	Dec. 15	
1920	13,620	11,804	11,169	9,712	9,751	92,260
1921	9,845	9,356	9,990	9,869	8,173	80,737
1922	9,121	10,827	16,830	9,344	7,070	75,154
1923	13,944	16,417	12,512	6,952	9,938	91,549
1924	15,542	10,585	14,878	10,855	8,381	97,324
1925	10,902	11,595	8,593	11,718	6,550	91,165
1928	17,130	11,263	9,373	13,403	10,548	113,638

Holdings of frozen fish.—That frozen fish is continuing to find favor with the consumers is indicated not only by the fact that in 1928 the amount of fish frozen increased over previous years, but also that the average monthly holdings of frozen fish in 1928 showed an increase of 10 per cent over the average monthly holdings during 1927 and 22 per cent over the 5-year average of monthly holdings. Holdings can not be correlated directly with the amount of fish frozen, due to the fact that we import fish frozen in Canada and Mexico and certain other countries. Compared with the 5-year average, the monthly holdings during 1928 showed an increase every month ranging between 7 and 41 per cent. When compared with the monthly holdings in 1927, increases are noted during 8 months, ranging from 6 to 26 per cent, while decreases are noted during 4 months ranging from 1 to 11 per cent. Total monthly holdings from August to December, inclusive, were largest, being in many instances, double the holdings for certain months during the period January to July, inclusive. Most fish were held in cold storage during December, while the least amount was held during April. This is correlated with the amounts frozen, in that there is an accumulation of stocks during the summer, when most fishing is done, and stocks are then carried over the winter, when there is little fishing, reaching a low ebb just at the beginning of the spring fishing season.

It is interesting to note that when the halibut season opened on February 15, 1928, the frozen halibut on hand amounted to 6,000,000 pounds. Stocks became depleted during the following two months, but soon began to exceed the holdings at the beginning of the season, until a peak of over 12,000,000 pounds was reported on hand on September 15. At the beginning of the mackerel season in April, about 600,000 pounds of frozen mackerel were in cold storage. Monthly holdings then increased in proportion to the fishing effort, and by October 15 around 10,000,000 pounds were in cold storage, which was the largest amount on hand during any month of the year.

As a general rule the monthly holdings of fish in the Pacific section are greatest, with average monthly holdings of 15,000,000 pounds. Those in the New England and Middle Atlantic section are usually about equal, with average monthly holdings of about 13,000,000 pounds. The average monthly holdings in the other sections vary between 500,000 pounds and 6,600,000 pounds.

Holdings of frozen fish, 1928

BY SPECIES AND MONTHS

Species	Month ended—					
	Jan. 15	Feb. 15	Mar. 15	Apr. 15	May 15	June 15
	Pounds	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*
Bluefish (all trade sizes)	274, 188	237, 013	225, 503	194, 040	161, 473	224, 992
Butterfish (all trade sizes)	317, 642	188, 536	105, 777	68, 790	46, 321	160, 026
Catfish	328, 324	295, 977	182, 541	146, 542	151, 765	175, 995
Cisco (Lake Erie)	652, 002	611, 725	556, 437	499, 879	329, 540	182, 279
Cisco (lake herring), including bluefin, blackfin, and chub	2, 976, 948	2, 440, 013	1, 502, 002	1, 014, 624	734, 435	754, 300
Cisco (tullibees, Canadian lakes)	1, 957, 972	2, 487, 214	2, 154, 696	1, 997, 939	1, 765, 863	1, 635, 092
Cod, haddock, hake, pollock	1, 359, 711	871, 338	652, 814	841, 025	1, 187, 508	1, 522, 183
Croaker	785, 741	506, 914	132, 455	61, 649	319, 406	715, 183
Flounders	520, 953	384, 610	252, 503	325, 444	581, 199	938, 557
Halibut (all trade sizes)	9, 583, 813	6, 192, 879	5, 339, 759	4, 741, 243	5, 657, 154	7, 296, 244
Herring, sea (including alewives and bluebacks)	3, 959, 495	4, 084, 577	4, 522, 840	3, 887, 422	3, 738, 620	3, 256, 226
Lake trout	1, 565, 226	1, 147, 995	666, 221	410, 085	369, 846	470, 225
Mackerel (except Spanish)	2, 653, 597	1, 776, 842	937, 062	573, 486	617, 520	4, 699, 633
Pike, blue and sauger	419, 791	300, 513	175, 331	68, 757	36, 642	387, 206
Pike, yellow or wall-eyed	412, 669	462, 690	317, 631	108, 619	57, 017	48, 676
Pike (including pickerel, jacks, and yellow jack)	1, 024, 084	974, 608	691, 831	544, 631	431, 120	454, 561
Sablefish (black cod)	2, 230, 031	1, 856, 687	1, 600, 594	1, 179, 101	1, 043, 911	1, 032, 921
Salmon, chinook	1, 231, 806	881, 929	558, 245	208, 935	83, 791	154, 795
Salmon, silver	2, 753, 845	2, 170, 446	1, 373, 362	690, 124	440, 553	355, 459
Salmon, fall and pink	942, 071	713, 128	512, 967	298, 298	235, 619	262, 911
Salmon, steelhead trout	313, 542	242, 716	84, 203	26, 402	31, 323	42, 961
Salmon, all other	1, 694, 246	1, 235, 645	528, 945	356, 578	334, 841	402, 628
Scup (porgies)	292, 435	201, 974	103, 099	75, 158	123, 927	552, 462
Shad and shad roe	390, 439	404, 781	349, 992	325, 042	397, 782	511, 727
Shellfish	1, 967, 027	2, 330, 211	1, 988, 630	1, 453, 044	997, 234	990, 129
Smelts, eulachon, etc	397, 813	1, 022, 302	1, 253, 091	710, 713	446, 712	426, 497
Squid	1, 133, 430	780, 355	440, 490	137, 520	936, 805	4, 365, 664
Sturgeon and spoonbill cat	1, 311, 514	1, 213, 367	1, 051, 954	919, 222	764, 545	723, 428
Suckers	89, 816	70, 446	38, 271	35, 147	36, 533	84, 026
Weakfish (including southern "sea trout")	798, 647	451, 279	79, 092	56, 265	144, 664	528, 276
Whitefish	1, 125, 698	1, 398, 434	1, 100, 572	576, 908	358, 224	412, 168
Whiting	2, 939, 972	1, 796, 210	1, 210, 760	695, 863	469, 031	2, 752, 386
Miscellaneous frozen fish	5, 516, 946	5, 143, 917	3, 838, 760	3, 244, 571	3, 481, 922	4, 425, 995
Total	53, 921, 434	44, 877, 271	34, 528, 430	26, 473, 066	26, 512, 846	40, 945, 811

Species	Month ended—					
	July 15	Aug. 15	Sept. 15	Oct. 15	Nov. 15	Dec. 15
	Pounds	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*
Bluefish (all trade sizes)	238, 423	485, 861	620, 735	626, 926	635, 889	704, 348
Butterfish (all trade sizes)	260, 349	480, 684	832, 267	894, 486	1, 037, 208	937, 765
Catfish	186, 134	195, 809	246, 080	222, 857	217, 676	256, 436
Cisco (Lake Erie)	117, 994	169, 769	140, 962	138, 113	91, 507	107, 390
Cisco (lake herring) including bluefin, blackfin, and chub	755, 215	920, 032	1, 200, 432	1, 223, 675	1, 467, 007	2, 100, 890
Cisco (tullibees, Canadian lakes)	1, 571, 604	1, 546, 981	1, 516, 917	1, 298, 849	1, 336, 219	1, 836, 333
Cod, haddock, hake, pollock	1, 673, 334	2, 377, 954	3, 048, 889	3, 555, 798	3, 332, 405	3, 381, 568
Croaker	923, 484	1, 361, 795	1, 024, 761	680, 725	565, 186	655, 703
Flounders	916, 505	931, 719	941, 200	948, 984	966, 451	1, 123, 599
Halibut (all trade sizes)	8, 850, 463	11, 283, 675	12, 364, 310	11, 561, 041	10, 456, 365	8, 959, 729
Herring, sea (including alewives and bluebacks)	2, 860, 245	3, 093, 442	2, 548, 074	2, 520, 471	2, 766, 530	2, 907, 567
Lake trout	563, 809	824, 320	920, 643	1, 086, 364	1, 749, 869	2, 326, 441
Mackerel (except Spanish)	8, 266, 436	9, 069, 879	9, 555, 422	9, 652, 318	8, 959, 192	8, 731, 653
Pike, blue and sauger	832, 839	720, 738	626, 280	787, 797	1, 309, 377	1, 364, 232
Pike, yellow or wall-eyed	89, 826	34, 560	87, 673	100, 130	261, 788	204, 304
Pike (including pickerel, jacks, and yellow jack)	450, 102	453, 194	442, 574	494, 051	815, 229	769, 068
Sablefish (black cod)	1, 074, 179	1, 302, 787	1, 632, 623	2, 200, 457	2, 399, 428	2, 257, 771
Salmon, chinook	496, 621	775, 064	1, 128, 489	1, 395, 300	1, 443, 182	1, 229, 967
Salmon, silver	785, 548	2, 280, 331	3, 889, 632	5, 105, 003	5, 617, 904	4, 992, 785
Salmon, fall and pink	346, 579	1, 253, 393	1, 310, 857	1, 703, 953	2, 447, 378	2, 057, 236
Salmon, steelhead trout	300, 661	202, 669	366, 669	354, 447	300, 519	329, 324
Salmon, all other	664, 463	1, 098, 361	1, 836, 218	1, 578, 370	1, 788, 143	1, 519, 041
Scup (porgies)	919, 563	971, 416	935, 230	867, 991	821, 024	735, 976
Shad and shad roe	528, 479	562, 613	615, 587	593, 320	543, 217	534, 747
Shellfish	706, 790	697, 321	1, 020, 177	1, 573, 003	2, 559, 593	3, 223, 275
Smelts, eulachon, etc	403, 161	388, 184	391, 748	415, 991	454, 176	471, 615
Squid	5, 186, 704	5, 605, 685	5, 352, 324	5, 058, 962	4, 646, 042	3, 968, 837
Sturgeon and spoonbill cat	809, 007	785, 777	735, 486	906, 919	938, 456	835, 847
Suckers	102, 967	107, 141	100, 011	102, 993	106, 609	94, 430
Weakfish (including southern "sea trout")	654, 374	1, 417, 865	1, 606, 649	1, 790, 957	2, 733, 871	2, 663, 911
Whitefish	627, 953	673, 280	602, 340	511, 441	887, 564	1, 284, 433
Whiting	6, 011, 759	7, 656, 278	6, 756, 377	6, 336, 805	6, 365, 056	6, 576, 987
Miscellaneous frozen fish	4, 964, 473	6, 441, 639	6, 954, 158	7, 116, 234	7, 655, 277	8, 951, 834
Total	53, 140, 048	66, 170, 219	71, 351, 794	78, 410, 281	77, 677, 332	78, 090, 034

Monthly holdings of frozen fish for 1928 and 1927, and the 5-year average, compared

[Expressed in thousands of pounds; that is, 000 omitted]

Month ended the 15th of—	1928	1927	5-year average	Increase (+) or decrease (−)	
				Compared with 1927	Compared with 5-year average
				Per cent	*Per cent*
January	53,921	58,655	50,959	−8	+6
February	44,877	48,684	39,516	−8	+14
March	34,528	34,889	27,191	−1	+27
April	26,473	24,732	19,079	+7	+39
May	26,513	29,781	21,884	−11	+21
June	40,946	36,694	28,982	+12	+41
July	53,140	42,116	38,294	+26	+39
August	66,170	54,063	49,459	+22	+34
September	71,352	60,328	58,052	+18	+23
October	73,410	65,958	64,853	+11	+13
November	77,677	66,791	67,510	+16	+15
December	78,090	64,788	65,061	+20	+20
Average	53,925	48,957	44,237	+10	+22

Monthly holdings of frozen fish, 1928

[Expressed in thousands of pounds; that is, 000 omitted]

BY GEOGRAPHICAL SECTIONS[1]

Month ended the 15th of—	New England	Middle Atlantic	South Atlantic	North Central East	North Central West	South Central	Pacific[2]	Total
January	9,017	13,371	1,884	10,453	3,815	539	14,842	53,921
February	5,647	12,479	1,389	9,681	4,176	549	10,956	44,877
March	3,685	9,577	554	6,753	3,729	451	9,779	34,528
April	2,496	7,341	358	4,430	3,171	374	8,303	26,473
May	3,257	6,876	369	3,750	2,760	403	9,098	26,513
June	9,519	11,887	801	4,597	2,813	464	10,865	40,946
July	16,938	13,605	1,070	4,871	3,011	513	13,132	53,140
August	21,856	14,796	2,276	5,344	3,060	481	18,337	66,170
September	22,925	15,143	2,153	5,455	3,166	476	22,034	71,352
October	23,044	15,942	2,000	5,972	3,163	432	22,857	73,410
November	21,493	18,961	2,201	7,386	4,264	582	22,790	77,677
December	19,460	21,363	3,174	11,241	4,411	663	17,778	78,090
Average	13,279	13,445	1,519	6,661	3,463	494	15,064	53,925

[1] New England includes the 6 States of that section; Middle Atlantic—New York, New Jersey, and Pennsylvania; South Atlantic—Delaware, Maryland, District of Columbia, Virginia, West Virginia, North Carolina, South Carolina, Georgia, and Florida; North Central East—Ohio, Indiana, Illinois, Michigan, and Wisconsin; North Central West—Minnestoa, Iowa, Missouri, North Dakota, South Dakota, Nebraska, and Kansas; South Central—Kentucky, Tennessee, Alabama, Mississippi, Louisiana, Texas, Oklahoma, and Arkansas; Mountain—Montana, Idaho, Wyoming, Colorado, New Mexico, Arizona, Utah, and Nevada; Pacific—Washington, Oregon, California, and Alaska.

[2] Includes a very small amount of fish held in the mountain section.

HOLDINGS OF CURED FISH

Only cured herring and mild-cured salmon are reported held in public cold-storage warehouses in the United States and Alaska during 1928. Monthly holdings of cured herring varied between 13,000,000 and 20,000,000 pounds, the lowest amount being reported in March and the highest in November. Monthly holdings of mild-cured salmon varied between 3,000,000 and 7,000,000 pounds, the lowest being reported in May and the highest in September. Stocks of cured fish held in public cold storage in the United States and Alaska have been consistently less during late years. The monthly holdings in 1928, compared with the 5-year average of the respective monthly holdings, shows a decrease each month varying between 1 and 13 per cent, and compared with the respective monthly holdings in 1927 there were decreases in 11 months ranging from 3 to 21 per cent. In only one month was there an increase, that being 4 per cent in December.

Holdings of cured fish, 1928

[By species and months]

Month ended the 15th of—	Cured herring	Mild-cured salmon	Total
	Pounds	*Pounds*	*Pounds*
January	15,413,238	6,970,511	22,383,749
February	14,679,029	5,275,499	19,954,528
March	12,857,370	3,650,905	16,508,275
April	13,331,131	3,232,877	16,564,008
May	13,110,194	2,965,752	16,075,946
June	13,504,281	3,276,397	16,780,678
July	14,382,506	3,896,266	18,278,772
August	15,269,833	5,224,056	20,493,889
September	17,424,778	7,230,645	24,655,423
October	19,137,274	6,952,942	26,090,216
November	20,337,528	6,102,052	26,439,580
December	20,256,516	5,515,415	25,771,931

Monthly holdings of cured fish for 1928 and 1927 and the 5-year average compared

[Expressed in thousands of pounds; that is, the 000 omitted]

Month ended the 15th of—	1928	1927	5-year average	Increase (+) or decrease (−): Compared with 1927	Increase (+) or decrease (−): Compared with 5-year average
				Per cent	*Per cent*
January	22,384	24,903	23,793	−10	−6
February	19,955	23,570	21,068	−15	−5
March	16,508	20,982	18,878	−21	−13
April	16,564	20,766	18,354	−20	−10
May	16,076	20,364	17,505	−21	−8
June	16,781	20,926	18,612	−20	−10
July	18,279	21,378	20,075	−14	−10
August	20,494	24,096	23,543	−15	−13
September	24,655	28,752	27,296	−14	−10
October	26,090	29,783	29,080	−12	−10
November	26,440	27,270	27,610	−3	−4
December	25,772	24,875	25,965	+4	−1
Average	20,833	23,972	22,648	−13	−8

FOREIGN FISHERY TRADE

The value of foreign trade in fishery products of the United States during 1927 amounted to $80,028,683, of which $58,854,938 represents the value of those imported for consumption and $21,173,745 the value of exports of domestic fishery products. Compared with the previous year this is an increase of 8 per cent in total trade, an increase of 6 per cent in value of imports, and an increase of 13 per cent in exports.

Imports consisted of 360,767,010 pounds of edible products (including fresh, frozen, cured, and canned fish), valued at $37,391,079, and nonedible products (comprised mainly of fish and marine-animal oils, pearls, and imitation pearls) valued at $21,463,859. Compared with 1927 this is an increase of 16 per cent in the quantity and 7 per cent in the value of edible products imported and an increase of 3 per cent in value of nonedible products imported. The increase in the quantity and value of the edible products imported was due chiefly to larger imports of fresh, frozen, and cured fish. The increase in the value of nonedible products imported was due almost entirely to the greater value of imitation pearls and pearls that had not been strung or set.

Fishery exports consisted of edible products amounting to 170,817,414 pounds, valued at $20,786,353, and nonedible products valued at $387,392. Compared with the previous year this is an increase of 8 per cent in the quantity and 13 per cent in the value of edible products exported and 3 per cent in the value of the nonedible products exported. The increase in edible exports is attributed chiefly to the larger exports of canned fish, while exports of other groups of edible fish products show little change from the preceding year. Exports of nonedible products also show but little change from that for 1927.

Considering only the amount of fishery products on which we usually have an unfavorable trade balance, the imports of fresh and frozen fish were about 21 times the exports in 1927, which is a somewhat higher ratio than in the year previous. In 1928 the imports of cured fish were almost 8 times the exports, which is a slightly higher ratio than a year ago, indicating a slackening in our cured-fish industry. Imports of fresh and canned shellfish were about two times as great as the exports in 1928, which is about the same ratio as in 1927 and 1926. Imports of all edible fishery products were about two times the exports, which is about the same ratio as in the previous year. Imports of fish and marine-animal oils were about 142 times the amount of the exports in 1928, which is a somewhat lower ratio than a year ago. While the unfavorable trade balance exists for fish and marine-animal oils, the fishery trade in the United States continues to discard large quantities of fish waste and offal, which are suitable for manufacture into oil and meal.

Contrasting these products with those on which we usually have a favorable trade balance, the exports of canned fish (which is the most important export group) were about four times the imports, which is about the same ratio as in 1927. Exports of miscellaneous edible fishery products were about four times the quantity of the imports in 1928, which is a considerably higher ratio than prevailed in 1927.

Considering the total trade, the value of all fishery products imported was about three times the value of all fishery products exported.

Exports of domestic fishery products, 1927 and 1928

Items	1927		1928	
	Quantity	*Value*	*Quantity*	*Value*
Fish, fresh, frozen, or packed in ice:				
Salmon...pounds..	3,079,251	$471,764	3,453,922	$555,316
Other fresh fish...do....	5,000,204	439,656	4,539,413	405,183
Total...do....	8,079,455	911,420	7,993,335	960,499

Exports of domestic fishery products, 1927 and 1928—Continued

Items	1927		1928	
	Quality	*Value*	*Quality*	*Value*
Fish, salted or dry cured:				
Cod....do	3,820,178	$374,347	3,165,472	$361,968
Haddock, hake and pollock....do	2,189,403	158,279	1,951,305	150,548
Herring....do	2,342,391	136,531	1,888,759	119,497
Salmon....do	2,356,291	510,406	4,367,236	975,502
Other....do	2,203,527	182,123	1,646,358	128,892
Total....do	12,911,790	1,361,686	13,019,130	1,736,407
Fish, pickled:				
Salmon....do	2,947,400	787,371	1,913,000	502,673
Other....do	1,522,400	93,392	932,800	72,045
Total....do	4,469,800	880,763	2,845,800	574,718
Fish, canned:				
Salmon....do	38,247,932	6,028,960	40,952,705	7,661,733
Sardines....do	79,439,503	6,817,662	80,253,474	6,522,711
Other....do	2,014,727	310,766	9,362,496	939,288
Total....do	119,702,162	13,157,388	130,568,675	15,123,732
Shellfish:				
Canned....do	3,863,323	825,636	4,730,944	1,011,106
Not canned....do	7,482,863	1,052,802	8,260,959	1,194,194
Total....do	11,346,186	1,878,438	12,991,903	2,205,300
Other fish products....do	1,918,114	150,929	3,398,571	185,697
Total edible products....do	158,427,507	18,340,624	170,817,414	20,786,353
Fish oils....do	692,128	80,051	881,820	105,368
Buttons, pearl, or shell....gross	395,605	128,400	454,529	135,504
Sponges....pounds	100,389	167,828	114,917	146,520
Total	....	296,228	....	282,024
Total nonedible products	....	376,279	....	387,392
Grand total	....	18,716,903	....	21,173,745

Imports of fishery products entered for consumption, 1927 and 1928

Item	1927		1928	
Edible fishery products:				
Fish, fresh, frozen, or packed in ice—	*Pounds*	*Value*	*Pounds*	*Value*
Cod, haddock, hake, and pollock	727,786	$35,484	829,906	$36,974
Eels	492,522	54,685	891,000	110,191
Fresh-water fishes	52,562,778	4,993,917	52,458,838	5,191,666
Halibut	4,014,279	478,685	4,357,977	490,653
Herring (frozen)	2,120,701	108,306	2,219,299	101,986
Herring (fresh sea)	16,959,583	132,786	54,331,131	344,212
Mackerel	2,187,412	155,925	2,169,342	146,157
Salmon	6,002,487	664,090	6,029,845	683,181
Smelts	6,716,378	930,845	8,800,895	1,209,779
Swordfish	713,987	106,422	802,045	132,371
Tuna	32,485,097	1,640,230	30,351,313	1,852,999
Other dutiable	10,065,451	1,083,200	8,036,000	817,941
Total	135,048,461	10,384,575	171,277,091	11,118,110
Fish, salted, dried, smoked, or pickled—				
Cod, dried	28,969,347	2,018,798	30,782,655	2,556,509
Finnan haddie	1,144,817	102,202	1,237,452	107,280
Hake and pollock, dried	755,414	44,756	1,884,404	112,135
Herring—				
Dried	1,210,687	75,525	1,036,843	51,863
Pickled or salted	39,291,828	2,541,124	46,439,695	3,064,147
Smoked, skinned, or boned	296,406	38,562	73,020	7,811
Mackerel, pickled or salted	12,071,146	789,004	8,130,849	568,700
Salmon dried	226,037	26,287	4,225	443
Salmon, kippered, smoked, salted, pickled or otherwise prepared	618,875	75,762	820,470	95,353
Other kippered, smoked, salted, pickled, or otherwise prepared, not elsewhere specified	5,133,696	567,916	25,464,235	2,338,707
Other dried fish	3,756,014	576,005	5,289,517	712,998
Others in bulk or packages	24,100,628	2,429,733	3,233,555	365,308
Total	117,594,895	9,285,674	124,396,920	9,981,199

Imports of fishery products entered for consumption, 1927 and 1928—Continued

Item	1927		1928	
	Pounds	*Value*	*Pounds*	*Value*
Fish packed in oil or other substances—				
Sardines	26,255,351	$5,094,583	29,243,293	$5,154,491
All others	5,922,330	1,430,683	5,132,731	1,336,825
Total	32,177,681	6,525,266	34,376,024	6,491,316
Fish roe, frozen, prepared, or preserved—				
Caviar	413,658	579,021	472,257	825,368
Other fish roe, preserved	310,413	76,683	299,492	56,598
Total	724,071	655,704	771,749	881,966
Shellfish—				
Crabs	56,708	4,568	76,660	14,879
Crab meat packed in ice, frozen, or otherwise prepared or preserved	9,300,219	4,052,750	12,506,130	4,897,835
Lobsters canned	1,773,413	1,016,706	1,605,881	1,004,472
Lobsters (other than canned), fresh frozen, packed in ice, or prepared or preserved in any manner (not specially provided for)	6,369,392	1,060,356	6,537,792	1,720,850
Turtles	745,030	40,503	670,501	38,041
Other shellfish and shrimp	8,067,729	1,228,144	8,548,262	1,242,411
Total	26,312,491	8,003,027	29,945,226	8,918,488
Total, edible fishery products	311,857,599	34,854,246	360,767,010	37,391,079
Nonedible fishery products:				
Fish and marine-animal oils—	*Quantity*		*Quantity*	
Cod oil ... Gallons	2,114,264	1,064,228	1,569,234	801,278
Cod-liver oil ... do	2,375,297	2,231,032	2,571,936	2,522,672
Herring, menhaden, and sod oil ... do	5,228,789	1,733,782	5,116,716	1,784,293
Other fish oils ... do	93,097	28,643	316,471	92,080
Seal oil ... do	629,160	250,969	194,794	86,407
Whale oil, sperm ... do	265,983	95,597	442,041	167,776
Whale oil, other ... do	7,084,127	3,178,725	6,456,866	3,021,378
Total ... do	17,790,717	8,582,976	16,668,058	8,475,884
Pearls and imitation pearl—				
Pearls and parts, not strung or set		6,043,162		7,083,654
Imitation half pearls and hollow or filled pearls, without holes or with holes partly through ... number	21,019,130	108,832		165,499
Imitation solid pearls, wholly or partly pierced, mounted or unmounted ... number	208,426	34,189		40,298
Imitation pearl beads		2,012,727		1,352,115
Total		8,198,910		8,641,566
Shells and buttons of pearl or shell—				
Shells, not manufactured—				
Green snail shell ... pounds	169,830	24,909	104,675	12,698
Mother-of-pearl ... do	6,516,562	1,708,675	6,516,745	1,882,556
All others ... do	4,353,837	230,432	2,280,987	257,313
Shells, manufactured		101,581		72,558
Shell pearl buttons—				
Fresh-water ... gross	1,419	963	3,015	1,344
Ocean or trochus ... do	106,946	35,282	118,758	45,375
Buttons, blanks, not turned, faced, or drilled ... gross	48	20	3,072	1,640
Buttons (from Philippine Islands) ... do	715,913	350,770	922,219	438,100
Total		2,452,632		2,711,584
Sponges ... pounds	811,456	1,075,398	933,232	1,124,297
Agar-agar ... do	383,250	243,168	397,368	285,659
Ambergris ... do	491	95,412	160	46,297
Cuttlefish bone ... do	281,261	36,510	287,403	35,870
Fish for purposes other than human consumption ... pounds	1,226,163	29,182	3,678,684	61,633
Fish skins, raw or salted ... do	435,723	19,864	745,880	29,440
Fish sounds, crude, dried, or salted for preservation only ... pounds	58,210	8,835	39,705	6,507
Sea grass, eelgrass, and seaweed, dyed or manufactured		34,470		44,636
Whalebone, unmanufactured ... pounds	3,441	1,761	350	456
Whalebone, manufactures of ... do	231	248	1	30
Total		469,450		510,528
Total nonedible fishery products		20,779,366		21,463,859
Grand total		55,633,612		58,854,938

Imports for consumption and domestic exports of fishery products, 1928, and ratio comparisons

Item	Imports		Exports		Ratio of imports to exports	
	Pounds	*Value*	*Pounds*	*Value*	*Quantity*	*Value*
Edible fishery products:						
Fish, fresh, frozen, or packed in ice	171,277,091	$11,118,110	7,993,335	$960,499	214:10	116:10
Fish, salted, dried, smoked, or pickled	124,396,920	9,981,199	15,864,930	2,311,125	78:10	43:10
Fish, canned or packed in oil	34,376,024	6,491,316	130,568,675	15,123,732	10:38	10:23
Shellfish, canned or fresh	29,945,226	8,918,488	12,991,903	2,205,300	23:10	40:10
Other fish products, roe, caviar, etc	771,749	881,966	3,398,571	185,697	10:44	47:10
Total	360,767,010	37,391,079	170,817,414	20,786,353	21:10	18:10
Nonedible fishery products:						
Fish and marine-animal oils [1]	125,010,435	8,475,884	881,820	105,368	1,418:10	804:10
All other		12,987,975		282,024		461:10
Total		21,463,859		387,392		554:10
Grand total		58,854,938		21,173,745		28:10

[1] Gallon of fish or marine-animal oil calculated at 7.5 pounds.

FISHERIES OF THE NEW ENGLAND STATES

The latest statistical canvass made by this division of the fisheries and fishery industries of New England (Maine, New Hampshire, Massachusetts, Rhode Island, and Connecticut) was for the calendar year 1924, and complete statistics were published in the report of the division of fishery industries for 1925 and in condensed form in Statistical Bulletin No. 703.

During 1924 the fisheries and fishery industries of New England gave employment to 24,513 persons, of whom 15,983 were employed in fishing operations, 1,922 in the wholesale fishery trade, and 6,608 in the canning, salting, smoking, and by-products industries. The yield of the fisheries aggregated 406,822,165 pounds, valued at $18,818,132, while the output of the canning, salting, smoking, and by-products industries was valued at $14,253,831. Annual statistics are collected on the vessel fisheries that center at Boston and Gloucester, Mass., and Portland, Me. A discussion of those for 1928 follows:

VESSEL FISHERIES AT PRINCIPAL NEW ENGLAND PORTS

ECONOMIC ASPECT

Landings of fishery products at the principal New England ports (Boston and Gloucester, Mass., and Portland, Me.) during 1928 amounted to 277,981,691 pounds as landed, valued at $10,849,145. This exceeded the amount landed and value of the landings for any year for which records are available. Increased landings are due in a large measure to the use of many of the important species for filleting purposes. Of the total landings, 99 per cent consisted of fresh fish and 1 per cent of salt fish.

Boston received the lion's share, the landings there in 1928 amounting to 218,387,689 pounds, valued at $8,806,164, or 79 per cent of the total. This is an increase over 1927 of 12 per cent in amount and 19 per cent in value. Landings at Gloucester in 1927 amounted to 41,903,833 pounds, valued at $1,477,700, or 15 per cent of the total.

This is a decrease of 20 per cent in amount and 1 per cent in value compared with the amount and value of the landings in 1927. At Portland 17,690,169 pounds of fishery products, valued at $565,281, were landed. This was 6 per cent of the total landings at the three ports and an increase of 8 per cent in amount and 5 per cent in value compared with the landings in 1927.

Species landed.—Among the landings of fresh fish, haddock far outranked other species in volume landed, the amount of all sizes in 1928 being 155,322,225 pounds, or 56 per cent of the total fresh fish. This is an increase of 21 per cent over the amount landed in 1927. Of the total haddock landed, 47 per cent were taken from South Channel and the remainder chiefly from Georges Bank, Nantucket Shoals, and Browns Bank.

Cod was of next importance, although a poor second. The landings of all sizes of this species, fresh, amounted to 58,154,811 pounds, or 21 per cent of the total amount of the fresh fish landed at the three ports in 1927. This is a decrease of 5 per cent from that landed in 1927. Cod was taken mainly on Georges Bank and South Channel.

Mackerel landings, fresh, amounted to 24,164,760 pounds at the three ports, or 9 per cent of the total landings of fresh fish. This is 78 per cent of the total catch of mackerel by the American mackerel fleet, and a decrease of 23 per cent compared with the landings of this species in 1927.

Flounders, a species rapidly assuming importance, ranked fourth in importance among the fresh fish, with landings of 10,414,020 pounds, or 4 per cent of the total landings of all fresh fish. This is an increase of 24 per cent over 1927.

Hake, with landings of 8,411,563 pounds, or 3 per cent of the total fresh-fish landings, ranked fifth in importance and increased 44 per cent over the landings of the previous year.

Pollock, with landings of 8,031,830 pounds, or 3 per cent of the total landings of fresh fish, in 1928 ranked sixth in importance and increased 5 per cent over the landings of the previous year.

The landings of all other varieties of fresh fish, amounting to 4 per cent of the total, increased in 1928 over the respective amount of the landings in 1927, except cusk, halibut, and herring.

Among the salt fish herring was the most important species, with landings of 1,410,564 pounds. This was 53 per cent of the landings of all salt fish and was a decrease of 68 per cent compared with the landings of this species in 1927. The landings of salt ground fish (cod, haddock, hake, cusk, pollock, and halibut) amounted to 1,186,234 pounds, or 44 per cent of the total landings of salt fish at the three ports. The combined total landings of all of the above species of ground fish landed in 1928 decreased 44 per cent compared with the total of these respective species of ground fish landed in 1927. Landings of salt mackerel were almost insignificant in 1928, amounting to 88,137 pounds, which was a decrease of 50 per cent under the landings of this species, salted, in 1927.

While the landings of salt fish by vessels at the three ports has declined tremendously during late years, it does not indicate that the salt-fish trade is declining at the same rate, although a decline is apparent. Due to improved methods of handling fish aboard vessels, improved methods of catching, and faster vessels, more fish can be brought in fresh. Large quantities of the fresh fish are still salted, especially cod, most of the trade being centered at Gloucester. Large quantities of the fresh fish are also converted into dried and smoked fish products. It has been estimated that the value of all cured fish products prepared in the United States annually is about $12,000,000.

Fishery by months.—Total landings of fish at the three ports during the month of October, which amounted to 29,918,466 pounds, exceeded those for any other month during the year. Landings during July were second largest, amounting to 27,829,838 pounds. Landings during June were third largest, amounting to 26,610,731 pounds, although those during March were almost as large, amounting to 26,046,162 pounds. As a rule, landings during each of the warmer months (May to September) were larger than during the colder months (November to April).

The following table gives the economic statistics obtained on the landings of fishery products at Boston, Gloucester, and Portland during 1927 for vessels of 5 net tons and upward, as measured by the United States Customs Service. The weights of fresh and salted fish given in this table represent the weights as landed from the vessels. Many of the fresh fish landed are eviscerated on the vessels. This is true of the ground-fish group except the flounders. Swordfish are eviscerated and beheaded. Fresh mackerel, flounders, and herring are landed in the round. Species included under "other" are generally landed in the round. Salted ground fish are landed eviscerated and beheaded; salted mackerel, eviscerated and split; and salted herring, gibbed. The values are those received by the fishermen. The grades or sizes given for certain species are those recognized in the trade.

Landings by fishing vessels at principal New England ports, 1928

BOSTON: BY MONTHS

Species	January		February		March		April	
	Pounds	*Value*	*Pounds*	*Value*	*Pounds*	*Value*	*Pounds*	*Value*
Cod, fresh:								
Large	1,826,965	$110,422	3,422,248	$159,508	3,977,397	$158,760	1,990,791	$80,501
Market	546,640	20,482	264,165	12,244	350,390	12,196	600,305	16,278
Scrod	12,230	269	8,660	208	10,455	210	12,795	159
Haddock, fresh:								
Large	7,695,798	422,796	9,265,736	562,229	15,044,455	588,830	11,751,406	281,569
Scrod	923,270	38,341	1,132,985	49,026	1,625,740	44,408	1,474,785	20,777
Hake, fresh:								
Large	482,050	23,893	255,435	10,228	214,820	12,898	72,476	2,966
Small			500	15	500	10		
Pollock, fresh	340,937	15,208	184,164	11,359	118,092	6,785	75,878	4,521
Cusk, fresh	182,010	7,322	90,545	4,487	142,060	5,987	158,245	3,276
Halibut, fresh	17,034	7,528	163,657	39,956	432,038	73,675	558,532	92,289
Flounders, fresh	479,225	36,598	811,858	44,430	823,145	40,528	920,695	37,190
Other, fresh	72,765	5,336	108,631	5,519	106,642	5,112	111,452	2,587
Total, fresh	12,578,924	688,195	15,708,584	904,209	22,845,734	949,393	17,727,360	642,113
Landed in 1927:								
Fresh	15,760,931	581,195	16,732,362	550,548	19,859,179	690,957	12,443,463	489,618

Landings by fishing vessels at principal New England ports, 1928—Continued

BOSTON: BY MONTHS—Continued

Species	May		June		July	
	Pounds	*Value*	*Pounds*	*Value*	*Pounds*	*Value*
Cod, fresh:						
Large	1,785,122	$61,862	1,751,448	$40,219	2,020,618	$79,065
Market	1,059,592	23,668	1,132,426	25,650	1,515,951	34,286
Scrod	900	9	1,000	10	215	2
Cod, salted: Large					1,865	37
Haddock, fresh:						
Large	9,116,904	174,267	8,256,160	221,255	9,438,712	186,979
Scrod	820,740	8,492	953,620	12,325	755,635	8,708
Hake, fresh: Large	101,205	3,326	196,625	3,529	305,130	4,526
Hake, salted: Large					6,760	112
Pollock, fresh	87,050	2,625	101,485	2,030	131,757	3,146
Cusk, fresh	113,765	2,041	33,592	762	60,055	1,112
Halibut, fresh	373,474	66,059	430,642	72,268	335,228	49,750
Mackerel, fresh	1,675,005	98,168	5,130,135	213,090	3,915,625	185,053
Flounders, fresh	1,018,805	21,244	446,700	15,075	372,549	13,952
Swordfish, fresh			185,558	59,142	1,301,427	262,067
Herring, fresh					3,000	38
Other, fresh	87,630	1,511	33,848	734	58,550	2,943
Total fresh	16,190,192	463,272	18,653,239	666,089	20,214,452	831,627
Total salted					8,625	149
Grand total	16,190,192	463,272	18,653,239	666,089	20,223,077	831,776
Landed in 1927:						
Fresh	15,528,116	448,984	17,733,302	580,727	15,176,211	628,497
Salted	8,000	390	4,000	200	32,400	1,456
Total	15,536,116	449,374	17,737,302	580,927	15,208,611	629,953

Species	August		September		October		November	
	Pounds	*Value*	*Pounds*	*Value*	*Pounds*	*Value*	*Pounds*	*Value*
Cod, fresh:								
Large	2,321,858	$88,490	1,448,665	$89,784	1,835,518	$94,945	1,453,236	$82,142
Market	2,696,825	58,457	1,870,875	50,652	2,881,355	75,050	1,059,325	36,803
Scrod	700	4	4,050	54	11,270	192	5,565	88
Haddock, fresh:								
Large	9,190,936	211,603	10,388,787	326,988	14,613,016	445,559	9,253,516	474,126
Scrod	561,355	7,362	664,020	12,777	1,525,275	27,441	805,580	26,966
Hake, fresh:								
Large	407,575	6,772	650,200	13,881	1,184,314	21,675	1,467,768	39,478
Small					22,000	277	57,395	973
Pollock, fresh	389,345	7,032	814,369	6,707	482,245	7,457	422,404	6,955
Cusk, fresh	61,380	939	42,995	1,002	171,090	3,538	173,050	4,622
Halibut, fresh	471,760	77,367	263,316	55,333	163,971	32,414	61,004	16,856
Mackerel, fresh	2,687,000	177,803	902,404	122,635	617,323	32,838	287,952	34,751
Mackerel, salted	19,600	1,266						
Flounders, fresh	331,125	16,909	580,167	30,373	962,138	48,291	922,167	47,197
Swordfish, fresh	659,256	146,043	114,745	29,732	2,568	808	216	69
Herring, fresh	15,000	200	1,000	20				
Herring, salted					6,000	180		
Other, fresh	19,165	1,300	90,396	12,748	51,981	4,038	64,332	2,281
Total fresh	19,818,280	800,281	17,335,989	752,686	24,474,064	794,523	16,033,510	773,307
Total salted	19,600	1,266			6,000	180		
Grand total	19,832,880	801,547	17,335,989	752,686	24,480,064	794,703	16,033,510	773,307
Landed in 1927:								
Fresh	19,197,510	815,383	18,189,319	637,253	18,835,373	673,279	14,114,617	531,703
Salted	19,400	1,056						
Total	19,216,910	816,439	18,189,319	637,253	18,835,373	673,279	14,114,617	531,703

Landings by fishing vessels at principal New England ports, 1928—Continued

BOSTON: BY MONTHS—Continued

Species	December		Total, 1928		1927	
	Pounds	*Value*	*Pounds*	*Value*	*Pounds*	*Value*
Cod, fresh:						
Large	1,307,232	$68,370	25,091,098	$1,114,068	29,678,238	$1,189,704
Market	803,035	24,389	14,780,884	390,149	10,490,120	267,313
Scrod	14,286	518	82,126	1,723	141,315	1,913
Cod, salted: Large			1,865	37		
Haddock, fresh:						
Large	10,771,663	403,160	124,787,089	4,299,361	96,118,574	2,878,336
Scrod	809,188	17,985	12,052,193	274,608	13,741,779	270,733
Hake, fresh:						
Large	1,164,025	32,353	6,501,623	180,525	4,724,916	130,586
Small	1,250	48	81,645	1,323	54,525	699
Hake, salted: Large			6,760	112		
Pollock, fresh	489,610	9,824	3,087,336	83,649	3,201,525	86,112
Cusk, fresh	344,460	8,381	1,573,247	43,469	1,680,124	44,905
Halibut, fresh	45,606	13,547	3,316,262	597,042	4,320,036	764,079
Mackerel, fresh	69,617	8,573	15,285,061	872,911	20,380,280	860,083
Mackerel, salted			19,600	1,266	63,800	3,102
Flounders, fresh	914,292	48,967	8,582,866	400,754	(1)	(1)
Swordfish, fresh			2,263,770	497,861	(1)	(1)
Herring, fresh	400	12	19,400	270	(1)	(1)
Herring, salted			6,000	180		
Other, fresh	43,472	2,747	848,864	46,856	10,345,557	873,977
Total, fresh	16,778,136	638,874	218,353,464	8,804,569	194,876,989	7,368,440
Total, salted			34,225	1,595	63,800	3,102
Grand total	16,778,136	638,874	218,387,689	8,806,164	194,940,789	7,371,542
Landed in 1927:						
Fresh	11,306,606	740,296			194,876,989	7,368,440
Salted					63,800	3,102
Total	11,306,606	740,296			194,940,789	7,371,542

[1] Included in "Other, fresh."

NOTE.—The weights of fresh and salted fish given in these statistics represent the fish as landed from the vessels, and the values are those received by the fishermen. Large cod are classified as those weighing over 10 pounds; market cod, 2½ to 10 pounds; and scrod cod, 1 to 2½ pounds. Large haddock are those weighing over 2½ pounds and scrod haddock 1 to 2½ pounds. Large hake are those weighing over 6 pounds and small hake under 6 pounds.

GLOUCESTER: BY MONTHS

Species	January		February		March		April	
	Pounds	*Value*	*Pounds*	*Value*	*Pounds*	*Value*	*Pounds*	*Value*
Cod, fresh:								
Large	265,050	$18,169	478,080	$30,039	1,068,855	$49,533	1,306,405	$54,352
Market	210	8	660	33	14,430	403	64,705	1,240
Cod, salted:								
Large					2,400	120	24,455	1,250
Market					150	6	2,949	123
Haddock, fresh:								
Large	169,270	10,196	109,270	7,717	441,020	14,817	1,622,905	29,545
Scrod	38,590	1,571	23,850	1,260	53,015	1,255	160,010	1,374
Hake, fresh: Large							1,300	14
Pollock, fresh	24,110	1,714			1,155	12	4,285	42
Cusk, fresh							9,810	108
Flounders, fresh	240,340	13,569	196,760	13,815	390,090	32,808	110,600	6,905
Herring, salted	787,140	30,271						
Total, fresh	737,570	45,227	808,620	52,864	1,968,565	98,828	3,280,020	93,580
Total, salted	787,140	30,271			2,550	126	27,404	1,373
Grand total	1,524,710	75,498	808,620	52,864	1,971,115	98,954	3,307,424	94,953
Landed in 1927:								
Fresh	1,391,540	42,587	1,755,345	49,382	6,548,000	145,929	4,923,195	138,149
Salted	1,696,480	61,420	385	16	341,395	12,762	298,008	10,029
Total	3,088,020	104,007	1,755,730	49,398	6,889,395	158,691	5,221,203	148,178

Landings by fishing vessels at principal New England ports, 1928—Continued

GLOUCESTER: BY MONTHS—Continued

Species	May		June		July	
	Pounds	*Value*	*Pounds*	*Value*	*Pounds*	*Value*
Cod, fresh:						
Large	2,533,670	$74,248	2,415,325	$67,122	1,480,240	$40,045
Market	532,090	10,645	530,645	8,821	600,900	12,584
Scrod	150	2			400	4
Cod, salted:						
Large	192,890	10,092	154,287	8,004	105,460	5,593
Market	38,800	1,533	43,528	1,692	21,590	843
Scrod					400	11
Haddock, fresh:						
Large	1,078,170	19,475	491,655	9,256	1,254,085	17,629
Scrod	52,210	587	44,055	480	82,215	780
Hake, fresh, large	13,505	234	17,485	313	19,665	274
Pollock, fresh	135,670	3,230	171,105	4,018	30,705	409
Pollock, salted	155	4	1,395	28	1,250	25
Cusk, fresh	14,480	173	21,300	292	50,870	779
Cusk, salted	240	5	780	16	2,160	43
Halibut, salted	80	8	2,815	246	45	2
Mackerel, fresh	85,210	4,981	2,053,240	75,986	2,359,580	93,179
Mackerel, salted					19,310	676
Flounders, fresh	32,750	1,369	26,900	1,047		
Swordfish, fresh					410	94
Other, fresh					23,800	238
Total, fresh	4,477,905	114,939	5,771,710	167,335	5,902,870	166,015
Total, salted	232,165	11,642	202,805	9,986	150,215	7,193
Grand total	4,710,070	126,581	5,974,515	177,321	6,053,085	173,208
Landed in 1927:						
Fresh	3,978,079	75,882	3,742,935	63,447	6,513,856	140,487
Salted	417,040	15,640	635,642	23,873	239,850	9,065
Total	4,395,119	91,522	4,378,577	87,320	6,753,706	149,552

Species	August		September		October		November	
	Pounds	*Value*	*Pounds*	*Value*	*Pounds*	*Value*	*Pounds*	*Value*
Cod, fresh:								
Large	734,500	$20,015	864,785	$43,260	581,097	$28,744	330,230	$18,763
Market	484,245	10,805	272,405	5,830	180,220	4,156	45,180	1,175
Scrod	2,420	24			2,600	30	1,895	22
Cod, salted:								
Large	174,370	9,301	130,645	7,150	40,695	2,132	13,125	716
Market	18,618	792	9,030	406	3,835	167	962	44
Haddock, fresh:								
Large	854,730	13,259	537,350	12,536	1,231,105	28,181	525,057	26,429
Scrod	36,570	378	21,930	334	106,135	1,395	52,590	1,607
Haddock, salted:								
Large					8,170	425		
Scrod					70	2		
Hake, fresh:								
Large	19,981	250	82,655	1,669	134,240	2,121	77,607	1,782
Small					2,355	37	875	17
Hake, salted:								
Large			760	18	1,115	17		
Small							840	17
Pollock, fresh	45,325	562	209,835	4,715	532,305	10,361	1,663,660	27,673
Pollock, salted	2,505	50	2,505	47	700	18	80	2
Cusk, fresh	97,445	1,580	58,215	963	28,675	486	12,595	250
Cusk, salted	2,905	66	430	9				
Halibut, fresh					187	41	704	170
Halibut, salted	580	58						
Mackerel, fresh	1,333,800	63,221	195,870	24,766	669,671	28,417	1,054,179	109,223
Mackerel, salted	38,520	3,027	9,980	1,031	340	68		
Flounders, fresh	11,430	457	43,320	2,518	103,440	5,910	82,147	5,675
Swordfish, fresh	10,400	2,080	7,530	1,807				
Herring, fresh			181,400	1,814	71,400	889		
Other, fresh	101,070	1,029			7,852	622	15,987	272
Total, fresh	3,731,916	113,660	2,475,295	100,212	3,651,282	111,390	3,862,636	193,058
Total, salted	237,498	13,294	153,350	8,661	54,925	2,829	15,007	779
Grand total	3,969,414	126,954	2,628,645	108,873	3,706,207	114,219	3,877,643	193,837
Landed in 1927:								
Fresh	7,670,980	187,888	2,945,538	97,504	2,106,140	103,080	2,919,086	64,817
Salted	313,645	12,662	102,752	4,924	53,733	2,520	14,410	682
Total	7,984,625	200,550	3,048,290	102,428	2,159,873	105,600	2,933,496	65,499

Landings by fishing vessels at principal New England ports, 1928—Continued

GLOUCESTER: BY MONTHS—Continued

Species	December		Total, 1928		1927	
	Pounds	*Value*	*Pounds*	*Value*	*Pounds*	*Value*
Cod, fresh:						
Large	268,689	$15,587	12,326,926	$459,872	16,401,220	$469,203
Market	36,195	838	2,761,885	56,538	1,958,342	32,949
Scrod	325	7	7,790	89	10,586	105
Cod, salted:						
Large	15,065	904	853,392	45,262	1,658,590	65,905
Market	550	27	140,012	5,633	216,503	6,302
Scrod			400	11	3,833	76
Haddock, fresh:						
Large	589,405	20,870	8,904,022	209,910	10,533,191	181,081
Scrod	75,395	1,460	746,495	12,481	730,000	6,283
Haddock, salted:						
Large			8,170	425	49,580	625
Scrod			70	2		
Hake, fresh:						
Large	18,140	343	384,578	7,000	213,015	2,977
Small	500	7	3,730	61		
Hake, salted:						
Large	445	10	2,320	45	14,505	291
Small			840	17	760	15
Pollock, fresh	1,265,020	23,077	4,083,175	75,813	3,636,000	72,067
Pollock, salted			8,590	174	9,570	191
Cusk, fresh	4,610	64	298,000	4,695	324,500	4,175
Cusk, salted			6,515	139	31,732	731
Halibut, fresh	17	3	908	214	37,085	2,937
Halibut, salted			3,520	314	5,797	555
Mackerel, fresh	392,900	42,253	8,144,450	442,026	10,459,005	411,813
Mackerel, salted			68,150	4,802	95,390	5,157
Flounders, fresh	84,430	5,773	1,322,207	89,846	(1)	(1)
Swordfish, fresh			18,340	3,981	(1)	(1)
Herring, fresh			252,800	2,703	(1)	(1)
Herring, salted	617,424	23,018	1,404,564	53,289	4,410,436	163,825
Other, fresh	3,275	197	151,984	2,358	1,752,900	66,672
Total, fresh	2,738,901	110,479	39,407,290	1,367,587	46,055,844	1,250,262
Total, salted	633,484	23,959	2,496,543	110,113	6,496,696	243,673
Grand total	3,372,385	134,438	41,903,833	1,477,700	52,552,540	1,493,935
Landed in 1927:						
Fresh	1,561,150	141,110			46,055,844	1,250,262
Salted	2,383,356	90,080			6,496,696	243,673
Total	3,944,506	231,190			52,552,540	1,493,935

[1] Included in "Other, fresh."

PORTLAND: BY MONTHS

Species	January		February		March		April	
	Pounds	*Value*	*Pounds*	*Value*	*Pounds*	*Value*	*Pounds*	*Value*
Cod, fresh:								
Large	35,644	$2,155	212,900	$8,530	107,361	$4,154	204,385	$5,829
Market	24,563	1,145	23,377	1,265	34,150	1,563	50,495	1,137
Scrod	6,413	67	4,355	46	6,045	59	2,955	19
Cod, salted, large							116,000	1,710
Haddock, fresh:								
Large	309,008	19,850	315,203	20,499	826,630	30,649	981,485	16,660
Scrod	10,146	103	9,450	95	8,980	92	3,108	21
Hake, fresh:								
Large			515	26	3,540	144		
Small	41,193	1,766	20,640	797	30,526	989	5,790	143
Hake, salted, small			1,125	17				
Pollock, fresh	17,681	610	14,008	596	22,972	1,027	5,120	100
Cusk, fresh	51,323	2,247	34,885	1,880	55,252	2,405	66,673	1,434
Cusk, salted					100	1		
Halibut, fresh	1,085	286	5,147	966	11,535	2,086	2,689	495
Flounders, fresh	66,813	3,170	63,932	3,145	82,945	3,017	22,432	800
Other, fresh	15,774	454	29,773	851	39,277	1,240	12,036	285
Total, fresh	579,643	31,853	734,185	38,696	1,229,213	47,425	1,357,163	26,923
Total, salted			1,125	17	100	1	116,000	1,710
Grand total	579,643	31,853	735,310	38,713	1,229,313	47,426	1,473,163	28,633
Landed in 1927:								
Fresh	621,969	30,807	484,143	25,459	1,341,123	44,367	1,661,918	44,516
Salted			745	16	2,630	83	8,890	373
Total	621,969	30,807	484,888	25,475	1,343,753	44,450	1,670,808	44,889

Landings by fishing vessels at principal New England ports, 1928—Continued

PORTLAND: BY MONTHS—Continued

Species	May		June		July	
	Pounds	*Value*	*Pounds*	*Value*	*Pounds*	*Value*
Cod, fresh:						
Large	376,971	$12,249	281,890	$11,201	269,556	$11,385
Market	62,154	1,343	15,586	325	6,959	157
Scrod	4,565	41	965	8	1,385	8
Cod, salted:						
Large	21,775	1,087	1,510	76		
Market	1,970	79	135	5		
Haddock, fresh:						
Large	2,475,252	37,899	1,258,817	20,444	659,009	13,018
Scrod	895	4	2,140	14	3,995	20
Hake, fresh:						
Large	6,742	125	685	7	610	8
Small	45,826	924	35,790	423	44,315	806
Hake, salted, small	260	5				
Pollock, fresh	67,492	1,394	95,421	1,438	117,279	2,172
Pollock, salted	45	1				
Cusk, fresh	39,305	879	6,280	93	969	29
Cusk, salted	620	12				
Halibut, fresh	35,802	5,921	3,430	628	530	78
Mackerel, fresh			236,000	8,903	96,114	4,138
Flounders, fresh	45,485	892	13,795	138	33,555	832
Swordfish, fresh					121,724	23,073
Herring, fresh			9,000	182		
Other, fresh	16,261	345	21,533	464	197,676	3,853
Total, fresh	3,176,750	61,516	1,981,332	44,218	1,553,676	59,577
Total, salted	24,670	1,184	1,645	81		
Grand total	3,201,420	62,700	1,982,977	44,299	1,553,676	59,577
Landed in 1927:						
Fresh	2,553,151	48,520	1,856,378	43,858	1,092,078	41,052
Salted	18,965	806	1,320	56	29,907	1,013
Total	2,572,116	49,326	1,857,698	43,914	1,121,985	42,065

Species	August		September		October		November	
	Pounds	*Value*	*Pounds*	*Value*	*Pounds*	*Value*	*Pounds*	*Value*
Cod, fresh:								
Large	539,598	$20,264	214,265	$10,614	195,940	$10,301	108,685	$5,975
Market	43,557	1,095	11,838	1,879	30,408	756	28,819	789
Scrod	2,090	21	2,795	15	10,992	59	5,810	36
Cod, salted:								
Large	7,240	344						
Market	3,000	113						
Haddock, fresh:								
Large	174,505	6,232	238,389	10,921	490,436	20,257	474,352	22,299
Scrod	5,510	50	12,541	83	18,492	114	19,580	115
Hake, fresh:								
Large	3,620	82	7,065	103	135	3	145	4
Small	81,407	1,552	331,628	6,715	344,995	7,251	259,295	6,162
Pollock, fresh	91,172	1,476	129,978	1,845	128,493	1,795	102,638	1,364
Cusk, fresh	1,903	33	7,700	154	83,770	1,885	56,695	1,435
Halibut, fresh	1,498	393	307	36	1,395	222	564	108
Mackerel, fresh	357,627	18,744	26,998	1,630	7,422	344	11,088	1,123
Mackerel, salted			387	31				
Flounders, fresh	15,610	458	21,183	1,316	37,015	1,805	46,965	2,712
Swordfish, fresh	119,996	24,994	19,810	4,762				
Herring, fresh	32,100	401			301,100	1,231	91,400	572
Other, fresh	226,259	8,539	71,119	1,531	81,602	1,602	52,544	1,042
Total, fresh	1,696,452	79,329	1,095,616	41,604	1,732,195	47,625	1,258,600	43,736
Total, salted	10,240	457	387	31				
Grand total	1,706,692	79,786	1,096,003	41,635	1,732,195	47,625	1,258,600	43,736
Landed in 1927:								
Fresh	1,724,483	73,709	1,866,309	58,449	1,307,303	39,219	993,397	39,227
Salted	24,291	808	25,405	1,083	15,985	729	2,505	124
Total	1,748,774	74,517	1,891,714	59,532	1,323,288	39,948	995,902	39,351

Landings by fishing vessels at principal New England ports, 1928—Continued

PORTLAND: BY MONTHS—Continued

Species	December		Total, 1928		1927	
	Pounds	*Value*	*Pounds*	*Total*	*Pounds*	*Total*
Cod, fresh:						
Large	126,006	$6,135	2,673,201	$108,792	2,237,740	$95,971
Market	45,495	1,257	377,401	12,711	362,189	11,641
Scrod	5,130	32	53,500	411	87,695	936
Cod, salted:						
Large			146,525	3,217	99,252	4,153
Market			5,105	197	8,906	328
Scrod					200	4
Haddock, fresh:						
Large	519,693	20,658	8,722,779	238,886	7,273,711	193,029
Scrod	14,815	99	109,647	810	145,328	1,616
Haddock, salted, large					520	10
Hake, fresh:						
Large	10,005	287	33,062	789	15,465	447
Small	165,520	4,259	1,406,925	31,787	837,480	21,486
Hake, salted:						
Large					280	7
Small			1,385	22	1,680	37
Pollock, fresh	69,065	977	861,319	14,794	814,186	13,440
Pollock, salted			45	1	1,080	39
Cusk, fresh	74,450	1,950	479,205	14,424	688,601	21,508
Cusk, salted			720	13	2,260	55
Halibut, fresh	807	191	64,789	11,410	416,365	72,374
Mackerel, fresh			735,249	34,882	514,951	14,034
Mackerel, salted			387	31	16,465	458
Flounders, fresh	59,197	2,416	508,947	20,696	(1)	(1)
Swordfish, fresh			261,530	52,829	(1)	(1)
Herring, fresh			433,600	2,336	(1)	(1)
Other, fresh	50,994	1,037	814,848	16,243	2,831,890	86,561
Total, fresh	1,141,177	39,298	17,536,002	561,800	16,225,601	533,943
Total, salted			154,167	3,481	130,643	5,091
Grand total	1,141,177	39,298	17,690,169	565,281	16,356,244	539,034
Landed in 1927:						
Fresh	723,349	44,760			16,225,601	533,943
Salted					130,643	5,091
Total	723,349	44,760			16,356,244	539,034

[1] Included in "Other, fresh."

SUMMARY: BY PORTS

Species	Boston		Gloucester		Portland	
	Pounds	*Value*	*Pounds*	*Value*	*Pounds*	*Value*
Cod, fresh:						
Large	25,091,098	$1,114,068	12,326,926	$459,872	2,673,201	$108,792
Market	14,780,884	390,149	2,761,885	56,538	377,401	12,711
Scrod	82,126	1,723	7,790	89	53,500	411
Cod, salted:						
Large	1,865	37	853,392	46,262	146,525	3,217
Market			140,012	5,633	5,105	197
Scrod			400	11		
Haddock, fresh:						
Large	124,787,089	4,299,361	8,904,022	209,910	8,722,779	238,886
Scrod	12,052,193	274,608	746,495	12,481	109,647	810
Haddock, salted:						
Large			8,170	425		
Scrod			70	2		
Hake, fresh:						
Large	6,501,623	180,525	384,578	7,000	33,062	789
Small	81,645	1,323	3,730	61	1,406,925	31,787
Hake, salted:						
Large	6,760	112	2,320	45		
Small			840	17	1,385	22
Pollock, fresh	3,087,336	83,649	4,083,175	75,813	861,319	14,794
Pollock, salted			8,590	174	45	1
Cusk, fresh	1,573,247	43,469	298,000	4,695	479,205	14,424
Cusk, salted			6,515	139	720	13
Halibut, fresh	3,316,262	597,042	908	214	64,789	11,410
Halibut, salted			3,520	314		
Mackerel, fresh	15,285,061	872,911	8,144,450	442,026	735,249	34,882
Mackerel, salted	19,600	1,266	68,150	4,802	387	31
Flounders, fresh	8,582,866	400,754	1,322,207	89,846	508,947	20,696
Swordfish, fresh	2,263,770	497,861	18,340	3,981	261,530	52,829
Herring, fresh	19,400	270	252,800	2,703	433,600	2,336
Herring, salted	6,000	180	1,404,564	53,289		

Landings by fishing vessels at principal New England ports, 1928—Continued

SUMMARY: BY PORTS—Continued

Species	Boston		Gloucester		Portland	
	Pounds	*Value*	*Pounds*	*Value*	*Pounds*	*Value*
Other, fresh	848,864	$46,856	151,984	$2,358	814,848	$16,243
Total, fresh	218,353,464	8,804,569	39,407,290	1,367,587	17,536,002	561,800
Total, salted	34,225	1,595	2,496,543	110,113	154,167	3,481
Grand total	218,387,689	8,806,164	41,903,833	1,477,700	17,690,169	565,281
Landed in 1927:						
Fresh	194,876,989	7,368,440	46,055,844	1,250,262	16,225,601	533,943
Salted	63,800	3,102	6,496,696	243,673	130,643	5,091
Total	194,940,789	7,371,542	52,552,540	1,493,935	16,356,244	539,034

Species	Total, 1928		1927	
	Pounds	*Value*	*Pounds*	*Value*
Cod, fresh:				
Large	40,091,225	$1,682,732	48,317,198	$1,754,878
Market	17,920,170	459,398	12,810,651	311,903
Scrod	143,416	2,223	239,596	2,954
Cod, salted:				
Large	1,001,782	48,516	1,757,842	70,058
Market	145,117	5,830	225,409	6,630
Scrod	400	11	4,033	80
Haddock, fresh:				
Large	142,413,890	4,748,157	113,925,476	3,252,446
Scrod	12,908,335	287,899	14,617,107	278,632
Haddock, salted:				
Large	8,170	425	50,100	635
Scrod	70	2		
Hake, fresh:				
Large	6,919,263	188,314	4,953,396	134,010
Small	1,492,300	33,171	892,005	22,185
Hake, salted:				
Large	9,080	157	14,785	298
Small	2,225	39	2,440	52
Pollock, fresh	8,031,830	174,256	7,651,711	171,619
Pollock, salted	8,635	175	10,650	230
Cusk, fresh	2,350,452	62,588	2,693,225	70,588
Cusk, salted	7,235	152	33,992	786
Halibut, fresh	3,381,959	608,666	4,773,486	839,390
Halibut, salted	3,520	314	5,797	555
Mackerel, fresh	24,164,760	1,349,819	31,354,236	1,286,830
Mackerel, salted	88,137	6,099	175,655	8,717
Flounders, fresh	10,414,020	511,296	8,359,131	419,744
Swordfish, fresh	2,543,640	554,671	2,245,493	513,582
Herring, fresh	705,800	5,309	2,735,000	36,911
Herring, salted	1,410,564	53,469	4,410,436	163,825
Other, fresh	[1] 1,815,696	[1] 65,457	1,590,723	56,973
Total, fresh	275,296,756	10,733,956	257,158,434	9,152,645
Total, salted	2,684,935	115,189	6,691,139	251,866
Grand total	277,981,691	10,849,145	263,849,573	9,404,511
Landed in 1927:				
Fresh			257,158,434	9,152,645
Salted			6,691,139	251,866
Total			263,849,573	9,404,511

[1] The items under "Other" include bluebacks, 444,125 pounds, value $6,038; bonito, 40 pounds, value $10; butterfish, 110,668 pounds, value $17,677; eels, 38 pounds, value $2; "perch" or cunner, 30 pounds, value $2; rosefish, 106,027 pounds, value $1,716; salmon, 7 pounds, value $2; sea robins, 300 pounds, value $3; shad, 34,561 pounds, value $1,156; sharks, 62,488 pounds, value $1,114; skates, 22,645 pounds, value $337; smelt, 441 pounds, value $87; sturgeon, 2,614 pounds, value $578; tuna, 696 pounds, value $81; whiting, 28,846 pounds, value $791; wolffish, 466,599 pounds, value $13,827; lobster, 138 pounds, value $38; scallops, 5,894 pounds, value $1,812; livers, 368,145 pounds, value $7,715; spawn, 159,674 pounds, value $12,436; and tongues, 1,730 pounds, value $35.

BIOLOGICAL ASPECT

Paralleling the northeastern coast line of North America lies a chain of fishing grounds—a series of plateaus and ridges rising from the ocean bed to make comparatively shallow soundings. For centuries these have played a large part in feeding the nations bordering upon the Atlantic Ocean, and the development of their resources has been a great factor in the exploration of the New World.

These grounds extend from the Flemish Cap, in 44° 06′ west longitude and 47° north latitude, marking the easternmost point of this great area, for a distance of about 2,000 miles to New York, providing an almost continuous extent of most productive fishing ground. Within this chain of grounds is the Gulf of Maine, where the chain is further extended by series of smaller grounds, and again, lying inside of these, the fishing area is increased by a very large number of smaller grounds and fishing spots situated but a short distance from the mainland. All of these banks are breeding places for the valuable cod, haddock, cusk, hake, pollock, halibut, and flounders, and each in its proper season constitutes a fishing ground where may be taken many other important species of migratory and pelagic fishes, such as mackerel and herring. Fishing vessels landing fares at Boston and Gloucester, Mass., and Portland, Me., make their catches on certain of these grounds. A discussion of the activities of these vessels during 1928 is contained in this section.

In 1928 the fishing fleet landing fares at the three New England ports numbered 405 steam, motor, and sail vessels of over 5 net tons, as measured by the United States Customs Service. These made 11,616 trips to the fishing grounds and were absent from port 48,849 days, or on the average about 4.2 days per trip. Their catches of edible fish landed at the three ports amounted to 279,795,460 pounds when the salted fish had been converted to the basis of fresh gutted fish. This does not represent the entire catch of edible fish of these vessels, for small quantities, estimated at not more than 5 per cent of their total catch, were landed at ports in New England other than these three and at New York City.

The fishing vessels landing fares at these three ports do not always operate the same type of gear throughout the year; at one season of the year a certain vessel may be outfitted as a line trawler, at another season as a purse seiner, and at still another season for swordfishing with harpoons. Thus, vessels may fish two or three types of gear during the year. In such a case the vessel is classed with others operating similar gear while it is fishing that type of gear.

From the tables it will be noted that the grand total of the number of vessels operated is exclusive of duplication and that the total number of vessels operating each type of gear is also shown.

Line trawls.—A line-trawl fishery was prosecuted by 99 vessels in 1928. These vessels made 1,851 trips to 22 main fishing grounds and were absent from port 12,768 days, or an average of about 6.9 days per trip. Their catches aggregated 77,208,237 pounds, or 28 per cent of the total landings by vessels at the three ports. Of this amount, haddock constituted 42 per cent, cod 42 per cent, hake 8 per cent, and halibut 4 per cent. Other species of importance in the catch by line trawls were cusk and pollock. Of the total catch, 30 per cent was taken in South Channel, 21 per cent on Georges Bank, 12 per cent on Browns Bank, and 10 per cent on Western Bank. Other banks on which fair quantities of fish were taken by line trawls were La Have and Jeffreys Ledge.

Hand lines.—A hand-line fishery was prosecuted by 42 vessels in 1928. These vessels made 371 trips to 10 main fishing grounds and were absent from port 2,872 days, or an average of about 7.7 days per trip. Their catches aggregated 12,993,668 pounds, or 5 per cent of the total landings by vessels at the three ports. Of this amount, cod constituted 83 per cent, haddock 7 per cent, pollock 6 per cent, and halibut 2 per cent. Only minor quantities of other species were taken by hand lines. Of the total catch 66 per cent was taken on Georges Bank, 11 per cent on Browns Bank, and 9 per cent on Nantucket Shoals. Other grounds on which fair quantities of fish were taken by hand lines are Cape Shore and Smith Channel.

Harpoons.—A fishery with harpoons was prosecuted by 80 vessels in 1928. These vessels made 236 trips to 7 main fishing grounds and were absent from port 3,788 days, or an average of 16 days per trip. Their catch amounted to 2,413,583 pounds of swordfish and 326 pounds of other fish, or a total of about 1 per cent of the total landings by vessels at the three ports. Of the total catch, 66 per cent was taken on Georges Bank. Other grounds on which considerable quantities of swordfish were taken by harpoons are Browns Bank and Cape Shore.

Otter trawls, large vessels.—A fishery with otter trawls was prosecuted by 43 vessels of 91 net tons and over in 1928. These vessels made 1,010 trips to seven main fishing grounds and were absent from port 7,789 days, or an average of 7.7 days per trip (7.5 days in 1927). This is an increase of 17 vessels over the number operated in 1927, an increase of 27 per cent in the number of trips, and an increase of 31 per cent in the number of days absent. The catch amounted to 87,497,720 pounds, or 31 per cent of the total landings by vessels at the three ports. Of the total amount, 87 per cent consisted of haddock, 7 per cent of cod, 2 per cent of flounders, 2 per cent of hake, and 2 per cent of pollock. Only minor quantities of other species were taken by large otter trawlers. Of the total catch, 56 per cent was taken on South Channel, 37 per cent on Georges Bank, and 6 per cent on Nantucket Shoals. Minor catches were made on the other grounds, where large otter trawlers fished.

It is interesting to note the comparative statistics on the landings by large otter trawlers of cod, haddock, and hake at the three ports during certain years from 1908 to 1928 upon which records are available. Haddock has always been the most important species (in volume) landed by this type of vessel. Beginning with landings of about 1,500,000 pounds in 1908, they increased steadily each year until 1920, when nearly 52,000,000 pounds were landed. The following year there was a decline to about 27,000,000 pounds. During the three years following the landings remained fairly constant around 35,000,000 pounds, then increased rapidly, until in 1928 the landings were about 76,000,000 pounds.

The landings of cod, the next important species taken by large otter trawlers, increased from about 200,000 pounds in 1908 to about 15,000,000 pounds in 1923. Since then there has been a decline, although the catch in 1928 amounted to over 6,000,000 pounds. The landings of hake by large otter trawlers began with 46,000 pounds in 1908 and increased steadily until 1928, when nearly 1,500,000 pounds were landed.

Cod, haddock, and hake landed at Boston and Gloucester, Mass., and Portland, Me., by large otter trawlers in various years

Year	Trips	Cod	Haddock	Hake	Year	Trips	Cod	Haddock	Hake
		Pounds	*Pounds*	*Pounds*			*Pounds*	*Pounds*	*Pounds*
1908	44	209, 800	1, 542, 000	46, 600	1921	346	2, 482, 833	26, 734, 893	241, 650
1909	47	159, 800	1, 719, 000	74, 400	1922	578	11, 161, 947	35, 878, 524	576, 370
1910	59	125, 850	2, 773, 000	46, 600	1923	665	14, 961, 590	35, 527, 297	471, 600
1911	178	564, 500	7, 367, 100	151, 700	1924	543	8, 231, 430	35, 197, 940	616, 853
1912	295	1, 952, 950	12, 966, 700	105, 500	1925	607	7, 309, 930	44, 034, 281	711, 212
1913	326	1, 667, 806	12, 488, 992	209, 485	1926	667	5, 203, 911	52, 405, 653	894, 885
1914	387	1, 149, 595	15, 383, 550	259, 913	1927	794	3, 982, 905	69, 237, 652	994, 730
1920	646	6, 311, 389	51, 962, 457	....	1928	1, 010	6, 295, 138	75, 876, 486	1,455,675

Otter trawls, medium vessels.—A fishery with otter trawls was also prosecuted by 89 vessels of 21 to 90 net tons in 1928. Medium otter trawlers are referred to by some in the fisheries as "draggers." These vessels made 1,072 trips to 12 main fishing grounds and were absent from port 6,074 days, or an average of 5.7 days per trip. Their catches aggregated 29,426,209 pounds, or 10 per cent of the total landings by vessels at the three ports. Of this amount, haddock constituted 82 per cent, flounders 9 per cent, and cod 6 per cent. Only minor quantities of other species were taken by medium otter trawlers. Of the total catch, 40 per cent was taken in South Channel, 34 per cent on Georges Bank, 17 per cent on Nantucket Shoals, 4 per cent off Chatham, and 3 per cent on shore grounds. Only minor quantities were taken on the other grounds where medium otter trawlers fished.

Otter trawls, small vessels.—A fishery with otter trawls was also prosecuted by 120 vessels of 5 to 20 net tons in 1928. Small otter trawlers are referred to by some in the fisheries as "flounder draggers." These vessels made 1,181 trips to 7 main fishing grounds and were absent from port 4,092 days, or an average of 3.5 days per trip. Their catches aggregated 11,286,971 pounds, or 4 per cent of the total landings by vessels at the three ports. Of this amount flounders constituted 46 per cent and haddock 44 per cent. Only minor quantities of other species were landed by small otter trawlers. Of the total catch, 44 per cent was taken on shore grounds, 26 per cent on Nantucket Shoals, and 17 per cent on South Channel. Only minor quantities were taken on the other grounds where small otter trawlers fished.

V–D trawls (otter trawls), large vessels.—A fishery with V–D otter trawls was prosecuted by 6 vessels of 91 net tons and over in 1928. These vessels made 30 trips to 3 main fishing grounds and were absent from port 222 days, or an average of 7.4 days per trip. Their catches aggregated 3,533,365 pounds, or 1 per cent of the total landings by vessels at the three ports. Of this amount, 93 per cent consisted of haddock; the remainder consisted principally of cod and flounders. Of the total catch, 46 per cent was made on Georges Bank, 35 per cent on Nantucket Shoals, and 19 per cent on South Channel.

V–D trawls (otter trawls), medium vessels.—A fishery with V–D otter trawls was prosecuted by 30 vessels of 21 to 90 net tons in 1928. These vessels made 324 trips to 7 main fishing grounds and were absent from port 1,966 days, or an average of 6.1 days per trip. Their catches aggregated 13,592,296 pounds, or 5 per cent of the total landings by vessels at the three ports. Of this amount 89 per cent consisted of haddock. The remainder of the catch was made up chiefly of cod, flounders, and hake. Of the total catch, 56 per cent was made on South Channel, 33 per cent on Georges Bank, and 9 per cent on Nantucket Shoals. Only minor quantities were taken from the other banks where these vessels fished.

Sink gill nets.—A fishery with sink gill nets was prosecuted by 40 vessels in 1928. They made 3,769 trips to three main fishing grounds and were absent from port 3,783 days, or an average of about 1 day per trip. Their catch amounted to 14,248,659 pounds, or 5 per cent of the total landings by vessels at the three ports. Of this amount, 52 per cent consisted of cod and 32 per cent of pollock. Only minor quantities of other species were taken with this type of gear. Of the total catch, 87 per cent was taken on shore grounds, 10 per cent on Jeffreys Ledge, and 3 per cent on Platts Bank.

Drift gill nets.—A fishery with drift gill nets was prosecuted by 82 vessels in 1928. They made 755 trips to three main fishing grounds and were absent from port 1,842 days, or an average of about 2.4 days per trip. Their catch amounted to 4,588,484 pounds, or 2 per cent of the total landings by vessels at the three ports. Of this amount, 54 per cent consisted of mackerel and 46 per cent of herring, including 8,057 pounds of other fish. Of the total catch, 54 per cent, consisting almost entirely of mackerel, was taken on shore grounds; 26 per cent, consisting entirely of herring, off Newfoundland; and 20 per cent, consisting entirely of herring, at Bay of Islands.

Purse seines.—A fishery with purse seines (mackerel fishery) was prosecuted by 116 vessels in 1928. They made 1,016 trips to eight main fishing grounds and were absent from port 3,645 days, or an average of about 3.6 days per trip. Their landings at the three New England ports amounted to 23,000,740 pounds, or 8 per cent of the total landings at these ports. Of this amount, 95 per cent consisted of mackerel, 3 per cent of herring, and 2 per cent of other species of fish. Of the total, 54 per cent was taken on shore grounds, 15 per cent on Georges Bank, 12 per cent on South Channel, and 10 per cent off Chatham. Only minor quantities were taken on the other banks where these boats fished.

Scallop drags (trawls).—A fishery with scallop drags or trawls was prosecuted by one vessel in 1928. It made one trip to Boston and was absent from port eight days. The catch consisted of 5,202 pounds of scallop meats and was taken on Georges Bank.

Summary.—In general, regular otter trawls were the most important gear used by the New England vessels, catching 45 per cent of the total landings by vessels at the three ports. Line trawls were next in importance, catching 28 per cent of the total. Purse seines caught 8 per cent, gill nets 7 per cent, V–D otter trawls 6 per cent, hand lines 5 per cent, and harpoons and scallop drags combined 1 per cent.

Among the fishing grounds South Channel was most important, furnishing 35 per cent of the fish caught by the vessels. Georges Bank, which is near South Channel, was second, furnishing 28 per cent. Shore grounds furnished 12 per cent, Nantucket Shoals 7 per cent, and Browns Bank 4 per cent. All of these are grounds off the United States. The catch on any one of the other banks where fishing was prosecuted by the vessels furnished less than 10,000,000 pounds each.

The fishery products landed at the three ports by vessels are taken chiefly on fishing grounds off the United States west of 66° W. longitude. In 1928 these grounds furnished 92 per cent of the total landings at the three ports.

Those fishing grounds off Canadian Provinces east of 66° W. longitude furnished 6 per cent, while those off Newfoundland, also east of 66° W. longitude, furnished 2 per cent. The large catch on grounds off the United States is due chiefly to the large catches by otter trawlers on South Channel, Georges Bank, and Nantucket Shoals, which fishing grounds are suited to fishing with this type of gear and which are comparatively near packing centers. Compared with 1927, there was an increase of 7 per cent in the landings of fish taken on grounds off the United States, a decrease of 9 per cent in the landings of fish taken off Canadian Provinces, and a decrease of 42 per cent in the landings of fish taken off Newfoundland.

Landings by fishing vessels at Boston and Gloucester, Mass., and Portland, Me., 1928

BY GEAR AND FISHING GROUNDS

Gear and fishing grounds	Vessels fishing	Trips	Days absent	Cod			Haddock		Hake	
				Large	Market	Scrod	Large	Scrod	Large	Small
	Number	*Number*	*Number*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*
Line trawls:										
Grand Bank	14	34	905	467,570	32,669		28,000		5,750	
Green Bank	4	8	217	70,827	12,770		150		5,655	
St. Peters Bank	8	17	400	30,100	5,662				200	860
Labrador coast	1	1	29							
Gulf of St. Lawrence	3	4	111	29,127	24,094					
Quereau Bank	6	10	219	72,259	4,139				10,997	1,680
The Gully	2	3	64							
Western Bank (Sable Island Bank)	19	68	1,130	5,025,925	1,648,365		1,029,755		13,660	
Cape Shore	13	15	151	233,285	177,460		292,300	1,000	30,590	
La Have Bank	23	69	905	2,002,911	958,306	3,230	2,188,020	8,125	85,491	514
Browns Bank	33	120	1,254	2,595,237	1,229.026	3.102	4,482,585	2,000	119,050	
Georges Bank	57	279	2,762	8,564,059	629,963	3,000	5,905,875	51,270	133,195	135
South Channel	48	445	2,550	3,640,935	3,061,121	3,480	12,478,277	29,170	3,238,675	45,895
Off Chatham	8	11	55	42,808	46,960	400	278,885		28,250	
Nantucket Shoals	8	9	49	47,150	27,205		168,600	2,400	40,540	
Cashes Bank	19	40	187	222,077	68,494	2,995	301,975	5,505	105,057	21,647
Fippenies Bank	13	19	67	77,820	29,465	1,250	172,965	6,420	111,160	7,025
Platts Bank	9	56	121	73,365	24,839	8,967	356,156	12,705	4,050	262,090
Jeffreys Ledge	39	373	904	329,194	185,363	31,408	2,738,027	88,378	392,110	728,624
Tillies Bank	2	2	6	4,795	1,480	530	28,235	575		16,330
Middle Bank (Stellwagen Bank)	14	54	203	76,061	42,575	2,380	789,449	4,450	303,213	22,000
Shore, general	32	214	479	105,709	84,375	12,665	848,680	24,756	24,055	131,509
Total	[1] 99	1,851	12,768	23,711,214	8,294,331	73,407	32,087,934	236,754	4,651,698	1,238,309
Hand lines:										
Grand Bank	1	1	22							
Cape Shore	10	26	239	310,527	379,735	4,375	30,871	1,950	630	
La Have Bank	2	2	18	30,550	13,600		2,600			
Browns Bank	16	32	237	663,545	470,920	160	150,350		5,600	
Georges Bank	24	224	1,825	4,415,725	2,888,537	2,950	573,110	10,040	3,940	
South Channel	10	16	93	258,377	202,655		97,650		2,700	
Nantucket Shoals	15	59	388	383,045	744,740	1,350	58,955	3,230	3,250	
Cashes Bank	1	1	6	4,300	2,900		7,200		2,700	
Jeffreys Ledge	1	1	4	200						
Shore, general	8	9	40	13,580	19,327	360	31,445	85	8,450	205
Total	[1] 42	371	2,872	6,079,849	4,722,414	9,195	952,181	15,305	27,270	205

[1] Exclusive of duplication.

Landings by fishing vessels at Boston and Gloucester, Mass., and Portland, Me., 1928—Continued

BY GEAR AND FISHING GROUNDS—Continued

Gear and fishing grounds	Vessels fishing	Trips	Days absent	Cod			Haddock		Hake	
				Large	Market	Scrod	Large	Scrod	Large	Small
	Number	*Number*	*Number*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*
Harpoons:										
Western Bank (Sable Island Bank)	1	1	15							
Cape Shore	27	27	595							
Browns Bank	39	48	662							
Georges Bank	73	144	2,308							
South Channel	1	1	15							
Nantucket Shoals	8	9	105							
Shore, general	5	6	88							
Total	[1] 80	236	3,788							
Otter trawls, large:										
Western Bank (Sable Island Bank)	2	2	19	5,000	5,300		199,000	11,500	250	
Browns Bank	1	1	9	2,480	680		47,000		2,800	
Georges Bank	34	325	2,534	1,515,456	1,265,701	15,070	24,774,916	3,417,620	260,240	
South Channel	38	612	4,724	1,810,806	1,415,555	14,865	37,272,026	4,501,605	1,144,170	1,325
Off Chatham	3	3	18	5,300	5,020		211,400	39,100	1,750	
Nantucket Shoals	25	60	457	110,700	111,300	2,425	4,785,169	471,195	45,060	
Shore, general	3	7	28	6,050	3,430		144,955	1,090	80	
Total	[1] 43	1,010	7,789	3,455,792	2,806,986	32,360	67,434,466	8,442,020	1,454,350	1,325
Otter trawls, medium:										
La Have Bank	2	2	25	7,600	1,700		61,200	500	475	
Browns Bank	1	1	14	13,900			2,000		600	
Georges Bank	52	277	1,858	296,410	276,520	2,280	7,804,415	1,040,985	53,310	
Clarks Bank	4	8	47	5,825	5,100		263,870	29,185	3,775	
South Channel	50	393	2,390	306,198	370,900	2,340	9,096,281	1,007,285	177,424	3,405
Off Chatham	16	41	220	33,630	23,905	1,230	773,820	101,360	19,885	
Nantucket Shoals	36	144	865	85,187	444,590	1,441	3,448,420	267,548	17,725	
Cashes Bank	1	3	14	4,150	2,550		14,270	6,500	10,080	
Jeffreys Ledge	3	4	10	1,750	1,015	260	31,050	2,550	3,805	
Middle Bank (Stellwagen Bank)	1	1	3	340	145		2,670			
Off Race Point	1	1	2	200	75		1,485	245	550	
Shore, general	44	197	626	17,165	15,410	840	278,745	32,067	27,945	1,240
Total	[1] 89	1,072	6,074	772,355	1,141,910	8,391	21,778,226	2,488,225	315,574	4,645
Otter trawls, small:										
Georges Bank	19	40	270	14,025	39,095	480	630,590	75,120	7,845	
South Channel	16	83	451	45,826	88,715	300	1,393,189	95,235	35,510	330
Off Chatham	7	18	94	8,880	7,615		230,195	19,420	7,960	
Nantucket Shoals	38	136	708	35,455	394,050	2,475	1,383,630	29,825	4,251	

Jeffreys Ledge	3	3	17	505	325		24,600	785	1,895	
Middle Bank (Stellwagen Bank)	5	7	21	5,425	4,770	130	35,315	1,165	1,100	
Shore, general	101	894	2,531	117,009	111,151	2,770	963,282	33,848	85,780	34,735
Total	[1] 120	1,181	4,092	227,124	645,721	6,155	4,680,801	255,398	144,341	35,065
V-D trawls, large:										
Georges Bank	4	11	76	58,645	11,890	400	1,277,975	219,845	1,230	
South Channel	5	9	71	11,405	17,800	12,200	532,440	52,175	6,380	
Nantucket Shoals	2	10	75	4,815	13,280		1,166,150	40,135	1,500	
Total	[1] 6	30	222	74,865	42,970	12,600	2,976,565	312,155	9,110	
V-D trawls, medium:										
Georges Bank	19	89	585	132,630	112,050	340	3,562,066	475,585	24,490	
Clarks Bank	1	3	21	3,275	2,425		90,300	28,350	2,500	
South Channel	17	186	1,145	170,345	189,155	330	6,310,351	561,965	121,435	
Off Chatham	2	4	20	1,395	1,310		79,050	6,205	3,300	
Nantucket Shoals	11	27	148	18,800	128,885		903,745	78,630	7,845	
Jeffreys Ledge	2	3	7	690	95		2,455		1,315	
Shore, general	7	12	40	1,040	1,030		50,735	7,400	2,640	
Total	[1] 30	324	1,966	328,175	434,950	670	10,998,702	1,158,135	163,525	
Sink gill nets:										
Platts Bank	4	75	75	246,820	2,543		1,770		1,680	25,902
Jeffreys Ledge	7	290	291	743,994	29,436	235	149,964		3,700	88,354
Shore, general	40	3,404	3,417	6,354,331	80,439	1,195	1,370,112	490	166,175	102,939
Total	[1] 40	3,769	3,783	7,345,145	112,418	1,430	1,521,846	490	171,555	217,195
Drift gill nets:										
Off Newfoundland	3	3	116							
Bay of Islands	2	2	82							
Shore, general	78	750	1,644							
Total	[1] 82	755	1,842							
Purse seines:										
Cape Shore	6	6	46							
Georges Bank	45	91	351							
South Channel	64	105	408							
Off Chatham	62	157	564							
Nantucket Shoals	20	25	106							
Jeffreys Ledge	5	9	17							
Middle Bank (Stellwagen Bank)	35	51	233							
Shore, general	110	572	1,920							
Total	[1] 116	1,016	3,645							
Scallop drags:										
Georges Bank	1	1	8							
Grand total	[1] 405	11,616	48,849	41,994,519	18,201,700	144,206	142,430,721	12,908,482	6,937,423	1,496,744

[1] Exclusive of duplication.

NOTE.—Otter trawls and V-D trawls are classified according to the size of the vessel. The weight of salt fish landed has been converted to the basis of fresh fish.

Landings by fishing vessels at Boston and Gloucester, Mass., and Portland, Me., 1928—Continued

BY GEAR AND FISHING GROUNDS

Gear and fishing grounds	Pollock	Cusk	Halibut	Flounders	Swordfish	Mackerel	Herring	Other	Total
	Pounds	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*
Line trawls:									
Grand Bank	200	860	990,874		24,564				1,550,487
Green Bank	208	510	223,979		117				314,216
St. Peters Bank			498,259						535,081
Labrador coast			46,365						46,365
Gulf of St. Lawrence			102,972						156,193
Quereau Bank	275	9,800	189,769		3,754				292,673
The Gully			44,073						44,073
Western Bank (Sable Island Bank)	77,955	34,185	51,891		171			400	7,882,307
Cape Shore	31,560	22,985	2,560		3,185			3,800	798,725
La Have Bank	84,066	169,902	87,869		3,943			3,970	5,596,847
Browns Bank	106,525	434,220	164,792		11,538			34,312	9,182,387
Georges Bank	133,568	275,536	422,554	30,745	53,767			5,465	16,209,132
South Channel	470,011	400,910	109,444	4,907	102	700		39,612	23,523,239
Off Chatham	4,595	14,085	1,119					1,885	418,987
Nantucket Shoals	10,200	27,450	22,995	4,135				425	351,100
Cashes Bank	22,272	194,110	15,392	480				9,020	969,024
Fippenies Bank	7,490	33,760	1,443					2,090	450,888
Platts Bank	14,251	67,345	774	250				40,015	864,807
Jeffreys Ledge	100,600	425,112	5,425	10,967				187,231	5,222,439
Tillies Bank	695	2,800						4,138	59,578
Middle Bank (Stellwagen Bank)	20,380	54,940	1,731	1,050				3,965	1,322,194
Shore, general	16,737	84,681	34,860	10,679				39,289	1,417,995
Total	1,101,588	2,253,191	3,019,140	63,213	101,141	700		375,617	77,208,237
Hand lines:									
Grand Bank			42,159						42,159
Cape Shore	160,985	10,730	2,038	140	104			10,585	912,670
La Have Bank	1,680	100	111					175	48,816
Browns Bank	90,030	22,745	8,625	685	4,070			21,403	1,438,133
Georges Bank	481,204	29,135	130,906		6,943			26,590	8,569,082
South Channel	32,445	1,350	25,968		1,833			994	623,972
Nantucket Shoals	23,975		6,362	6,280				1,400	1,232,587
Cashes Bank	2,500	2,000	56						21,656
Jeffreys Ledge	7,650								7,850
Shore, general	21,500	300	61	1,295				135	96,743
Total	821,969	66,360	216,288	8,400	12,950			61,282	12,993,668
Harpoons:									
Western Bank (Sable Island Bank)					410				410
Cape Shore					133,177			326	133,503
Browns Bank					562,371				562,371

Georges Bank					1,591,731				1,591,731
South Channel					26,884				26,884
Nantucket Shoals					65,812				65,812
Shore, general					33,198				33,198
Total					2,413,583			326	2,413,909
Otter trawls, large:									
Western Bank (Sable Island Bank)	650		574	1,800				2,200	226,274
Browns Bank	800		185	1,760					55,706
Georges Bank	253,791	2,820	33,759	572,976				62,210	32,174,559
South Channel	1,111,990	13,770	81,182	1,278,108		745	1,400	263,135	48,910,682
Off Chatham	1,330		401	1,680				140	266,121
Nantucket Shoals	19,360		6,077	116,805				33,676	5,701,767
Shore, general	75	55	217	6,750					162,612
Total	1,387,996	16,645	122,395	1,979,879		745	1,400	361,361	87,497,720
Otter trawls, medium:									
La Have Bank	135	6,400	795	3,685				780	83,270
Browns Bank	400		843						17,743
Georges Bank	22,355	130	4,369	623,555	1,314	117		20,311	10,146,071
Clarks Bank	160		310	15,285				715	324,225
South Channel	21,955	452	8,583	668,298	1,121	80		48,603	11,712,925
Off Chatham	1,748		1,726	62,645				26,730	1,046,679
Nantucket Shoals	6,585		2,104	736,537				10,510	5,020,647
Cashes Bank	700	5,400	162						43,812
Jeffreys Ledge	280	975		950				1,725	44,360
Middle Bank (Stellwagen Bank)				2,140					5,296
Off Race Point	6,250			840					9,645
Shore, general	3,015	3,125	918	578,722		255		12,090	971,537
Total	63,583	16,482	19,810	2,692,657	2,435	452		121,464	29,426,209
Otter trawls, small:									
Georges Bank	1,640		873	162,808	11,286			2,645	946,407
South Channel	2,715		1,635	218,982				13,141	1,895,577
Off Chatham	705		361	33,775				12,357	321,268
Nantucket Shoals	6,295		265	1,138,675				3,190	2,998,111
Jeffreys Ledge	50			2,680				60	30,900
Middle Bank (Stellwagen Bank)	990			22,757				1,615	73,267
Shore, general	6,332	4,320	432	3,579,727				62,055	5,021,441
Total	18,727	4,320	3,566	5,159,404	11,286			95,063	11,286,971
V-D trawls, large:									
Georges Bank	1,155		1,197	32,745				13,950	1,619,032
South Channel	5,725		424	22,915				10,932	672,396
Nantucket Shoals	230			13,720				2,107	1,241,937
Total	7,110		1,621	69,380				26,989	3,533,365

Landings by fishing vessels at Boston and Gloucester, Mass, and Portland, Me., 1928—Continued

Gear and fishing grounds	Pollock	Cusk	Halibut	Flounders	Swordfish	Mackerel	Herring	Other	Total
	Pounds	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*
V-D trawls, medium:									
Georges Bank	3,805	500	2,615	144,180	162	110		7,371	4,465,904
Clarks Bank			35	3,900				885	131,670
South Channel	12,800	805	3,043	210,200	2,083	83		25,493	7,608,088
Off Chatham	200			4,865				1,980	98,305
Nantucket Shoals	7,600	50	64	43,985				4,260	1,193,854
Jeffreys Ledge	35			2,675					7,265
Shore, general			60	22,855				1,450	87,210
Total	24,440	1,355	5,817	432,660	2,245	193		41,429	13,592,296
Sink gill nets:									
Platts Bank	58,540	160						27,203	364,618
Jeffreys Ledge	347,740	1,630	11	880				71,061	1,437,005
Shore, general	4,217,389	4,694	351	7,547		69,550		71,824	12,447,036
Total	4,623,669	6,484	362	8,427		69,550		170,088	14,248,659
Drift gill nets:									
Off Newfoundland							1,180,710		1,180,710
Bay of Islands							926,136		926,136
Shore, general						2,473,581		8,057	2,481,638
Total						2,473,581	2,106,846	8,057	4,588,484
Purse seines:									
Cape Shore						272,500			272,500
Georges Bank						3,532,732		235	3,532,967
South Channel						2,774,375		8,000	2,782,375
Off Chatham						2,152,496		46,610	2,199,106
Nantucket Shoals						848,970		1,200	850,170
Jeffreys Ledge						17,844	8,400	111,339	137,583
Middle Bank (Stellwagen Bank)						603,172	91,600	53,400	748,172
Shore, general						11,536,433	613,400	328,034	12,477,867
Total						21,738,522	713,400	548,818	23,000,740
Scallop drags:									
Georges Bank								5,202	5,202
Grand total	8,049,082	2,364,837	3,388,999	10,414,020	2,543,640	24,283,743	2,821,646	1,815,696	279,796,460

NOTE.—Otter trawls and V-D trawls are classified according to the size of the vessel. The weight of salt fish landed has been converted to the basis of fresh fish.

SUMMARY: BY FISHING GROUNDS

Fishing grounds	Vessels fishing	Trips	Days absent	Cod			Haddock		Hake	
				Large	Market	Scrod	Large	Scrod	Large	Small
East of 66° W. longitude										
Off Newfoundland:	*Number*	*Number*	*Number*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*
Grand Bank	14	35	927	467,570	32,669		28,000		5,750	
Green Bank	4	8	217	70,827	12,770		150		5,655	
St. Peters Bank	8	17	400	30,100	5,662				200	860
Bay of Islands	2	2	82							
Off Newfoundland	3	3	116							
Total	[1] 21	65	1,742	568,497	51,101		28,150		11,605	860
Off Canada:										
Labrador coast	1	1	29							
Gulf of St. Lawrence	3	4	111	29,127	24,094					
Quereau Bank	6	10	219	72,259	4,139				10,997	1,680
The Gully	2	3	64							
Western Bank (Sable Island Bank)	21	71	1,164	5,030,925	1,653,665		1,228,755	11,500	13,910	
Cape Shore	51	74	1,031	543,812	557,195	4,375	323,171	2,950	31,220	
La Have Bank	24	73	948	2,041,061	973,606	3,230	2,251,820	8,625	85,966	514
Total	[1] 81	236	3,566	7,717,184	3,212,699	7,605	3,803,746	23,075	142,093	2,194
West of 66° W. longitude										
Off United States:										
Browns Bank	85	202	2,176	3,275,162	1,700,626	3,262	4,681,935	2,000	128,050	
Georges Bank	241	1,481	12,577	14,996,950	5,223,756	24,520	44,528,947	5,290,465	484,250	135
Clarks Bank	5	11	68	9,100	7,525		354,170	57,535	6,275	
South Channel	201	1,850	11,847	6,243,891	5,345,901	33,515	67,180,214	6,247,435	4,726,294	50,955
Off Chatham	92	234	971	92,013	84,810	1,630	1,573,350	166,085	61,145	
Nantucket Shoals	143	479	2,901	685,152	1,864,050	7,691	11,914,669	892,963	120,171	
Cashes Bank	20	44	207	230,527	73,944	2,995	323,445	12,005	117,837	21,647
Fippenies Bank	13	19	67	77,820	29,465	1,250	172,965	6,420	111,160	7,025
Platts Bank	13	131	196	320,185	27,382	8,967	357,926	12,705	5,730	287,992
Jeffreys Ledge	58	683	1,250	1,076,333	216,234	31,903	2,946,096	91,713	402,825	816,978
Tillies Bank	2	2	6	4,795	1,480	530	28,235	575		16,330
Middle Bank (Stellwagen Bank)	54	113	460	81,826	47,490	2,510	827,434	5,615	304,313	22,000
Off Race Point	1	1	2	200	75		1,485	245	550	
Shore, general	265	6,065	10,813	6,614,884	315,162	17,830	3,707,954	99,646	316,125	270,628
Total	[1] 399	11,315	43,541	33,708,838	14,937,900	136,603	138,598,825	12,885,407	6,783,725	1,493,690
Grand total	[1] 405	11,616	48,849	41,994,519	18,201,700	144,208	142,430,721	12,908,482	6,937,423	1,496,744

[1] Exclusive of duplication.

Landings by fishing vessels at Boston and Gloucester, Mass., and Portland, Me., 1928—Continued

SUMMARY: BY FISHING GROUNDS—Continued

Fishing grounds	Pollock	Cusk	Halibut	Flounders	Swordfish	Mackerel	Herring	Other	Total
East of 66° W. longitude									
Off Newfoundland:	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*
Grand Bank	200	860	1,033,033		24,564				1,592,646
Green Bank	208	510	223,979		117				314,216
St Peters Bank			498,259						535,081
Bay of Islands							926,136		926,136
Off Newfoundland							1,180,710		1,180,710
Total	408	1,370	1,755,271		24,681		2,106,846		4,548,789
Off Canada:									
Labrador coast			46,365						46,365
Gulf of St. Lawrence			102,972						156,193
Quereau Bank	275	9,800	189,769		3,754				292,673
The Gully			44,073						44,073
Western Bank (Sable Island Bank)	78,605	34,185	52,465	1,800	581			2,600	8,108,991
Cape Shore	192,545	33,715	4,598	140	136,466	272,500		14,711	2,117,398
La Have Bank	85,881	176,402	88,775	3,685	3,943			4,925	5,728,433
Total	357,306	254,102	529,017	5,625	144,744	272,500		22,236	16,494,126
West of 66° W. longitude									
Off United States:									
Browns Bank	197,755	456,965	174,445	2,445	577,979			55,715	11,256,339
Georges Bank	897,518	308,121	596,275	1,567,009	1,665,203	3,532,959		143,979	79,260,087
Clarks Bank	160		345	19,185				1.600	455,895
South Channel	1,657,641	417,287	230,279	2,403,410	32,023	2,775,983	1,400	409,910	97,756,138
Off Chatham	8,578	14,085	3,607	102,965		2,152,496		89,702	4,350,466
Nantucket Shoals	74,245	27,500	37,867	2,060,137	65,812	848,970		56,758	18,655,985
Cashes Bank	25,472	201,510	15,610	480				9,020	1,034,492
Fippenies Bank	7,490	33,760	1,443					2,090	450,888
Platts Bank	72,791	67,505	774	250				67,218	1,229,425
Jeffreys Ledge	466,355	427,717	5,436	18,152		17,844	8,400	371,416	6,887,402
Tillies Bank	695	2,800						4,138	59,578
Middle Bank (Stellwagen Bank)	21,370	54,940	1,731	25,947		603,172	91,600	58,960	2,148,928
Off Race Point	6,250			840					9,645
Shore, general	4,265,048	97,175	36,899	4,207,575	33,198	14,079,819	613,400	522,934	35,197,277
Total	7,691,368	2,109,365	1,104,711	10,408,395	2,374,215	24,011,243	714,800	1,793,460	258,752,545
Grand total	8,049,082	2,364,837	3,388,999	10,414,020	2,543,640	24,283,743	2,821,646	1,815,696	279,795,460

NOTE.—The weight of salt fish landed has been converted to the basis of fresh fish.

Days' absence from port of fishing vessels landing fish at Boston and Gloucester, Mass., and Portland, Me., 1928

Fishing grounds	Jan.	Feb.	Mar.	Apr.	May	June	July
Off Newfoundland:							
Grand Bank	7			142	190	165	105
Green Bank			44	34	76		
St. Peters Bank		107	114	131		48	
Off Newfoundland	116						
Total	123	107	158	307	266	213	105
Off Canada:							
Gulf of St. Lawrence					54	22	
Quereau Bank				64	52		
The Gully			32		32		
Western Bank (Sable Island Bank)				28	518	304	191
Cape Shore						46	
La Have Bank	127	9		102	38	35	102
Total	127	9	32	194	694	407	293
Off United States:							
Browns Bank	185	32	57	212	138	30	517
Georges Bank	449	815	1,499	954	872	1,019	2,822
Clarks Bank	7			29	10		
South Channel	1,119	1,101	808	581	403	701	1,177
Off Chatham	8	85	67	126	42	26	108
Nantucket Shoals	30	36	109	361	810	206	132
Cashes Bank	43	19	17	11	45	7	
Fippenies Bank	26		3	2			
Platts Bank	4						22
Jeffreys Ledge	123	94	126	19	43	68	57
Middle Bank (Stellwagen Bank)	3	10	26	23	6	8	36
Shore, general	570	666	1,078	912	1,107	1,636	501
Total	2,567	2,858	3,790	3,230	3,476	3,701	4,872
Grand total	2,817	2,974	3,980	3,731	4,436	4,821	5,270

Fishing grounds	Aug.	Sept.	Oct.	Nov.	Dec.	Total
Off Newfoundland:						
Grand Bank	191	24	52		51	927
Green Bank	43	20				217
St. Peters Bank						400
Bay of Islands					82	82
Off Newfoundland						116
Total	234	44	52		133	1,742
Off Canada:						
Labrador coast		29				29
Gulf of St. Lawrence	35					111
Quereau Bank		59	5	89		219
The Gully						64
Western Bank (Sable Island Bank)		[illegible]				1,164
Cape Shore	91	530	207	133	24	1,031
La Have Bank	124	88	178	108	37	948
Total	250	829	390	280	61	3,566
Off United States:						
Browns Bank	664	30	[illegible]	86	265	[illegible],176
Georges Bank	1,420	556	1,028	792	856	12,577
Clarks Bank		7	5	10		68
South Channel	1,135	1,256	947	1,427	1,192	11,847
Off Chatham	392	78		13	26	971
Nantucket Shoals	168	164	507	150	228	2,901
Cashes Bank			24	4	37	207
Fippenies Bank				3	33	67
Platts Bank	49	2	71	29	19	196
Jeffreys Ledge	40	122	111	234	213	1,260
Tillies Bank				6		6
Middle Bank (Stellwagen Bank)	72	118	48	45	70	460
Off Race Point					2	2
Shore, general	470	489	1,103	1,668	618	10,818
Total	4,310	2,817	3,899	4,467	3,554	43,541
Grand total	4,794	3,690	4,341	4,747	3,748	48,849

ATLANTIC MACKEREL FISHERY

The 1928 Atlantic mackerel fishery of the United States resembled that of the previous year, with heavy southern and Block Island runs in the spring followed by a slack season in the Gulf of Maine during the summer and autumn. An unusual run of large mackerel appeared off Cape Ann and lasted well into December. Altogether the season's catch, amounting to nearly 31,000,000 pounds, was about 25.5 per cent below that of the previous year.

A statistical summary of the fishery appears in the accompanying table. This statement differs from last year's presentation in making a distinction between vessels fishing regularly during the specified subdivision of the season and those fishing only a fraction of the time. This year's statistics also show separately the catch in the south and that in the Block Island region. These were shown together as "south and west of Cape Cod" in last year's report. These changes have been introduced for the purpose of making a more accurate appraisal of the results of the fishery in terms of fishing effort. As heretofore, only the vessel fishery has been included, and the purse-seiners are listed separately under "seiners" and the drift gill-netters under "netters." The statistics were largely collected by the bureau's agents at Cape May, N. J., New York City, Boston, Gloucester, and Woods Hole, Mass., and Portland, Me. Data on landings at other ports were secured from unofficial sources and may be partially incomplete, but the error due to this is estimated to be well under 5 per cent. The miscellaneous shore fisheries are not included in this report; nor is the catch of bulls-eye mackerel, another species, though they were unusually plentiful this year, 935,675 pounds being caught in the vessel fishery.

Mackerel vessel fishery, 1928

Designation	Vessels	Tonnage	Crew	Trips	Catch: Medium and large	Catch: Small	Catch: Total
	Number	*Net tons*	*Number*	*Number*	*Pounds*	*Pounds*	*Pounds*
Southern fishery:							
Seiners—							
Regular	47	1,956	582	317	5,643,464		5,643,464
Miscellaneous				39	549,275		549,275
Netters—							
Regular	21	398	140	135	988,094		988,094
Miscellaneous				50	227,843		227,843
Total				541	7,408,676		7,408,676
Block Island fishery:							
Seiners—							
Regular	50	1,865	600	245	7,370,131	6,500	7,376,631
Miscellaneous				51	1,008,775		1,008,775
Netters—							
Regular	12	244	86	22	205,504		205,504
Miscellaneous				62	263,615		263,615
Total					8,848,025	6,500	8,854,525
Gulf of Maine fishery:							
Seiners—							
Regular	60	2,296	729	556	9,195,872	1,405,735	10,601,607
Miscellaneous				119	1,115,299	207,773	1,323,072
Netters—							
Regular, Spring	13	142	72	87	325,720		325,720
Regular, Fall	50	1,082	351	676	1,812,659		1,812,659
Miscellaneous, Spring				51	211,145		211,145
Miscellaneous, Fall				100	133,270		133,270
Total				1,470	12,793,965	1,613,508	14,407,473
Cape Shore fishery: Seiners	7	381	87	7	313,210		313,210
Total seiners				1,334	25,196,026	1,620,008	26,816,034
Total netters				1,183	4,167,850		4,167,850
Grand total				2,517	29,363,876	1,620,008	30,983,884

This special section on the mackerel fishery is an outgrowth of the cooperative program of the divisions of fishery industries and scientific inquiry for the study of the mackerel, in which the statistics of the fishery and the bionomics of the species are being investigated simultaneously. This scheme has already borne fruit in a practical way by providing a sufficient understanding of the principal causes of fluctuation in abundance. In advance of the 1928 season a trial prediction was made public, in which it was estimated that the catch would fall off 12.5 per cent or more as compared with the previous year. Thus, the outlook was a catch under 37,000,000 pounds. The actual realization—31,000,000 pounds—approached encouragingly near the estimated figure, and a continuation of this work promises to obviate much of the uncertainty that now attends this erratic fishery.

Southern fishery.—This area includes the entire region west of 72° W. longitude, which passes through the eastern end of Long Island about 9 miles west of Montauk Point. This roughly includes all waters off New York, New Jersey, Delaware, Maryland, and Virginia. Most of the vessels participating in this fishery sailed during the first week in April. Fish were sighted on the 8th and 9th of the month, and the first landings of significant amounts were made at Cape May on April 12. Most of the seiners continued to operate in this area until about May 25. Altogether, 47 vessels participated regularly, catching a total of over 5,600,000 pounds. An additional 500,000 pounds was caught by vessels fishing less continuously. From the figures given in the above table it may be calculated that the average vessel measured 41 net tons, carried a crew of 12, made about seven trips, and caught about 120,000 pounds of mackerel.

The netters in the southern fishery sailed later than the seiners, and most of them landed fish from April 28 to May 30. The total catch by netters was about 1,200,000 pounds. The average regular netter measured 19 net tons, carried a crew of 7, made about 6 trips, and caught about 47,000 pounds of mackerel.

Block Island fishery.—In this area we have included all waters between 72° W. longitude, near Montauk Point on the eastern end of Long Island, and a line drawn 145° from true north from Sankaty Head, Nantucket, thus including the area south of the southern shore of New England (mackerel are not commonly found in Long Island Sound). The fishery shifted from the south to this region about May 25 and lasted until about July 1. Although the season was only a little over half as long and the regular fleet approximately the same size as in the south, the catch—8,848,025 pounds—was somewhat larger than in the southern fishery. The average seiner measured 37 net tons, carried 12 men, made about 5 trips, and caught 147,000 pounds of mackerel. The netters fished a very short time in this area (May 17 to June 30), and average figures on their performance have little significance.

Gulf of Maine fishery.—This includes all of the inshore and offshore waters of the Gulf of Maine from Nantucket Shoals to Nova Scotia. Most of the mackerel fishing was done off the eastern shore of Cape Cod and Nantucket, with Massachusetts Bay as a secondary center of the fishery. Very few mackerel were taken in the northern half of the gulf. The seining season lasted from about July 1 to November 1, and the fishing in general was very poor after the month of July. Large mackerel were reported plentiful but in scattered schools, swimming deep and hard to set around. Small mackerel ("blink" size, about one-half pound each) were abundant for the first time since 1924, and though ordinarily in poor demand the scarcity of large mackerel made them salable, and a total catch of 1,600,000 pounds of these was landed by the seiners. Toward the end of the season a few trips were made in the Block Island area. In the interest of simplicity these were included as of the Gulf of Maine fishery. This fall the Block Island catch amounted to 31 trips landing 215,175 pounds of medium and large mackerel and 176,675 pounds of small mackerel.

Sixty seiners participated in the Gulf of Maine fishery. On the average they measured 38 net tons, carried 12 men, and made 9 trips, catching about 177,000 pounds during the season.

In the Gulf of Maine the netting season was divided naturally into two parts—spring and fall. During the former season—May 28 to July 16—only a few vessels fished regularly, but the fall run was of unusual magnitude and many seiners changed over to netting, so that during the period October 21 to December 11 there were 50 netters fishing regularly. On the average they measured 22 net tons, carried 7 men, made 13 trips, and caught about 36,000 pounds.

Cape Shore fishery.—A little more interest was shown in the Cape Shore fishery in 1928 than during the previous year, though it was still insignificant compared with years just prior to 1927. In all, 7 vessels fished off Nova Scotia during the early part of June, making one trip and catching about 44,500 pounds each.

Mackerel vessel-fishery catch 1905–1928

Year	Pounds [1]	Year	Pounds [1]
1905	15,398,070	1917	25,473,540
1906	8,106,960	1918	13,915,200
1907	16,902,270	1919	9,990,690
1908	14,376,990	1920	13,292,040
1909	11,702,190	1921	6,923,790
1910	3,909,150	1922	8,797,680
1911	8,322,060	1923	23,390,580
1912	7,011,240	1924	18,237,120
1913	9,327,330	1925	33,953,490
1914	14,477,970	1926	47,126,100
1915	16,051,170	1927	41,998,600
1916	20,642,580	1928	30,983,880

[1] Represents the weight of mackerel landed in the round plus the weight of mackerel landed salted, which has been converted to the equivalent of fresh mackerel in the round.

FISHERIES OF CONNECTICUT [3]

There were 944 fishermen employed in the vessel and boat fisheries of Connecticut in 1927, who fished for products other than clams, oysters, and scallops. Their catch amounted to 20,544,754 pounds, valued at $918,820. This is an increase of 42 per cent in amount and 26 per cent in the value as compared with the catch and value of corresponding products in 1926. Of the total value of the catch, that for flounders accounted for 35 per cent, lobsters 28 per cent, haddock 14 per cent, and menhaden 8 per cent.

Operating units.—The catch of fishery products was taken by 944 fishermen, who used 277 rowboats, 353 motor boats and vessels, 7 steam vessels, and 15 types of major fishing apparatus.

[3] Exclusive of the clam, oyster, and scallop fisheries. These statistics were collected by a representative of the State of Connecticut.

Catch by gear.—Two types of gear accounted for 90 per cent of the products taken in the commercial fisheries of Connecticut during 1927. Otter trawls and flounder drags were the most important of these gears, accounting for 49 per cent of the catch. Purse seines accounted for 41 per cent. The catch by otter trawls and flounder drags consisted principally of flounders and haddock. The catch by purse seines was exclusively menhaden and mackerel.

Fisheries by counties.—Fishing was prosecuted in the marine waters of 5 counties in Connecticut in 1927. Ranked according to value, the fisheries of New London County were by far the most important, accounting for 96 per cent of the total catch and 85 per cent of the total value of the catch. New Haven County ranked second, accounting for 1 per cent of the total catch and 6 per cent of the total value. Fairfield and Middlesex Counties each accounted for catches valued at nearly $40,000.

Fisheries of Connecticut,[1] *1927*

OPERATING UNITS: BY GEAR

Items	Haul seines	Purse seines	Gill nets	Pound nets	Fyke nets	Dip nets	Lines	Flounder drags [2]
Fishermen	116	98	41	30	50	44	181	340
Vessels, steam		3						4
Vessels and boats, motor	17	3	23	13	14	15	116	129
Boats, row	57	9	22	19	34	24	66	
Apparatus	75	7	29	28	260	29	988	141

Items	Lobster pots	Eel pots	Harpoons	Spears	Eel weirs	Eel racks	Traps	Total, exclusive of duplication
Fishermen	376	83	37	20	4	3	6	944
Vessels, steam								7
Vessels and boats, motor	239	33	14	11	2		3	358
Boats, row	123	59	1	21	6		8	277
Apparatus	23,420	2,058	14	62	3	3	3	

CATCH: BY GEAR

Species	Haul seines		Purse seines		Gill nets		Pound nets	
	Pounds	*Value*	*Pounds*	*Value*	*Pounds*	*Value*	*Pounds*	*Value*
Alewives	10,500	$105			800	$8	9,700	$107
Bluefish					840	210	420	104
Butterfish							7,600	780
Carp	306	39			6,000	480		
Eels, common	380	68					400	60
Flounders	50	5			10	1	20,840	1,887
Mackerel			779,945	$33,270			2,340	284
Menhaden			7,676,654	69,144	22,400	224	34,400	494
Minnows	9,799	2,303						
Mummichog	12,970	2,991						
Roach or shiners	1,068	294						
Scup							2,121	52
Sea robin							4,600	92
Skates					500	5	2,000	60
Smelt	8,327	2,480						
Spot							1,250	150
Squeteagues					175	44	23,985	4,731
Striped bass					1,000	300	2,654	651
Suckers	45,561	3,620			100	8		
Tautog	300	30					7,579	708
Whiting	300	6						
Lobsters							49	22
Squid							27,600	2,326
Total	89,561	11,941	8,456,599	102,414	31,825	1,280	147,538	12,508

[1] Exclusive of the clam, oyster, and scallop fisheries.
[2] Includes a few otter trawls used for fish other than flounders.

Fisheries of Connecticut, 1927—Continued

CATCH: BY GEAR—Continued

Species	Fyke nets		Dip nets		Lines		Flounder drags [1]	
	Pounds	*Value*	*Pounds*	*Value*	*Pounds*	*Value*	*Pounds*	*Value*
Alewives	14,400	$144	300	$4				
Bluefish					14,430	$3,768		
Bullheads	280	20			60	5		
Carp	4,675	668	50	8				
Cod					477,444	17,885	213,118	$12,098
Eels, common	5,075	1,321			6,025	504		
Eels, lamprey	899	397						
Flounders	1,747	145			4,137	405	7,772,404	315,251
Haddock					14,800	740	2,077,874	125,808
Hake	65	6					400	8
Halibut					90,000	9,000		
Mackerel					5,350	405		
Minnows			24	48				
Pickerel	250	33						
Pollock					15,637	469		
Roach or shiners	500	35	20	8				
Scup					2,250	325		
Sea bass					2,080	448		
Sea robin							32,600	632
Sharks							20,500	364
Skates	500	10			77	4	27,400	408
Smelt			67	17	170	45		
Squeteagues	500	75			400	65		
Striped bass	3	1			510	128		
Sturgeon							687	140
Suckers	47,370	3,596	200	21				
Tautog	600	60			68,097	6,618	160	20
Tomcod	89	8			30	3		
White perch	50	8						
Yellow perch	1,365	143						
Crabs, blue, hard			5,628	719				
Crabs, blue, soft			328	123				
Lobster							1,210	430
Total	78,368	6,670	6,617	948	701,497	40,817	10,146,353	465,159

Species	Lobster pots		Eel pots		Harpoons		Spears	
	Pounds	*Value*	*Pounds*	*Value*	*Pounds*	*Value*	*Pounds*	*Value*
Eels, common			73,375	$10,819			13,053	$1,774
Swordfish					106,766	$16,359		
Crabs, sand	18,500	$380						
Lobsters	671,751	257,268						
Total	690,251	257,648	73,375	10,819	106,766	16,359	13,053	1,774

Species	Eel weirs		Eel racks		Traps		Total	
	Pounds	*Value*	*Pounds*	*Value*	*Pounds*	*Value*	*Pounds*	*Value*
Alewives					1,000	$40	36,700	$408
Bluefish							15,690	4,082
Bullheads							340	25
Butterfish							7,600	780
Carp					156	24	11,187	1,219
Cod							690,562	29,983
Eels, common	1,000	$250	720	$165			100,028	14,961
Eels, lamprey							899	397
Flounders							7,799,188	317,694
Haddock							2,092,674	126,548
Hake							465	14
Halibut							90,000	9,000
Mackerel							787,635	33,959
Menhaden							7,733,454	69,862
Minnows							9,823	2,351
Mummichog							12,970	2,991

[1] Includes the catch of a few otter trawls used for fish other than flounders.

Fisheries of Connecticut, 1927—Continued

CATCH: BY GEAR—Continued

Species	Eel weirs		Eel racks		Traps		Total	
	Pounds	*Value*	*Pounds*	*Value*	*Pounds*	*Value*	*Pounds*	*Value*
Pickerel							250	33
Pollock							15, 637	469
Roach or shiners							1, 588	337
Scup							4, 371	377
Sea bass							2, 080	448
Sea robin							37, 200	724
Sharks							20, 500	364
Skates							30, 477	487
Smelt							8, 564	2, 542
Spot							1, 250	150
Squeteagues							25, 060	4, 915
Striped bass							4, 167	1, 080
Sturgeon							687	140
Suckers			75	4			93, 306	7, 249
Swordfish							106, 766	16, 359
Tautog							76, 736	7, 436
Tomcod							119	11
White perch							50	8
Whiting							300	6
Yellow perch							1, 365	143
Crabs, blue, hard							5, 628	719
Crabs, blue, soft							328	123
Crabs, sand							18, 500	380
Lobsters							673, 010	257, 720
Squid							27, 600	2, 326
Total	1, 000	250	795	169	1, 156	64	20,544,754	918, 820

OPERATING UNITS AND CATCH: BY COUNTIES

County	Fishermen	Vessels, steam	Vessels and boats, motor	Boats, row	Products	
	Number	*Number*	*Number*	*Number*	*Pounds*	*Value*
Fairfield	71		39	22	222, 155	$36, 065
Hartford	68		7	27	62, 319	6, 129
Middlesex	80		44	41	261, 427	39, 925
New Haven	114		58	48	267, 562	51, 486
New London	611	7	205	139	19, 731, 291	785, 215
Total	944	7	353	277	20, 544, 754	918, 820

FISHERIES OF THE MIDDLE ATLANTIC STATES

The latest statistical canvass of the fisheries and fishery industries of the Middle Atlantic States (New York, New Jersey, Pennsylvania, and Delaware), was for the calendar year 1926. The complete statistics for this canvass are published in the report of the division of fishery industries for 1927 and in condensed form in Statistical Bulletin No. 786.

During 1926 the fisheries and fishery industries of the Middle Atlantic States gave employment to 14,335 persons, of whom 9,953 were fishermen, 107 were engaged in the transporting trade, 3,412 were in the wholesale trade, and 843 in the canning and by-products industries. The catch of the fisheries of these States amounted to 168,012,495 pounds, valued at $12,456,256. The products of the canning, salting, smoking, and by-products industries had a value of $4,018,488.

VESSEL FISHERIES AT NEW YORK CITY AND GROTON, CONN., 1928 [4]

During 1928 fishing vessels of 5 net tons and over landed 71,177,000 pounds of fishery products at New York City and Groton. This is 40 per cent more than in 1927 and almost four times the landings during 1922, the first year for which there is a complete record. Most of the groundfish are taken with trawls.

Species landed.—The phenomenal growth of the landings at these ports during but a few years has been due mainly to the greater quantity of haddock landed. In 1928 the landings of this species amounted to 49,990,000 pounds, or 70 per cent of the total. This is almost 12 times the landings of this species in 1922. Most of these haddock are utilized by fish-packing plants in preparing packaged fish products. Next in value were flounders, with landings of 9,979,000 pounds, or 14 per cent of the total. This is slightly less than a year ago. Mackerel were third in importance with landings of 3,850,000 pounds, or 5 per cent of the total. This also is less than was landed in 1927. Cod ranked fourth in 1928 with landings of 2,970,000 pounds, or 4 per cent of the total, an increase of 108 per cent over the landings of this fish in 1927. Tilefish, a species common almost exclusively to these ports, were fifth, with landings of 2,365,000 pounds, or 3 per cent of the total. This was slightly less than in the previous year. The landings of all other species amounted to about 2,000,000 pounds.

Landings of fish at New York City and Groton, Conn., 1922–1928 [1]

[Expressed in thousands of pounds; that is, 000 omitted]

Year	Bluefish	Cod	Flounders	Haddock	Hake	Halibut	Mackerel	Pollock
1922	2.032	936	5,550	4,332			1,371	
1923	1,735	1,394	9,614	10,792			1,251	
1924	111	1,686	13,281	[2] 14,449			3,047	
1925	51	1,647	17,912	14,771		73	2,670	
1926	74	1,282	12,793	17,908		54	5,038	
1927	71	1,426	10,076	30,403		40	4,939	
1928	143	2,970	9,979	49,990	215	59	3,850	183

Year	Porgies, or scup, and sea bass	Sturgeon	Swordfish	Tilefish	Squeteague or weakfish	Miscellaneous	Total
1922	1,583	20	2	1,153	59	3,716	20,754
1923	2,553			1,364	272	4,857	33,832
1924	808			1,262	332	45	35,021
1925	1,318			1,015	1,099	66	40,622
1926	540			1,975	228	42	39,934
1927	459			2,777	171	410	50,772
1928	622		22	2,365	16	763	71,177

[1] Includes the landings of fish at Groton, Conn., beginning with November, 1927.
[2] Includes the landings of some mixed fish.

NOTE.—Where landings are not shown for certain species, it is probable they are included under "Miscellaneous."

[4] Statistics of the landings of fish by vessels of over 5 net tons at New York City have been collected during the past few years by J. H. Matthews, chairman, statistical committee, United States Fisheries Association. These have been forwarded to the bureau, where they have been compiled. Reports have been disseminated periodically through the pages of the official monthly publication of the United States Fisheries Association, whose headquarters are at 31A Fulton Street, New York City.

Since November, 1927, statistics of the landings of fish by vessels at Groton, Conn., have been included with those for fish landed at New York City, because at that time one of the firms packing fish at New York City moved its plant to Groton, thus requiring the trawlers to unload at Groton. Thus, by including the landings at Groton, the figures since November, 1927, are comparable with those for previous years. The statistics at both ports are combined to avoid advertising individual enterprise.

SHAD FISHERY OF THE HUDSON RIVER

The catch of shad in 1928 was made by 293 fishermen and amounted to 79,029 fish with a weight of 246,231 pounds and valued at $43,149 to the fishermen. The catch was about 71 per cent as large as that for 1927 and slightly over 93 per cent of that for 1926, but greater than for any other year since 1919. The average price per pound to fishermen during late years has declined, with that for 1920 appearing to be the peak. New York fishermen took 77 per cent of the catch and New Jersey fishermen took the remaining 23 per cent.

Above Peekskill drift gill nets were the prevailing apparatus of capture, but below that city stake gill nets were more popular. Some shad were taken incidentally in seines, but only two seines were fished for this species exclusively.

Shad fishery of the Hudson River, 1928

OPERATING UNITS AND CATCH: BY STATES

Items	New York			New Jersey			Total		
	Number	*Pounds*	*Value*	*Number*	*Pounds*	*Value*	*Number*	*Pounds*	*Value*
Fishermen	270			23			293		
Rowboats and scows	100		$4,810	7		$850	107		$5,660
Motor boats	38		4,780	4		3,950	42		8,730
Gill nets, drift	118		17,240				118		17,240
Gill nets, stake	16		1,455	7		2,100	23		3,555
Haul seines	2		350				2		350
Shore and accessory property			1,260			2,200			3,460
Total			29,895			9,100			38,995
Shad caught:									
With drift gill nets	53,477	169,557	27,656				53,477	169,557	27,656
With stake gill nets	4,100	14,291	3,292	17,950	52,050	10,460	22,050	66,341	13,752
With haul seines	2,350	6,640	1,045				2,350	6,640	1,045
With various apparatus incidentally	1,152	3,693	696				1,152	3,693	696
Total	61,079	194,181	32,689	17,950	52,050	10,460	79,029	246,231	43,149

Catch of shad in the Hudson River for various years, 1896 to 1928

Year	New York			New Jersey			Total		
	Number	*Pounds*	*Value*	*Number*	*Pounds*	*Value*	*Number*	*Pounds*	*Value*
1896	420,098	1,681,371	$58,921	168,800	675,595	$24,316	588,898	2,356,966	$83,237
1897	404,877	1,506,142	49,353	115,200	529,920	17,934	520,077	2,036,062	67,287
1898	410,395	1,534,877	50,875	129,855	606,423	18,510	540,250	2,141,300	69,385
1901	829,612	3,202,302	100,762	144,315	577,260	21,647	973,927	3,779,562	122,409
1904	100,624	402,496	28,896	57,657	201,800	17,758	158,281	604,296	46,654
1910 [1]	126,534	506,136	51,715	101,720	406,880	49,109	228,254	913,016	100,824
1915	11,606	48,564	5,969	4,249	20,104	2,674	15,855	68,668	8,643
1916	7,787	32,923	4,540	1,500	7,250	925	9,287	40,173	5,465
1917	10,615	38,344	5,810	1,400	5,040	720	12,015	43,384	6,530
1918	63,404	220,602	44,784	3,999	14,000	3,400	67,403	234,602	48,184
1919	76,501	301,306	60,690	13,800	73,668	23,034	90,301	374,974	83,724
1920	39,692	157,715	43,882	9,623	42,129	12,427	49,315	199,844	56,309
1921	28,948	104,883	24,329	6,500	25,920	6,294	35,448	130,803	30,623
1922	36,111	128,324	27,451	12,225	46,862	12,255	48,336	175,186	39,706
1923	28,636	97,863	22,644	6,450	23,865	6,000	35,086	121,728	28,644
1924	22,814	72,519	17,619	5,980	21,850	5,485	28,794	94,369	23,104
1925	34,568	110,359	24,030	4,300	13,975	2,400	38,868	124,334	26,430
1926	73,312	219,183	47,175	11,150	46,237	6,300	84,462	265,420	53,475
1927	89,984	299,693	56,950	20,300	58,362	6,700	110,284	358,055	63,650
1928	61,079	194,181	32,689	17,950	52,050	10,460	79,029	246,231	43,149

[1] Includes catch in lower New York Bay, Raritan Bay, and tributaries, but this was inconsiderable.

FISHERIES OF THE CHESAPEAKE BAY STATES

The latest statistical canvass of the fisheries and fishery industries of the Chesapeake Bay States (Maryland and Virginia) was for the calendar year 1925. Complete statistics are published in the report of the division of fishery industries for 1926 and in condensed form in Statistical Bulletin No. 745.

During 1925 the fisheries and fishery industries of Maryland and Virginia gave employment to 39,091 persons, of whom 25,856 were engaged in fishing operations, 9,671 in the wholesale fishery trade, and 3,564 in the canning, salting, smoking, and by-products industries. The products of the fisheries of the two States amounted to 333,205,769 pounds, valued at $13,948,060. The products of the canning and other fishery industries had a value of $4,936,664.

SHAD AND ALEWIFE FISHERIES OF THE POTOMAC RIVER

The catch of shad in 1928 was the largest for any year during the past 27 years, with the exception of 1922, and amounted to 716,420 in number, with a weight of 2,077,622 pounds, valued at $214,687 to the 754 fishermen prosecuting the fishery. This represents approximately 81 per cent of the catch for 1922 (which was the largest catch on record) and 90 per cent of the catch for 1901, which was the second largest year on record. The average price per pound received by the fishermen this year was somewhat less than in former years, due largely to competition from Pacific coast shad. It is interesting to note here that shad were introduced by the Bureau of Fisheries on the Pacific coast in 1871 and their numbers have increased rapidly, until now eastern cities are being supplied with large quantities of the Pacific fish.

More than four-fifths of the Potomac catch this year was made in Virginia waters and was taken largely in pound nets in Northumberland County. The rest of the catch was made in Maryland waters, mostly with drift gill nets. Buy boats from Washington, D. C., purchased most of the catch, although a considerable quantity was shipped from Widewater, Va., to New York and other eastern cities.

The catch of alewives amounted to 14,783,655 fish, weighing 5,903,062 pounds, and having a value to the fishermen of $58,297. This is the largest recorded catch since 1909, except that of 1924. It amounted to slightly over 50 per cent of that in 1909 but more than 97 per cent of that in 1924. The average price per pound to fishermen in 1928 was slightly lower than in 1924, but double that in 1909. Nearly 88 per cent of the entire catch was taken by Virginia fishermen, and virtually all in both States were caught in pound nets. Northumberland County, Va., produced the greater part of the total output. Many of the alewives caught in Virginia are handled by firms engaged in canning herring and herring roe.

Shad and alewife fisheries of the Potomac River, 1928

OPERATING UNITS AND CATCH: BY STATES

Items	Maryland			Virginia			Total		
	Number	*Pounds*	*Value*	*Number*	*Pounds*	*Value*	*Number*	*Pounds*	*Value*
Fishermen	221			533			754		
Row boats and scows	74		$2,890	148		$4,425	222		$7,315
Motor boats	53		12,960	186		56,800	239		69,760
Pound nets	74		13,725	321		109,575	395		123,300
Gill nets	74		9,580	305		10,475	379		20,055
Haul seines	2		650	2		1,100	4		1,750
Shore and accessory property			555			3,165			3,720
Total			40,360			185,540			225,900
Shad caught:									
With pound nets	21,644	65,544	10,321	439,460	1,280,611	138,495	461,104	1,346,155	148,816
With gill nets	103,537	288,003	26,083	135,164	404,085	37,304	238,701	692,088	63,387
With haul seines	13,315	29,579	1,184	3,300	9,800	1,300	16,615	39,379	2,484
Total	138,496	383,126	37,588	577,924	1,694,496	177,099	716,420	2,077,622	214,687
Alewives caught:									
With pound nets	1,737,475	694,990	9,235	12,773,180	5,098,872	47,432	14,510,655	5,793,862	56,667
With gill nets				59,000	23,600	600	59,000	23,600	600
With haul seines	64,000	25,600	330	150,000	60,000	700	214,000	85,600	1,030
Total	1,801,475	720,590	9,565	12,982,180	5,182,472	48,732	14,783,655	5,903,062	58,297

Catch of shad in the Potomac River for various years, 1896 to 1928

Year	Maryland			Virginia			Total		
	Number	*Pounds*	*Value*	*Number*	*Pounds*	*Value*	*Number*	*Pounds*	*Value*
1896	233,238	874,643	$20,524	450,825	1,690,594	$43,084	684,063	2,565,237	$63,608
1901	146,000	547,500	14,800	648,462	2,431,733	104,566	794,462	2,979,233	119,366
1904	83,147	311,801	16,343	289,500	1,085,625	51,709	372,647	1,397,426	68,052
1909	31,158	116,843	9,232	172,813	648,049	44,500	203,971	764,892	53,732
1915	17,196	64,485	6,827	165,206	619,523	65,300	182,402	684,008	72,127
1919	94,512	354,420	56,833	449,957	1,687,339	275,564	544,469	2,041,759	332,397
1920	80,944	302,237	55,963	448,414	1,677,543	278,501	529,358	1,979,780	334,464
1921	49,681	138,207	25,191	356,191	1,022,231	182,179	405,872	1,160,438	207,370
1922	203,682	706,501	95,140	680,494	2,409,070	324,882	884,176	3,115,571	420,022
1923	93,619	308,729	52,917	257,927	878,653	145,702	351,546	1,187,382	198,619
1924	37,505	127,285	20,469	134,805	450,925	67,981	172,310	578,210	88,450
1925	46,008	157,786	35,310	158,574	538,846	128,088	204,582	696,632	163,398
1926	51,601	162,861	34,808	285,061	871,345	182,653	336,662	1,034,206	217,461
1927	30,720	103,728	17,894	191,601	582,853	95,931	222,321	686,581	113,825
1928	138,496	383,126	37,588	577,924	1,694,496	177,099	716,420	2,077,622	214,687

NOTE.—The number of shad taken in the Potomac River in 1878 was 186,000; in 1880, 552,872; in 1889, 868,900; in 1890, 731,453; and in 1891, 621,977.

Catch of alewives in the Potomac River for various years, 1896 to 1928

Year	Maryland			Virginia			Total		
	Number	*Pounds*	*Value*	*Number*	*Pounds*	*Value*	*Number*	*Pounds*	*Value*
1896 [1]							24,437,885	9,775,154	$39,008
1909	4,883,000	1,953,200	$10,369	24,601,040	9,840,416	$42,854	29,484,040	11,793,616	53,223
1915	335,000	134,000	1,420	7,276,428	2,910,571	30,741	7,611,428	3,044,571	32,161
1919	1,488,583	772,867	15,508	7,379,319	2,904,054	45,508	8,867,902	3,676,921	61,016
1920	1,077,775	538,888	13,940	7,681,561	3,813,780	41,197	8,759,336	4,352,668	55,137
1921	1,395,000	558,000	9,010	8,908,510	3,563,404	35,031	10,303,510	4,121,404	44,041
1922	1,292,500	517,000	3,700	10,074,500	4,029,800	34,642	11,367,000	4,546,800	38,342
1923	2,119,787	847,916	8,764	9,308,782	3,722,912	40,657	11,428,569	4,570,828	49,421
1924	1,834,000	733,600	6,855	13,299,388	5,319,156	49,667	15,133,388	6,052,756	56,552
1925	415,000	166,000	2,070	7,420,380	2,968,152	35,271	7,835,380	3,134,152	37,341
1926	1,295,020	518,600	6,518	12,500,828	5,000,330	48,848	13,795,848	5,518,930	55,366
1927	1,272,000	508,699	5,741	10,336,067	4,136,666	44,847	11,608,067	4,645,365	50,588
1928	1,801,475	720,590	9,565	12,982,180	5,182,472	48,732	14,783,655	5,903,062	58,297

[1] Data not divisible for the 2 States.

TRADE IN FRESH AND FROZEN FISHERY PRODUCTS IN WASHINGTON, D. C.

The municipal fish wharf and market was built about 12 years ago on an arm of the Potomac River in the southwestern part of Washington, D. C. At the present time 17 firms have stalls in the market and 6 are in private buildings across the street, altogether employing about 70 people. These firms conduct a wholesale and retail business, chiefly wholesale, however. Some of the fish from the boats and vessels are sold at auction direct to the wholesalers. Several wholesalers also sell fish by auction to hucksters. The greater part of the business in the market is transacted at a set price.

Although the market is so situated that fishing boats may land their fish directly, only about 10 per cent of the fish are received in this way. The greater part arrive by truck from points in Maryland and Virginia, especially from the vicinity of Solomons and Galesville. Fish arriving by rail from points along the Atlantic coast, the Great Lakes, or the Pacific coast are also transported by truck from the railheads, as the market has no direct rail connections.

During 1928 the receipts of fresh and frozen fishery products amounted to 8,198,957 pounds, an increase of 3 per cent compared with the previous year and 13 per cent compared with the 5-year average.

There has been very little change in the kinds of fish handled at the market in the last eight years. Taking those species that constituted 75 per cent of the trade for the various years from 1921 to 1928, squeteague, or "sea trout," made up the greater portion of the trade each year; croaker has usually been second, river herring third, oysters fourth, shad fifth, haddock sixth, striped bass seventh, and butterfish eighth.

The retail business in Washington, D. C., is carried on by the stores in the municipal market, stores in the markets uptown, grocery stores, meat markets, and hucksters with horse and wagon. There are about 40 of these fish peddlers doing business at the present time, but their numbers are said to become fewer each year.

Not all of the fish consumed in the District of Columbia comes to the municipal fish wharf and market. It has been estimated that about 2,500,000 pounds are received direct from outside sources by hotels, fish markets, and restaurants. This, added to the amount received at the municipal wharf, would make a total of about 10,500,000 pounds of fresh and frozen fishery products handled in the District of Columbia during 1928. Virtually the entire amount was consumed in the District. According to the Bureau of the Census, the estimated population of the District of Columbia was 552,000 on July 1, 1928, making the per capita consumption of fresh and frozen products during 1928 about 19 pounds in the round weight.

Fishery products received at municipal fish wharf and market, Washington, D. C., 1928, in pounds

	January	February	March	April	May	June	July
Bass, black or sea	2,100	100	200		4,600	9,000	5,600
Bluefish	200	200			4,100	3,000	5,000
Butterfish	1,300	300		2,600	35,300	99,400	47,400
Carp	5,800	9,900	12,367	14,788	22,200	14,100	5,800
Catfish	2,400	15,200	27,235	17,151	14,300	15,000	12,800
Cod	1,800	3,600	4,900	1,300	2,600	1,600	1,200
Crevalle					200		
Croaker	42,200	23,400	10,650	94,000	111,600	243,600	214,600
Eels	100		435	1,027	520	915	810
Flounders	19,300	29,400	44,400	14,400	18,100	6,800	6,600
Groupers	100	400					
Haddock	29,320	49,500	58,980	32,755	43,340	44,970	41,430
Hake	6,600				200		
Halibut	5,900	11,100	8,850	13,500	9,200	9,000	4,000
Herring, river	34,200	82,100	150,200	306,895	204,850	4,050	
Hickory shad or "jacks"	10,500	8,600	3,300	1,000	600		
Kingfish	7,800	2,300	200	1,900	1,400	600	
Mackerel	23,900	23,300	17,400	12,200	23,950	48,000	39,400
Menhaden				1,200			
Mullet	4,300	2,000	1,058	502	400		
Perch	6,800	23,100	47,945	27,460	8,900	6,700	4,700
Pike or pickerel	1,400	700	200		200	500	
Pollock	4,000	650			2,200	800	1,000
Pompano	350				200	100	200
Redfish or red drum	200	200	400	350		500	1,400
Red snapper	400	200		200	390		200
Salmon	1,800	2,300	1,700			800	1,400
Scup or porgy		200			1,800	3,800	400
Shad	9,200	37,500	86,055	209,063	296,220	9,850	
Sheepshead	1,000	400				400	
Smelt	5,350	3,850	800				
Spot	4,100	1,800	800	480	1,700	9,400	51,600
Squeteagues or "sea trout"	60,400	18,400	8,100	37,200	194,600	200,600	220,100
Squid		100				400	1,400
Striped bass	5,100	7,200	15,995	38,105	22,850	5,900	14,100
Sturgeon				490	1,120	110	
Swordfish							735
Tilefish	400	500	900	500	600		
Whiting	500	1,000					
Clams, hard	2,752	3,392	3,200	3,104	6,528	9,920	7,968
Oysters:							
In the shell (meat)	40,628	36,407	16,296	6,776	140		
Opened (meat)	59,243	50,985	36,911	10,445			
Scallops	640	1,400	64	160	1,196	100	80
Crabs				600	8,085	92,985	128,970
Crab meat	1,680	865	1,425	2,520	8,550	18,275	23,250
Lobster	100	50	50	150	250	300	50
Shrimp	4,200	3,200	2,200	1,100	4,000	4,600	7,000
Turtles	350	228	14	28	2,547	1,835	365
Frogs				30	253	38	
Total	408,413	456,027	563,230	853,979	1,059,789	867,948	849,258

	August	September	October	November	December	Total
Bass, black or sea	800			1,700	2,900	26,500
Bluefish	8,200	10,000	15,700	200		46,600
Butterfish	46,200	39,400	22,800	5,000	700	300,400
Carp	3,800	10,900	14,800	5,800	5,900	128,155
Catfish	12,200	16,800	26,100	19,100	9,000	187,286
Cod	2,900	1,000	1,500	3,400	1,400	27,200
Crevalle			800			1,000
Croaker	118,400	62,200	83,200	37,900	49,000	1,040,750
Eels	110	1,465	1,985	1,500	900	9,467
Flounders	10,500	9,600	26,100	30,900	30,800	246,900
Groupers						500
Haddock	37,500	45,160	68,520	45,080	51,600	548,155
Hake	200		2,200	81,700	81,400	172,300
Halibut	6,200	5,600	6,000	4,600	3,000	86,950
Herring, river						782,295
Hickory shad or "jacks"						24,000
Kingfish		800	1,400	7,600	6,400	30,400
Mackerel	31,000	15,800	12,700	16,200	14,400	278,250
Menhaden						1,200
Mullet		2,600	2,300	7,200	1,600	21,960
Perch	15,300	8,100	15,000	15,600	14,300	193,905
Pigfish			800			800
Pike or pickerel	200	200	1,100	2,400	1,000	7,900
Pollock	2,000	5,900	4,600	1,300	2,900	25,350
Pompano			500			1,850
Redfish or red drum	300		100	1,600	200	5,250
Red snapper		200	300	1,000	200	3,090
Salmon	1,300	3,100	1,600	2,800	800	17,100

Fishery products received at municipal fish wharf and market, Washington, D. C., 1928, in pounds—Continued

	August	September	October	November	December	Total
Scup or porgy	200	200	200			6,800
Shad			600	4,800	1,900	666,188
Sheepshead			300	200		2,300
Smelt				100	1,300	11,400
Spot	25,200	6,200	32,900	17,200	3,300	154,680
Squeteagues or "sea trout"	243,400	30,760	350,600	112,900	76,100	1,552,160
Squid				100	200	2,200
Striped bass	22,400	31,840	37,900	23,700	14,300	239,390
Sturgeon			100			1,820
Swordfish	1,040	150				1,925
Tilefish	500	600	200	1,900	1,300	7,400
Whitefish	300	200	400		100	1,000
Whiting				25,800	21,800	49,100
Clams, hard	7,712	5,760	9,184	3,488	2,208	[1] 65,216
Oysters:						
In the shell (meat)		6,384	42,644	40,908	25,739	[2] 215,922
Opened (meat)		18,455	54,029	73,301	70,546	[3] 373,915
Scallops	80	80	840	80	240	4,960
Crabs	137,775	80,220	18,570	150		467,355
Crab meat	23,720	11,410	8,865	3,260	1,375	105,195
Lobster			50	250	450	1,700
Shrimp	13,000	5,000	6,900	3,700	4,200	59,100
Turtles	198	4	16	90	222	5,897
Frogs						321
Total	772,135	436,068	824,403	604,007	503,680	8,198,957

[1] 8,152 bushels. [2] 30,846 bushels. [3] 45,323 gallons.

NOTE.—The clams have been reduced to pounds on the basis of 8 pounds of meat to the bushel, the oysters on the basis of 7 pounds of meat to a bushel and 8¼ pounds to a gallon.

FISHERIES OF THE SOUTH ATLANTIC STATES

The latest statistical canvass, prior to that for 1927, of the fisheries and fishery industries of the South Atlantic States (North Carolina, South Carolina, Georgia, and east coast of Florida) was made for the calendar year 1923. Complete statistics are published in the report of the division of fishery industries for 1924 and in condensed form in Statistical Bulletin No. 652.

During 1923, the fisheries and fishery industries of the South Atlantic States employed 16,298 persons, of whom 10,274 were employed in fishery operations and 6,024 in the wholesale fishery trade and the canning, salting, smoking, and by-products industries. The products of the fisheries of these States amounted to 228,747,930 pounds, valued at $5,087,340.

The fisheries of the South Atlantic States are especially important for the production of shrimp, oysters, and menhaden. A larger catch was reported in 1927 than in any year for which there are records, except 1918. The fisheries in this district gave employment to 11,527 fishermen, or 14 per cent more than in 1923, the most recent year prior to 1927 for which records are available. Of the total number of fishermen employed in 1927, there were 1,229 regular fishermen engaged on vessels and 8,900 regular and 1,398 casual fishermen engaged in the shore and boat fisheries. Their catch amounted to 260,668,693 pounds, valued at $5,695,887. This is an increase of 14 per cent in quantity and 12 per cent in value compared with that for 1923. Of the total catch in 1927, 217,306,021 pounds were fish, valued at $3,757,056, and 43,362,672 pounds were shellfish and miscellaneous products, valued at $1,938,831.

Based on the value to the fishermen, shrimp, with a production of 29,992,313 pounds, valued at $1,173,333, was the most important of the fishery products in the South Atlantic States. Menhaden ranked second with a production of 157,965,461 pounds valued at $688,811. Other important species were shad, 3,104,048 pounds, valued at $620,851; mullet, 11,377,584 pounds, valued at $522,818; oysters, market and seed, 10,447,255 pounds, valued at $458,059; squeteagues or "sea trout," 5,473,793 pounds, valued at $359,673; kingfish or "king mackerel," 3,355,810 pounds, valued at $230,831; Spanish mackerel, 2,121,675 pounds, valued at $171,137; alewives, 14,123,497 pounds, valued at $149,240; bluefish, 1,636,891 pounds, valued at $147,039; striped bass, 744,810 pounds, valued at $120,383; and scallops, 834,750 pounds, valued at $119,767.

The industries related to the fisheries of the South Atlantic States gave employment to 3,278 persons, of whom 208 were engaged in transporting fishery products, 1,144 were employed in the wholesale trade, receiving $514,242 in salaries and wages, and 1,926 were employed in the canning and by-products trade, receiving $738,846 in salaries and wages. There were 146 establishments in the wholesale trade that handled fresh and frozen products, and 67 establishments in the prepared products and by-products trade. The latter manufactured products valued at $3,580,295, consisting principally of canned oysters and shrimp and menhaden products.

In addition, some of the fishermen of South Carolina prepared 190,700 pounds of salted fish, consisting mostly of salted mullet, valued at $17,196.

Fisheries of the South Atlantic States, 1927

OPERATING UNITS: BY STATES

Items	North Carolina	South Carolina	Georgia	Florida (east coast)	Total
Fishermen:					
On vessels	939	16	126	146	1,229
On boats or shore—					
Regular	4,524	988	671	2,717	8,900
Casual	786	406	124	82	1,398
Total	6,249	1,410	921	2,947	11,527
Vessels:					
Motor	65	2	31	19	117
Tonnage	1,673	28	390	312	2,403
Sail	60				60
Tonnage	489				489
Boats:					
Motor	1,631	99	175	1,179	3,084
Other	1,886	836	342	1,075	4,139
Apparatus:					
Gill nets	17,591	459	186	1,028	19,264
Square yards	2,722,664	437,203	110,441	1,200,860	4,471,168
Haul seines	636	33	6	92	767
Yards	187,716	4,235	1,998	49,800	243,749
Purse seines	47		3	4	54
Yards	11,100		600	1,260	12,960
Pound nets	2,767			14	2,781
Trammel nets				4	4
Square yards				1,000	1,000
Shrimp trawls	64	28	188	366	646
Yards at mouth	1,060	536	3,760	8,539	13,895
Otter trawls	1				1
Yards at mouth	20				20
Lines	301	110	444	6,879	7,734
Hooks, snoods, or baits	77,923	16,546	532	95,783	190,784
Fyke nets	780		20		800
Eel pots	3,800				3,800
Dip nets	329			35	364
Crab traps				275	275
Spears	215	34			249
Dredges	1,044	2	2		1,048
Yards at mouth	1,214	2	3		1,219
Tongs	373	38	147	62	620
Rakes	679	73		12	764
Grabs		436	191		627
Minor apparatus [1]	72	30	28	622	752

[1] Includes cast nets, crawfish traps, fish traps, box traps, revolving traps, turtle traps, and crawfish hooks.

Fisheries of the South Atlantic States, 1927—Continued

CATCH OF FISH

Products	North Carolina		South Carolina		Georgia	
	Pounds	*Value*	*Pounds*	*Value*	*Pounds*	*Value*
Alewives	13, 910, 605	$147, 032				
Angelfish or spadefish	12, 996	497				
Black bass	117, 006	18, 446				
Bluefish	852, 391	54, 281	12, 700	$1, 921		
Bonito	14, 713	447				
Bowfin	28, 150	591				
Butterfish	342, 254	11, 095	300	20		
Carp	632, 520	85, 898				
Catfish	452, 875	14, 771	4, 000	170	20, 035	$1, 208
Crevalle	600	12	1, 500	75		
Cod	764	39				
Croaker	3, 932, 058	77, 385	12, 600	670	3, 000	150
Drum, black	11, 413	323	3, 100	305		
Drum, red, or redfish	99, 147	3, 513	6, 650	403	1, 000	50
Eels	159, 769	12, 340			10	1
Flounders	348, 978	23, 009	14, 500	1, 391	200	10
Garfish	3, 000	30				
Gizzard shad	60, 349	1, 106				
Groupers					26, 272	1, 527
Grunts	9, 000	565			200	18
Harvestfish or "starfish"	937, 596	29, 227				
Hickory shad	529, 632	35, 328	18, 524	2, 582	14, 200	710
Jewfish					2, 388	110
Kingfish or "king mackerel"	25, 000	1. 380				
King whiting or "kingfish"	486, 882	27. 733	59, 500	6, 725	2, 600	130
Menhaden	98, 987, 261	489, 850			34, 102, 000	119, 857
Mullet	4, 325, 203	262, 192	461, 000	27, 360	8, 533	488
Pigfish	147, 225	2, 676	500	75		
Pike	21, 975	2, 726				
Pinfish or sailor's choice	25, 550	408				
Pompano	13, 221	1, 631	5, 500	825		
Porgies			500	35	3, 402	281
Sea bass	315, 601	25, 248	125, 000	11, 950	47, 694	4, 551
Shad	2, 386, 685	475, 292	182, 425	88, 313	187, 380	43, 578
Sharks			8. 000	240		
Skates			1, 000	30		
Sheepshead	22, 788	1, 335				
Snapper, red	1, 150	107			63, 643	6, 435
Spanish mackerel	200, 352	21, 163				
Spot	1, 959, 252	45, 531	216, 100	9, 798	800	40
Squeteagues or "sea trout"	4, 533, 807	263, 233	53, 500	5, 170	17, 541	2, 476
Strawberry bass	3, 350	311				
Striped bass	737, 805	119, 481			5, 355	490
Sturgeon	27, 139	3, 443	13, 250	1, 766	2, 625	303
Suckers	16, 609	918				
Sunfish	24, 019	549				
Tripletail	1, 013	27				
White perch	504, 653	40, 574				
Yellow perch	117, 706	7, 264				
Total	137, 340, 062	2, 259, 007	1, 200, 149	109, 824	34, 508, 878	181, 913

Products	Florida (east coast)		Total	
	Pounds	*Value*	*Pounds*	*Value*
Alewives	212, 892	$2, 208	14, 123, 497	$149, 240
Amberfish	9, 200	360	9, 200	360
Angelfish or spadefish	11, 030	359	24, 026	856
Black bass	118, 154	12, 862	235, 160	31, 308
Bluefish	771, 800	90, 837	1, 636, 891	147, 039
Blue runner or hardtail	88, 380	2, 602	88, 380	2, 602
Bonito			14, 713	447
Bowfin			28, 150	591
Butterfish			342, 554	11, 115
Carp			632, 520	85, 898
Catfish	1. 925, 233	77, 048	2, 402, 143	93, 197
Crappie	368, 059	25, 949	368, 059	25, 949
Crevalle	207, 800	6, 425	209, 900	6, 512
Cod			764	39
Croaker	39, 050	1, 553	3, 986, 708	79, 758
Drum, black	83, 600	2, 989	98, 113	3, 617

Fisheries of the South Atlantic States, 1927—Continued

CATCH OF FISH—Continued

Products	Florida (east coast)		Total	
	Pounds	*Value*	*Pounds*	*Value*
Drum, red, or redfish	163, 300	$9, 143	270, 097	$13, 109
Eels			159, 779	12, 341
Flounders	21, 250	985	384, 928	25, 395
Garfish			3, 000	30
Gizzard shad			60, 349	1, 106
Groupers	59, 900	2, 746	86, 172	4, 273
Grunts	24, 600	922	33, 800	1, 505
Harvestfish or "starfish"			937, 596	29, 227
Hickory shad	42, 246	2, 137	604, 602	40, 757
Hogfish	2, 800	154	2, 800	154
Jewfish	15, 100	338	17, 488	448
Kingfish or "king mackerel"	3, 330, 810	229, 451	3, 355, 810	230, 881
King whiting or "kingfish"	168, 600	8, 964	717, 582	43, 552
Margatefish	1, 100	44	1, 100	44
Menhaden	24, 876, 200	79, 604	157, 965 461	688, 811
Moonfish	3, 500	90	3, 500	90
Mullet	6, 582, 848	232, 778	11, 377, 584	522, 818
Permit	8, 890	263	8, 890	263
Pigfish	154, 650	5, 739	302, 375	8, 490
Pike			21, 975	2, 726
Pinfish or sailor's choice	304, 100	9, 236	329, 650	9, 644
Pompano	218, 950	44, 710	237, 671	47, 166
Porgies	12, 000	470	15, 902	786
Sea bass	31, 700	1, 962	519, 995	43, 711
Sergeantfish or snook	226, 250	10, 779	226, 250	10, 779
Shad	347, 558	63, 668	3, 104, 048	620, 851
Sharks			8, 000	240
Skates			1, 000	30
Sheepshead	54, 450	2, 234	77, 238	3, 569
Snapper, mangrove	40, 800	2, 435	40, 800	2, 435
Snapper, mutton	128, 900	6, 734	128, 900	6, 734
Snapper, red	59, 200	5, 868	123, 993	12, 410
Spanish mackerel	1, 921, 323	149, 974	2, 121, 675	171, 137
Spot	420, 750	11, 639	2, 596, 902	67, 008
Squeteagues or "sea trout"	868, 945	88, 794	5, 473, 793	359, 673
Strawberry bass	5, 000	250	8, 350	561
Striped bass	1, 650	412	744, 810	120, 383
Sturgeon			43, 014	5, 512
Suckers			16, 609	918
Sunfish	305, 264	9, 395	329, 283	9, 944
Tripletail			1, 013	27
White perch			504, 658	40, 574
Yellow perch			117, 706	7, 264
Yellowtail	19, 100	1, 202	19, 100	1, 202
Total	44, 256, 932	1, 206, 312	217, 306, 021	3, 757, 056

CATCH OF SHELLFISH AND MISCELLANEOUS PRODUCTS

Products	North Carolina		South Carolina		Georgia	
	Pounds	*Value*	*Pounds*	*Value*	*Pounds*	*Value*
Crabs, hard	955, 600	$19, 512	10, 000	$3, 000	58, 800	$2, 395
Crabs, soft	269, 000	44, 257				
Shrimp	1, 275, 832	45, 706	1, 657, 127	66, 705	12, 279, 969	468, 615
Squid	2, 000	60				
Clams, hard	315, 360	70, 940	46, 544	7, 307	800	100
Oysters, market, public	3, 026, 625	197, 742	4, 412, 331	123, 052	571, 305	36, 379
Oysters, market, private	14, 000	3, 000	1, 027, 950	32, 950	186, 032	7, 223
Oysters, seed, public	427, 000	17, 050				
Scallops	834, 750	119, 767				
Octopus	550	44	1, 000	200		
Terrapin			18, 351	7, 254	1, 440	540
Turtles	5, 000	270				
Sturgeon roe and caviar	50	50	165	99		
Total	7, 125, 767	518, 398	7, 173, 468	240, 567	13, 098, 346	515, 252

Fisheries of the South Atlantic States, 1927—Continued

CATCH OF SHELLFISH AND MISCELLANEOUS PRODUCTS—Continued

Products	Florida (east coast)		Total	
	Pounds	*Value*	*Pounds*	*Value*
Crabs, hard	121,400	$8,732	1,145,800	$33,639
Crabs, soft			269,000	44,257
Crabs, stone	6,400	576	6,400	576
Sea crawfish or spiny lobster	260,536	21,250	260,536	21,250
Shrimp	14,779,385	592,307	29,992,313	1,173,333
Squid			2,000	60
Clams, hard	9,600	1,000	372,304	79,347
Oysters, market, public	651,182	29,818	8,661,443	386,991
Oysters, market, private	130,830	10,845	1,358,812	54,018
Oysters, seed, public			427,000	17,050
Scallops			834,750	119,767
Octopus			1,550	244
Terrapin			19,791	7,794
Turtles	5,758	86	10,758	356
Sturgeon roe and caviar			215	149
Total	15,965,091	664,614	43,362,672	1,938,831

PRODUCTION OF CERTAIN SHELLFISH SHOWN IN NUMBERS AND BUSHELS

Products	North Carolina		South Carolina		Georgia	
	Quantity	*Value*	*Quantity*	*Value*	*Quantity*	*Value*
Crabs, hard ... number	2,866,800	$19,512	30,000	$3,000	176,400	$2,395
Crabs, soft ... do	807,000	44,257				
Clams, hard ... bushels	39,420	70,940	5,818	7,307	100	100
Oysters, market, public ... do	432,375	197,742	630,333	123,052	81,615	36,379
Oysters, market, private ... do	2,000	3,000	146,850	32,950	26,576	7,223
Oysters, seed, public ... do	61,000	17,050				
Scallops ... do	139,125	119,767				

Products	Florida (east coast)		Total	
	Quantity	*Value*	*Quantity*	*Value*
Crabs, hard ... number	364,200	$8,732	3,437,400	$33,639
Crabs, soft ... do			807,000	44,257
Crabs, stone ... do	8,533	576	8,533	576
Clams, hard ... bushels	1,200	1,000	46,538	79,347
Oysters, market, public ... do	93,026	29,818	1,237,349	386,991
Oysters, market, private ... do	18,690	10,845	194,116	54,018
Oysters, seed, public ... do			61,000	17,050
Scallops ... do			139,125	119,767

Industries related to the fisheries of the South Atlantic States, 1927

Items	North Carolina	South Carolina	Georgia	Florida (east coast)	Total
Transporting:					
Persons engaged ... number	61	111	29	7	208
Vessels:					
Motor ... do	42	15	15	3	75
Tonnage ... do	452	200	140	30	822
Sail ... do		40			40
Tonnage ... do		369			369
Wholesale trade:					
Establishments ... do	36	9	14	87	146
Persons engaged ... do	216	74	210	644	1,144
Salaries and wages paid ... dollars	91,615	44,566	104,299	273,762	514,242
Prepared products and by-products industries:					
Establishments ... number	35	15	12	5	67
Persons engaged ... do	339	600	768	219	1,926
Salaries and wages paid ... dollars	263,105	194,046	161,535	120,160	738,846
Products ... do	1,036,841	882,261	994,594	666,599	3,580,295

NORTH CAROLINA

In 1927 North Carolina was foremost among the States bordering on the South Atlantic in the importance of its fisheries, employing 54 per cent of the total number of fishermen and accounting for 55 per cent of the total catch. There were 6,865 persons employed. This is 26 per cent less than the number employed in 1923. Of the total, 6,249 were fishermen, 61 were employed on transporting vessels, 216 in the wholesale trade, and 339 in the prepared products and by-products industries.

The catch amounted to 144,465,829 pounds, valued at $2,777,405. This is an increase of 52 per cent in amount and 15 per cent in the value of the catch, as compared with the catch and its value in 1923. Of the total value of the catch, that for menhaden accounted for 18 per cent; shad, 17 per cent; squeteagues or "sea trout," 9 per cent; mullet, 9 per cent; oysters, 8 per cent; alewives, 5 per cent; and striped bass, 4 per cent. Of the total quantity, that for menhaden accounted for 69 per cent; alewives, 10 per cent; squeteagues or "sea trout," 3 per cent; mullet, 3 per cent; croaker, 3 per cent; oysters, 2 per cent; and shad, 2 per cent.

Operating units.—The catch of fishery products from the Atlantic Ocean and coastal streams was taken by 6,249 fishermen, who used 3,517 motor and other small boats, 65 motor vessels, 60 sailing vessels, and 14 types of major gear. The motor and sailing vessels had a combined capacity of 2,162 net tons.

Fisheries of North Carolina

OPERATING UNITS: BY GEAR

Items	Haul seines	Purse seines	Gill nets	Pound nets	Fyke nets	Dip nets	Lines	Shrimp trawls	Otter trawls	Revolving traps
Fishermen:										
On boats and shore—										
Regular	2,113	86	1,943	638	46	302	277	128		
Casual	222		332	162	11	27	10			8
On vessels	108	622					11		3	
Total	2,443	708	2,275	800	57	329	298	128	3	8
Boats:										
Motor	454	12	749	400	22	95	143	64		
Other	409	22	857	271	11	88	44			8
Vessels:										
Motor—										
5 to 10 tons	16	5					2		1	
11 to 20 tons	2	3					1			
21 to 30 tons		5								
31 to 40 tons		4								
41 to 50 tons		7								
51 to 60 tons		7								
61 to 70 tons		3								
71 to 80 tons		2								
Total	18	36					3		1	
Net tonnage	136	1,419					30		10	
Apparatus:										
Number	636	47	17,501	2,767	780	329	361	64	1	4
Length, yards	187,716	11,100								
Square yards			2,722,664							
Yards at mouth								1,060	20	
Hooks, snoods, or baits							77,923			

Fisheries of North Carolina—Continued

OPERATING UNITS: BY GEAR—Continued

Items	Box traps	Eel pots	Turtle traps	Spears	Dredges	Tongs	Rakes	By hand	Total, exclusive of duplication
Fishermen:									
On boats and shore—									
Regular	6	93	2	215	576	350	579	15	4,524
Casual		5					100		786
On vessels					185	16			939
Total	6	98	2	215	761	366	679	15	6,249
Boats:									
Motor		38	2		355	158	34		1,631
Other	6	61		165	30	124	291	10	1,896
Vessels:									
Motor—									
5 to 10 tons					1	2			28
11 to 20 tons					1	3			8
21 to 30 tons					1				6
31 to 40 tons									4
41 to 50 tons									7
51 to 60 tons									7
61 to 70 tons									3
71 to 80 tons									2
Total					3	5			65
Net tonnage					44	47			1,673
Sail—									
5 to 10 tons					50				50
11 to 20 tons					10				10
Total					60				60
Net tonnage					489				489
Grand total					63	5			125
Net tonnage					533	47			2,162
Apparatus:									
Number	18	3,800	50	215	1,044	373	679		
Yards at mouth					1,214				

Catch by gear.—Four types of gear accounted for 94 per cent of the products taken in the marine and coastal river fisheries of North Carolina during 1927. Listed in the order of their importance they were purse seines, which accounted for 69 per cent of the catch; pound nets, 10 per cent; haul seines, 10 per cent; and gill nets, 5 per cent.

The catch by purse seines consisted almost entirely of menhaden; that by pound nets was made up largely of alewives, squeteagues or "sea trout," and shad; that by haul seines consisted principally of alewives, croaker, mullet, and spot; and that by gill nets was made up chiefly of mullet, shad, croaker, squeteagues or "sea trout," and alewives.

Fisheries of North Carolina, 1927

CATCH: BY GEAR

Species	Haul seines		Purse seines		Gill nets		Pound nets	
	Pounds	*Value*	*Pounds*	*Value*	*Pounds*	*Value*	*Pounds*	*Value*
Alewives	4,486,255	$52,368			598,200	$13,368	8,576,150	$78,356
Angelfish or spadefish	7,771	289					4,875	193
Black bass	95,546	14,992			950	104	2,385	408
Bluefish	442,016	26,254			338,875	22,336	65,500	5,121
Bonito	4,334	128			10,000	300	379	19
Bowfin	6,750	154					10,950	136
Butterfish	123,550	4,310			10,925	615	207,779	6,170
Carp	461,752	25,523			20,350	1,416	31,118	889
Catfish	168,971	4,330			29,100	1,052	117,304	3,371
Crevalle	600	12						
Cod					500	25	264	14
Croaker	2,541,227	45,064			659,483	15,893	662,348	13,668
Drum, black	4,493	100			4,000	160	2,920	63
Drum, red, or redfish	66,250	2,383			12,041	400	19,856	650
Eels							7,029	652
Flounders	57,765	3,424			26,325	1,898	135,688	8,470
Garfish	3,000	30						
Gizzard shad	15,600	290			11,600	220	21,749	886
Harvestfish or "starfish"	68,000	2,390			54,000	1,620	815,596	25,217
Hickory shad	64,210	3,238			265,423	17,540	199,599	14,510
King whiting or "kingfish"	160,713	8,259			301,957	17,748	84,212	1,726
Menhaden			98,987,261	$489,850				
Mullet	2,369,997	141,148	348,400	21,340	1,585,665	98,425	21,141	1,279
Pigfish	109,000	1,613			26,000	519	4,925	78
Pike	6,100	722			4,100	248	2,535	236
Pinfish or sailor's choice	2,500	20			9,500	185	11,350	107
Pompano	6,867	850			1,100	131	5,254	650
Sea bass							108	9
Shad	111,702	19,009			1,179,923	241,104	1,086,710	213,639
Sheepshead	12,298	672			5,100	335	5,390	328
Spanish mackerel	33,019	3,330			32,464	3,337	114,869	12,496
Spot	1,243,800	27,851			414,650	11,803	297,802	5,782
Squeteague or "sea trout," gray	774,134	36,524			642,555	33,789	2,156,375	91,499
Squeteague or "sea trout," speckled	677,598	66,086			210,443	26,764	64,502	8,168
Strawberry bass	500	40					350	21
Striped bass	188,496	27,267	16,700	2,505	288,910	50,420	233,499	37,291
Sturgeon	7,892	977			15,916	1,965	3,331	501
Sturgeon roe					50	50		
Suckers	400	8			7,500	450	4,379	310
Sunfish	18,775	431					3,591	72
Tripletail							1,013	27
White perch	281,050	17,209			30,775	4,116	136,912	14,999
Yellow perch	48,512	2,737			8,850	213	12,564	1,025
Crabs, soft	113,600	18,735						
Shrimp	60,000	2,600						
Total	14,835,043	561,367	99,352,361	513,695	6,801,630	568,549	15,082,301	548,536

Fisheries of North Carolina, 1927—Continued

CATCH: BY GEAR—Continued

Species	Fyke nets		Dip nets		Lines		Shrimp trawls	
	Pounds	*Value*	*Pounds*	*Value*	*Pounds*	*Value*	*Pounds*	*Value*
Alewives	55,000	$1,050	135,000	$990				
Angelfish or spadefish					350	$15		
Black bass	18,125	2,942						
Bluefish					6,000	570		
Bowfin	9,450	261						
Carp	107,100	7,460						
Catfish	93,300	3,428			34,000	2,280		
Drum, red, or redfish					1,000	80		
Eels	4,990	303						
Flounders	8,000	393			800	58	13,000	$540
Gizzard shad	12,000	210						
Grunts					9,000	565		
Hickory shad	400	40						
Kingfish or king mackerel					9,000	900	16,000	480
Pigfish					7,300	466		
Pike	9,240	1,520						
Pinfish or sailor's choice					2,200	98		
Sea bass					315,493	25,239		
Shad	8,350	1,540						
Snapper, red					1,150	107		
Spanish mackerel					20,000	2,000		
Spot							2,500	75
Squeteague or "sea trout," gray					4,000	275	4,000	120
Strawberry bass	2,500	250						
Striped bass	10,100	1,978						
Suckers	4,330	150						
Sunfish	1,653	46						
White perch	46,816	3,340						
Yellow perch	52,780	3,289						
Crabs, hard					940,600	19,062		
Crabs, soft			128,200	20,932				
Shrimp							1,215,832	43,106
Octopus					550	44		
Squid							2,000	60
Total	444,134	28,200	263,200	21,922	1,351,443	51,757	1,253,332	44,381

Species	Otter trawls		Revolving traps		Box traps		Eel pots	
	Pounds	*Value*	*Pounds*	*Value*	*Pounds*	*Value*	*Pounds*	*Value*
Alewives			60,000	$900				
Bowfin					1,000	$40		
Carp			200	10	12,000	600		
Catfish			200	10	10,000	300		
Croaker	69,000	$2,760						
Eels							147,750	$11,385
Flounders	400	16						
Spot	500	20						
Squeteague or "sea trout," gray	200	8						
Striped bass			100	20				
White perch			100	10	9,000	900		
Total	70,100	2,804	60,600	950	32,000	1,840	147,750	11,385

Species	Turtle traps		Spears		Dredges	
	Pounds	*Value*	*Pounds*	*Value*	*Pounds*	*Value*
Flounders			107,000	$8,210		
Crabs, hard					15,000	$450
Crabs, soft					27,200	4,590
Oysters, market, public					2,107,700	133,985
Oysters, seed, public					133,000	4,750
Scallops					657,990	95,108
Turtles	4,000	$200				
Total	4,000	200	107,000	8,210	2,940,890	238,883

Species	Tongs		Rakes		By hand	
	Pounds	*Value*	*Pounds*	*Value*	*Pounds*	*Value*
Clams, hard			307,360	$69,440	8,000	$1,500
Oysters, market, public	883,925	$61,557			35,000	2,200
Oysters, market, private	14,000	3,000				
Oysters, seed, public	294,000	12,300				
Scallops			176,760	24,659		
Turtles					1,000	70
Total	1,191,925	76,857	484,120	94,099	44,000	3,770

Fisheries by counties.—Fishing was prosecuted in the marine and coastal river waters of 22 counties in North Carolina in 1927. Ranked according to value, the fisheries of Carteret County were the most important, accounting for 57 per cent of the total catch and 35 per cent of the total value of the catch. Dare County was next, accounting for 4 per cent of the total catch and 17 per cent of the total value. Brunswick County ranked third, with 21 per cent of the total catch and 10 per cent of the total value. Other counties accounting for catches in excess of $100,000 in value were Pamlico, Beaufort, and Hyde.

Fisheries of North Carolina, 1927

OPERATING UNITS AND CATCH: BY COUNTIES

County	Fishermen		Vessels		Motor boats	Other boats	Products	
	Regular	Casual						
	Number	*Number*	*Number*	*Net tonnage*	*Number*	*Number*	*Pounds*	*Value*
Beaufort	322		26	209	77	109	2,340,739	$126,667
Bertie		36			6	7	937,090	18,945
Brunswick	618	110	8	374	42	135	30,441,747	267,575
Camden	5	4			7	2	35,700	2,832
Carteret	2,055		69	1,396	579	477	81,741,670	977,898
Chowan		158			56	64	6,072,772	75,428
Craven	66	28			20	54	832,282	54,873
Currituck	263	8			117	34	1,173,045	86,636
Dare	753				331	213	6,312,596	474,228
Gates		40			1	40	14,800	2,049
Hertford	4	34			2	33	284,190	6,008
Hyde	230		2	16	123	80	2,544,035	121,286
Martin	6	104			2	41	1,230,275	13,781
New Hanover	296	90			25	168	742,425	60,708
Onslow	193	35	1	8	28	121	1,413,043	87,395
Pamlico	254	2	14	108	88	91	2,338,950	135,614
Pasquotank	48		5	51	14	17	415,228	43,921
Pender	120	20			2	84	578,678	48,481
Perquimans	60				30	30	692,400	60,338
Pitt		17				7	19,880	775
Tyrrell	103				47	42	831,520	33,560
Washington	67	109			34	87	3,472,764	76,922
Total	5,463	786	125	2,162	1,631	1,886	144,465,829	2,777,405

INDUSTRIES RELATED TO THE FISHERIES

Transporting trade.—In 1927 there were 61 persons engaged in North Carolina primarily in transporting the catch from the fishing grounds to market. In this trade 42 registered motor vessels, with a capacity of 452 net tons, were operated. The size of vessel in most popular use ranged from 5 to 10 net tons.

Wholesale trade.—There were 36 wholesale establishments in North Carolina engaged chiefly in handling fresh and frozen fishery products. This is 25 per cent of the total number of such establishments in the South Atlantic section. The large amount of fish used in reduction factories in this State accounts for the small number of wholesale dealers in comparison with the total amount of fish caught. These establishments employed 216 persons, who received $91,615 in salaries and wages. Beaufort County had 8 wholesale establishments, Carteret County 7, and Onslow County 5. Other counties had fewer than this.

Prepared and by-products trade.—There were 35 establishments in North Carolina in 1927 engaged in canning and curing fishery products and in manufacturing fishery by-products. These employed 339 persons, who received $263,105 in salaries and wages. The commodities manufactured, which were largely products from the reduction of menhaden, were valued at $1,036,841. This was 29 per cent of the total production of prepared fishery products and by-products manufactured in the South Atlantic States. North Carolina ranks first in the output of such products. Detailed statistics of most of these manufactured items may be obtained from Fishery Industries of the United States, 1927, Bureau of Fisheries Document No. 1050.

Industries related to the fisheries of North Carolina, 1927

TRANSPORTING

Items	Number
Men on transporting vessels	61
Transporting motor vessels:	
5 to 10 tons	24
11 to 20 tons	15
21 to 30 tons	3
Total	42
Net tonnage	452

WHOLESALE FISHERY TRADE

Items	Beaufort	Brunswick and Craven	Carteret	Dare	Hyde and New Hanover	Onslow	Pamlico, Pender, and Pasquotank	Totals
Establishments	8	4	7	3	3	5	6	36
Persons engaged:								
Proprietors or managers	10	4	8	3	4	10	13	52
Salaried employees	1	3	2				1	7
Wage earners	53	46	16	6	9	4	23	157
Paid to salaried employees	$2,000	$3,556	$3,010				$9,900	$18,466
Paid to wage earners	$20,640	$10,090	$9,510	$3,110	$7,960	$1,830	$20,009	$73,149

PREPARED FISHERY PRODUCTS AND BY-PRODUCTS

Items	Number	Items	Amount
Establishments	35	Salaries paid	$66,230
Persons engaged:		Wages paid	196,875
Proprietors or managers	48		
Salaried employees	34	Total salaries and wages paid	263,105
Wage earners	257		

Products	Quantity	Value	Products	Quantity	Value
Salted:			Menhaden:		
Mullet ... pounds	511,600	$45,469	Dry scrap ... tons	5,049	$233,549
Spot ... do	156,400	11,956	Acidulated scrap ... do	7,468	161,790
Canned:			Fish meal ... do	2,304	124,110
Alewife roe			Oil ... gallons	782,778	330,685
... standard cases[1]	1,568	8,935	Miscellaneous products[2]		38,632
Oysters ... do	15,618	81,715			
			Total		1,036,841

[1] A standard case contains four dozen 1-pound cans of alewife roe or four dozen 5-ounce cans of oysters.
[2] Includes canned shrimp, poultry feed and lime from crushed oyster shells, and porpoise oil.

SOUTH CAROLINA

The fisheries and related fishery industries of South Carolina employed 2,195 persons in 1927, which is 1 per cent more than the number employed in 1923. Of the total, 1,410 were fishermen, 111 were employed on transporting vessels, 74 in the wholesale trade, and 600 in the prepared products and by-products industries.

The catch amounted to 8,373,617 pounds, valued at $350,391. This is an increase of 24 per cent in amount and 23 per cent in value as compared with the catch and its value for 1923. Of the total value of the catch, that of oysters accounted for 45 per cent; shrimp, 19 per cent; shad, 11 per cent; and mullet, 8 per cent. Of the total quantity, that of oysters accounted for 65 per cent; shrimp, 20 per cent; mullet, 6 per cent; and spot, 3 per cent.

Operating units.—The catch of fishery products in South Carolina during 1927 was taken by 1,410 fishermen, who used 935 motor and other small boats, 2 motor vessels with a capacity of 28 net tons, and 9 types of major gear.

Fisheries of South Carolina, 1927

OPERATING UNITS: BY GEAR

Items	Haul seines	Gill nets	Cast nets	Lines	Shrimp trawls	Spears	Dredges	Tongs	Rakes	Grabs	Total, exclusive of duplication
Fishermen:											
On boats or shore—											
Regular	226	167		90	50			70	32	433	988
Casual	52	333	30		6	44			41	3	406
On vessels				8			8				16
Total	278	500	30	98	56	44	8	70	73	436	1,410
Boats:											
Motor	2	65		10	28			4	1	15	99
Other	31	222	30	32		34		79	48	491	836
Vessels (motor):											
5 to 10 tons				1							1
11 to 20 tons							1				1
Total				1			1				2
Net tonnage				9			19				28
Apparatus:											
Number	33	459	30	110	28	34	2	38	73	436	
Length, yards	4,235										
Square yards		437,203									
Yards at mouth					536		2				
Hooks, snoods, or baits				16,546							

Catch by gear.—Four types of gear accounted for 94 per cent of the products taken in the fisheries of South Carolina during 1927. Listed in the order of their importance, they were tongs and grabs, which accounted for 64 per cent; shrimp trawls, 18 per cent; haul seines, 8 per cent; and gill nets, 4 per cent.

The catch by tongs and grabs consisted entirely of oysters; that by shrimp trawls consisted entirely of shrimp; that by haul seines was made up chiefly of mullet and spot; and that by gill nets consisted principally of shad, mullet, and hickory shad.

Fisheries of South Carolina, 1927

CATCH: BY GEAR

Species	Haul seines		Gill nets		Cast nets		Lines	
	Pounds	*Value*	*Pounds*	*Value*	*Pounds*	*Value*	*Pounds*	*Value*
Bluefish	8,200	$796	4,500	$1,125				
Butterfish	300	20						
Catfish			1,000	20			3,000	$150
Crevalle							1,500	75
Croaker	2,500	165	100	5			10,000	500
Drum, black	100	5					3,000	300
Drum, red, or redfish	4,200	252	200	6			250	25
Flounders	1,100	108			2,000	$200	400	33
Hickory shad			18,524	2,582				
King whiting	8,000	650	1,500	75			50,000	6,000
Mullet	401,000	23,740	58,000	3,420	2,000	200		
Pigfish							500	75
Pompano	5,500	825						
Porgies							500	35
Sea bass							125,000	11,950
Shad			182,425	38,313				
Sharks							8,000	240
Skates							1,000	30
Spot	203,000	9,040	13,000	750			100	8
Squeteague or "sea trout," gray	3,000	300	3,500	300			30,000	2,400
Squeteague or "sea trout," speckled	8,000	860	2,000	360				
Sturgeon			13,250	1,766				
Sturgeon caviar			165	99				
Crabs, hard							10,000	3,000
Shrimp	10,000	300			98,930	4,946		
Octopus							1,000	200
Terrapin	4,587	1,949						
Total	659,487	39,010	298,164	4,882	102,930	5,346	244,250	25,021

Species	Shrimp trawls		Spears		Dredges	
	Pounds	*Value*	*Pounds*	*Value*	*Pounds*	*Value*
Flounders			2,000	$120		
Hickory shad			11,000	1,050		
Sturgeon			7,000	950		
Oysters, market, public					21,000	$750
Oysters, market, private					98,000	3,500
Shrimp	1,548,197	$61,459				
Total	1,548,197	61,459	20,000	2,120	119,000	4,250

Species	Tongs and grabs		Rakes		By hand	
	Pounds	*Value*	*Pounds*	*Value*	*Pounds*	*Value*
Clams, hard			46,544	$7,307		
Oysters, market, public	4,389,231	$121,252	2,100	1,050		
Oysters, market, private	929,950	29,450				
Terrapin					13,764	$5,305
Total	5,319,181	150,702	48,644	8,357	13,764	5,305

Fisheries by counties.—Fisheries were prosecuted in the waters of six counties in South Carolina in 1927. Ranked according to value, the fisheries of Beaufort County were most important, accounting for 55 per cent of the total quantity and 44 per cent of the total value of the catch. Charleston County ranked second, accounting for 33 per cent of the total quantity and 30 per cent of the total value. The other counties, in the order of their importance, were Georgetown, Horry, Colleton, and Allendale.

Fisheries of South Carolina, 1927

OPERATING UNITS AND CATCH: BY COUNTIES

County	Fishermen		Vessels		Motor boats	Other boats	Products	
	Regular	Casual						
	Number	*Number*	*Number*	*Net tonnage*	*Number*	*Number*	*Pounds*	*Value*
Allendale	5					4	2,380	$497
Beaufort	389	6			33	304	4,618,964	155,608
Charleston	203	30	2	28	17	247	2,765,184	106,919
Colleton	68					45	31,350	5,755
Georgetown		330			49	117	377,589	46,343
Horry	254	40				59	578,150	36,160
Total	1,004	406	2	28	90	836	8,373,617	350,391

INDUSTRIES RELATED TO THE FISHERIES

Transporting trade.—There were 111 persons in South Carolina in 1927 engaged primarily in transporting the catch from the fishing grounds to market. In this trade there were 15 registered motor vessels with a total capacity of 200 net tons and 40 registered sailing vessels with a total capacity of 369 net tons. The size of vessel in most popular use ranged from 5 to 10 net tons.

Wholesale trade.—There were nine wholesale establishments in South Carolina in 1927 engaged chiefly in handling fresh fish and shellfish. Of these, six were in Charleston and Georgetown Counties and three in Beaufort County. These establishments employed 74 persons, who received $44,566 in salaries and wages.

Prepared and by-products trade.—There were 15 establishments in South Carolina in 1927 engaged in the prepared fishery products and by-products industries. These employed 600 persons, who received $194,046 in salaries and wages. The products manufactured, which were principally canned oysters and oyster-shell products, were valued at $882,261. Detailed statistics of most of these manufactured items may be obtained from Fishery Industries of the United States, 1927, Bureau of Fisheries Document No. 1050.

In addition, the fishermen themselves prepared 190,700 pounds of salted fish, valued at $17,196, which consisted mostly of salted mullet.

Industries related to the fisheries of South Carolina, 1927

TRANSPORTING

Items	Number	Items	Number
Men on transporting vessels	111	Transporting vessels—Continued.	
Transporting vessels:		Sail—	
Motor—		5 to 10 tons	31
5 to 10 tons	7	11 to 20 tons	8
11 to 20 tons	7	21 to 30 tons	1
41 to 50 tons	1	Total	40
Total	15	Net tonnage	369
Net tonnage	200		

Industries related to the fisheries of South Carolina, 1927—Continued

WHOLESALE FISHERY TRADE

Items	Charleston and Georgetown	Beaufort	Total
Establishments	6	3	9
Persons engaged:			
Proprietors or managers	10	3	13
Salaried employees	7	1	8
Wage earners	24	29	53
Paid to salaried employees	$20,049	$800	$20,849
Paid to wage earners	$19,117	$4,600	$23,717

PREPARED FISHERY PRODUCTS AND BY-PRODUCTS

Items	Number	Items	Amount
Establishments	15	Salaries paid	$27,935
Persons engaged:		Wages paid	166,111
Proprietors or managers	12		
Salaried employees	13	Total salaries and wages paid	194,046
Wage earners	575		

Products	Quantity	Value	Products	Quantity	Value
Canned:			Oyster-shell products:		
Oysters.....standard cases [1]	111,924	$588,060	Poultry feed.....tons	16,149	$179,639
Shrimp—			Lime.....do	1,225	9,188
Dry pack.....do	3,656	23,595	Other products		420
Wet pack.....do	14,244	81,359			
			Total		882,261

[1] A standard case contains 4 dozen 5-ounce cans of oysters, 4 dozen 5-ounce cans in the dry pack, or 4 dozen 5¾-ounce cans in the wet pack of shrimp.

PRODUCTS PREPARED BY THE FISHERMEN

Salted fish	Pounds	Value
Bluefish	200	$16
Mullet	123,000	12,220
Spot	67,500	4,960
Total	190,700	17,196

GEORGIA

The fisheries and related fishery industries of Georgia employed 1,928 persons in 1927, which is 5 per cent less than the number employed in 1923. Of the total 921 were fishermen, 29 were employed on transporting vessels, 210 in the wholesale trade, and 768 in the prepared-products and by-products industries.

The catch amounted to 47,607,224 pounds, valued at $697,165. This is an increase of 19 per cent in amount and 4 per cent in value as compared with the catch and its value for 1923. Of the total value of the catch, that of shrimp accounted for 67 per cent; menhaden, 17 per cent; oysters, 6 per cent; and shad, 6 per cent. Of the total quantity, menhaden accounted for 72 per cent; shrimp, 26 per cent; and oysters, 2 per cent.

Operating units.—The catch of fishery products in Georgia during 1927 was taken by 921 fishermen, who used 517 motor and other small boats, 31 motor vessels with a capacity of 390 net tons, and 9 types of major gear.

Fisheries of Georgia, 1927

OPERATING UNITS: BY GEAR

Items	Haul seines	Purse seines	Gill nets	Fyke nets	Cast nets	Lines	Shrimp trawls	Dredges	Tongs	Grabs	Total, exclusive of duplication
Fishermen:											
On boats or shore—											
Regular	12		200	8	29	67	324		141	178	671
Casual			124								124
On vessels		60				8	52	6	6		126
Total	12	60	324	8	29	75	376	6	147	178	921
Boats:											
Motor			2			2	162		6	17	175
Other	6		165	4	29	67			113	160	342
Vessels (motor):											
5 to 10 tons							24				24
11 to 20 tons						1	2	1	1		4
41 to 50 tons		1									1
51 to 60 tons		1									1
61 to 70 tons		1									1
Total		3				1	26	1	1		31
Net tonnage		166				14	196	14	14		390
Apparatus:											
Number	6	3	186	20	28	444	188	2	147	191	
Length, yards	1,998	600									
Square yards			110,441								
Yards at mouth							3,760	3			
Hooks, snoods, or baits						532					

Catch by gear.—Two types of gear accounted for 97 per cent of the products taken in the fisheries of Georgia during 1927. Of this amount, purse seines took 72 per cent of the catch (exclusively menhaden) and shrimp trawls, 25 per cent (only shrimp).

Fisheries of Georgia, 1927

CATCH: BY GEAR

Species	Haul seines		Purse seines		Gill nets	
	Pounds	*Value*	*Pounds*	*Value*	*Pounds*	*Value*
Croaker					3,000	$150
Drum, red, or redfish					1,000	50
Flounders					200	10
Hickory shad					14,200	710
King whiting					2,600	130
Menhaden			34,102,000	$119,357		
Mullet					5,733	320
Shad					187,380	43,578
Spot					800	40
Squeteague or "sea trout," speckled					15,766	2,210
Striped bass					4,555	410
Sturgeon					2,625	303
Terrapin	1,440	$540				
Total	1,440	540	34,102,000	119,357	237,859	47,911

Fisheries of Georgia, 1927—Continued

CATCH: BY GEAR—Continued

Species	Fyke nets		Cast nets		Lines	
	Pounds	*Value*	*Pounds*	*Value*	*Pounds*	*Value*
Catfish	20,000	$1,200			35	$8
Eels					10	1
Groupers					26,272	1,627
Grunts					200	18
Jewfish					2,388	110
Mullet			2,800	$168		
Porgies					3,402	281
Sea bass					47,694	4,551
Snapper, red					63,643	6,435
Squeteague or "sea trout", speckled			275	41	1,500	225
Striped bass					800	80
Crabs, hard					58,800	2,395
Shrimp			40,000	1,600		
Total	20,000	1,200	43,075	1,809	204,744	15,631

Species	Shrimp trawls		Dredges		Tongs and grabs		By hand	
	Pounds	*Value*	*Pounds*	*Value*	*Pounds*	*Value*	*Pounds*	*Value*
Shrimp	12,239,969	$467,015						
Clams, hard					800	$100		
Oysters, market, public			21,000	$1,500	504,266	32,906	46,039	$1,973
Oysters, market, private					186,032	7,223		
Total	12,239,969	467,015	21,000	1,500	691,098	40,229	46,039	1,973

Fisheries by counties.—Fishing was prosecuted in the marine waters of seven counties in Georgia in 1927. Ranked according to value, the fisheries of Glynn County were most important, accounting for 19 per cent of the total quantity and 51 per cent of the total value of the catch. Camden County ranked next, accounting for 73 per cent of the total quantity and 23 per cent of the total value. Chatham County ranked third in importance, with 5 per cent of the total quantity and 18 per cent of the total value. Following in order were McIntosh, Bryan, Liberty, and Effingham Counties.

Fisheries of Georgia, 1927

OPERATING UNITS AND CATCH: BY COUNTIES

County	Fishermen		Vessels		Motor boats	Other boats	Products	
	Regular	Casual						
	Number	*Number*	*Number*	*Net tonnage*	*Number*	*Number*	*Pounds*	*Value*
Bryan	54					27	39,200	$9,240
Camden	118		3	166	16	26	34,836,957	157,411
Chatham	182	118	7	61	34	174	2,529,012	125,154
Effingham		6				3	3,920	924
Glynn	305		18	133	100	35	8,954,659	356,643
Liberty	52		1	14	1	33	42,000	3,000
McIntosh	86		2	16	24	44	1,201,476	44,793
Total	797	124	31	390	175	342	47,607,224	697,165

INDUSTRIES RELATED TO THE FISHERIES

Transporting trade.—There were 29 persons in Georgia in 1927 engaged primarily in transporting the catch from the fishing grounds to market. In this trade there were 15 registered motor vessels with a total capacity of 140 net tons. The size of vessel in most popular use ranged from 5 to 10 net tons.

Wholesale trade.—There were 14 wholesale establishments in Georgia in 1927 engaged chiefly in handling fresh fish and shellfish. Of the total, 11 were in Chatham County and 3 in Glynn County. These establishments employed 210 persons, who received $104,299 in salaries and wages.

Prepared and by-products trade.—There were 12 establishments in Georgia in 1927 engaged in canning and curing fishery products and in the manufacture of fishery by-products. These employed 768 persons, who received $161,535 in salaries and wages. The products manufactured, which were principally canned shrimp and menhaden products, were valued at $994,594. This is nearly 28 per cent of the production of prepared fishery products and by-products manufactured in the South Atlantic States. Georgia ranks second in the output. Detailed statistics of most of these manufactured items may be obtained from Fishery Industries of the United States, 1927, Bureau of Fisheries Document No. 1050.

Industries related to the fisheries of Georgia, 1927

TRANSPORTING

Items	Number
Men on transporting vessels	29
Transporting vessels (motor):	
5 to 10 tons	11
11 to 20 tons	4
Total	15
Net tonnage	140

WHOLESALE FISHERY TRADE

Items	Chatham	Glynn	Total
Establishments	11	3	14
Persons engaged:			
Proprietors or managers	13	5	18
Salaried employees	18	4	22
Wage earners	40	130	170
Paid to salaried employees	$42,180	$4,545	$46,725
Paid to wage earners	$37,953	$19,621	$57,574

PREPARED FISHERY PRODUCTS AND BY-PRODUCTS

Items	Number	Products	Quantity	Value
Establishments	12	Canned:		
Persons engaged:		Oysters....standard cases [1]	9,339	$46,755
Proprietors or managers	14	Shrimp—		
Salaried employees	8	Dry pack....do	30,871	196,201
Wage earners	746	Wet pack....do	79,715	488,007
Salaries paid	$18,410	Miscellaneous products [2]		263,541
Wages paid	$143,125	Total		994,594
Total salaries and wages paid	$161,535			

[1] A standard case contains 4 dozen 5-ounce cans of oysters, 4 dozen 5-ounce cans in the dry pack, or 4 dozen 5¼-ounce cans in the wet pack of shrimp.
[2] Includes canned clam chowder, canned terrapin meat and terrapin soup, and acidulated scrap and oil from menhaden.

EAST COAST OF FLORIDA[5]

The fisheries and related fishery industries of the east coast of Florida employed 3,817 persons in 1927, which is 36 per cent more than the number employed in 1923. Of the total, 2,947 were fishermen, 7 were employed on transporting vessels, 644 in the wholesale trade, and 219 in the prepared-products and by-products industries.

The catch amounted to 60,222,023 pounds, valued at $1,870,926. This is a decrease of 31 per cent in amount and an increase of 9 per cent in value as compared with the catch and its value for 1923. Of the total value of the catch, that of shrimp accounted for 32 per cent; mullet, 12 per cent; kingfish or "king mackerel," 12 per cent; Spanish mackerel, 8 per cent; bluefish, 5 per cent; and squeteagues or "sea trout," 5 per cent. Of the total quantity, that of menhaden accounted for 41 per cent; shrimp, 25 per cent; mullet, 11 per cent; kingfish or "king mackerel," 6 per cent; catfish, 3 per cent; and Spanish mackerel, 3 per cent.

Operating units.—The catch of fishery products on the east coast of Florida during 1927 was taken by 2,947 fishermen, who used 2,254 motor and other small boats, 19 motor vessels with a capacity of 312 net tons, and 11 types of major gear.

Fisheries of the east coast of Florida, 1927

OPERATING UNITS: BY GEAR

Items	Haul seines	Purse seines	Gill nets	Pound nets	Trammel nets	Dip nets	Lines
Fishermen:							
On boats or shore—							
Regular	240		1,027	7	4	59	751
Casual	7						61
On vessels		111					2
Total	247	111	1,027	7	4	59	814
Boats:							
Motor	57		462	5		35	445
Other	178		578	6	4	35	228
Vessels (motor):							
5 to 10 tons							1
11 to 20 tons		1					
41 to 50 tons		2					
81 to 90 tons		1					
Total		4					1
Net tonnage		176					6
Apparatus:							
Number	92	4	1,028	14	4	35	6,879
Length, yards	49,800	1,260					
Square yards			1,200,860		1,000		
Hooks, snoods, or baits							95,783

[5] See pp. 515 to 524 for complete statistics for Florida.

Fisheries of the east coast of Florida, 1927—Continued

OPERATING UNITS: BY GEAR—Continued

Items	Shrimp trawls	Craw-fish traps	Crab traps	Tongs	Rakes	Minor apparatus [1]	By hand	Total, exclusive of duplication
Fishermen:								
On boats or shore—								
Regular	929	11	12	50		69	45	2,717
Casual				12	12	2		82
On vessels	35	2						14[illegible]
Total	964	13	12	62	12	71	45	2,947
Boats:								
Motor	352	6	12	6	2	36		1,179
Other		3		47	6	38	45	1,075
Vessels (motor):								
5 to 10 tons	10	1						11
11 to 20 tons	4							5
41 to 50 tons								2
81 to 90 tons								1
Total	14	1						1[illegible]
Net tonnage	130	6						312
Apparatus:								
Number	366	499	275	62	12	123		
Yards at mouth	8,539							

[1] Includes crawfish hooks, cast nets, and fish traps.

Catch by gear.—Four types of gear accounted for 94 per cent of the products taken in the fisheries of the east coast of Florida during 1927. Listed in the order of their importance they were purse seines, which accounted for 42 per cent of the catch; shrimp trawls, 25 per cent; gill nets, 19 per cent; and lines, 8 per cent. The catch by purse seines consisted principally of menhaden; by shrimp trawls, principally shrimp; by gill nets, chiefly mullet, Spanish mackerel, bluefish, and squeteagues or "sea trout"; and by lines, largely kingfish or "king mackerel."

Fisheries of the east coast of Florida, 1927

CATCH: BY GEAR

Species	Haul seines		Purse seines		Gill nets		Pound nets	
	Pounds	*Value*	*Pounds*	*Value*	*Pounds*	*Value*	*Pounds*	*Value*
Alewives	69,092	$770					148,800	$1,438
Angelfish or spadefish			500	$20	8,430	$264		
Black bass	103,954	11,438						
Bluefish			50,000	5,000	671,900	80,322		
Bluerunner or hardtail			8,000	120	82,440	2,367		
Catfish	1,334,233	53,368					89,800	3,592
Crappie	359,229	25,323					5,580	391
Crevalle	900	41	1,000	40	171,950	5,012		
Croaker	700	33			21,750	648		
Drum, black	2,700	91			40,050	871		
Drum, red, or redfish	10,500	480	200	8	96,050	4,828		
Flounders	650	33			6,600	266		
Groupers					100	5		
Grunts			1,500	60	11,150	351		
Hickory shad	39,386	1,969			2,860	168		
Hogfish			400	16				
King whiting or "kingfish"	36,400	1,832			67,500	4,004		
Menhaden			24,876,200	79,604				
Moonfish					3,500	90		
Mullet	17,800	735	175,000	3,500	6,371,548	227,633		
Permit					8,890	263		
Pigfish	500	24			153,650	5,700		
Pinfish	1,200	58	200	8	297,240	8,973		
Pompano	50	10			214,900	43,825		
Sea bass					4,000	160		
Sergeantfish or snook	100	4			192,000	9,209		
Shad	170,222	28,496			177,336	35,172		

Fisheries of the east coast of Florida, 1927—Continued

CATCH: BY GEAR—Continued

Species	Haul seines		Purse seines		Gill nets		Pound nets	
	Pounds	*Value*	*Pounds*	*Value*	*Pounds*	*Value*	*Pounds*	*Value*
Sheepshead	500	$25	400	$16	40,280	$1,546		
Snapper, mangrove			400	16	22,860	1,041		
Snapper, mutton					104,100	3,914		
Spanish mackerel			12,500	1,000	1,817,323	141,606		
Spot	1,050	43			396,450	10,401		
Squeteagues or "sea trout"	18,000	1,820			653,945	65,654		
Strawberry bass					5,000	250		
Striped bass					1,650	412		
Sunfish	296,164	9,054					900	$27
Yellowtail			4,900	196	11,200	826		
Crabs, hard					4,400	132		
Turtles	5,758	86						
Total	2,468,588	135,733	25,126,200	89,604	11,661,852	655,913	240,080	5,448

Species	Trammel nets		Dip nets		Lines		Shrimp trawls	
	Pounds	*Value*	*Pounds*	*Value*	*Pounds*	*Value*	*Pounds*	*Value*
Amberfish					9,200	$360		
Angelfish or spadefish					2,100	75		
Black bass					13,700	1,374		
Bluefish					37,900	4,555	12,000	$960
Bluerunner or hardtail					2,940	115		
Catfish	10,000	$400			491,200	19,688		
Crappie	1,000	100			1,250	95		
Crevalle					24,650	636	2,000	80
Croaker					15,100	812	1,500	60
Drum, black					38,350	1,977	2,500	50
Drum, red, or redfish					55,050	3,767	1,500	60
Flounders					9,000	446	5,000	240
Groupers					59,800	2,741		
Grunts					11,950	511		
Hogfish					2,400	138		
Jewfish					15,100	338		
Kingfish or king mackerel					3,330,810	229,451		
King whiting or "kingfish"					4,700	308	60,000	2,820
Margatefish					1,100	44		
Mullet	15,000	750						
Pigfish					500	15		
Pinfish					5,460	197		
Pompano					4,000	875		
Porgies					12,000	470		
Sea bass					27,700	1,802		
Sergeantfish or snook					33,350	1,566		
Sheepshead					12,770	627	500	20
Snapper, mangrove					17,540	1,378		
Snapper, mutton					24,800	2,820		
Snapper, red					59,200	5,868		
Spanish mackerel					91,500	7,368		
Spot					21,750	1,135	1,500	60
Squeteagues or "sea trout"					182,000	19,820	15,000	1,500
Sunfish	400	20			1,000	50		
Yellowtail					3,000	180		
Crabs, hard					69,000	5,000		
Sea crawfish or spiny lobster			105,936	$7,416				
Shrimp							14,773,385	592,007
Total	26,400	1,270	105,936	7,416	4,691,870	316,602	14,874,885	597,857

Species	Crawfish traps		Tongs and rakes		Minor apparatus [1]		By hand	
	Pounds	*Value*	*Pounds*	*Value*	*Pounds*	*Value*	*Pounds*	*Value*
Black bass					500	$50		
Crappie					1,000	40		
Crevalle					7,300	616		
Mullet					4,000	160		
Sunfish					6,800	244		
Crabs, hard					48,000	3,600		
Crabs, stone					6,400	576		
Sea crawfish or spiny lobster	129,600	$12,084			25,000	1,750		
Shrimp					6,000	300		
Clams, hard			3,200	$400			6,400	$600
Oysters, market, public			254,282	22,958			396,900	6,860
Oysters, market, private			116,830	8,345			14,000	2,500
Total	129,600	12,084	374,312	31,703	105,000	7,336	417,300	9,960

[1] Includes catch of crab traps, crawfish hooks, cast nets, and fish traps.

Fisheries by counties.—Fishing was prosecuted in the marine waters of 15 counties on the east coast of Florida in 1927. Ranked according to value, the fisheries of Nassau County were most important, accounting for 55 per cent of the total catch and 21 per cent of the total value of the catch. St. John County was next in importance, accounting for 12 per cent of the total catch and 15 per cent of the total value. Other counties accounting for catches in excess of $100,000 in value were Palm Beach, St. Lucie, Martin, Brevard, and Putnam.

Fisheries of the east coast of Florida, 1927

OPERATING UNITS AND CATCH: BY COUNTIES

County	Fishermen		Vessels		Motor boats	Other boats	Products	
	Regular	Casual						
	Number	*Number*	*Number*	*Net tonnage*	*Number*	*Number*	*Pounds*	*Value*
Brevard	199				101	165	3,784,426	$162,021
Clay	40	26			12	46	410,520	16,718
Dade	196		2	17	137	83	1,231,346	60,021
Duval	252	25			95	163	1,278,600	78,991
Flagler		3				3	5,250	413
Indian River	89				47	66	1,270,830	62,911
Marion	12				3	9	172,033	8,688
Martin	159				77	68	2,358,850	166,503
Nassau	537		10	234	123	70	33,009,565	401,312
Palm Beach	206				156	9	2,940,750	220,877
Putnam	207	10			48	185	2,204,219	125,541
St. John	607	12	5	41	242	16	7,047,820	285,031
St. Lucie	209				108	70	2,859,084	185,194
Seminole	49				2	31	224,000	19,375
Volusia	108	6	2	20	28	91	1,424,730	77,330
Total	2,865	82	19	312	1,179	1,075	60,222,023	1,870,926

INDUSTRIES RELATED TO THE FISHERIES

Transporting trade.—There were only seven persons in 1927 engaged on the east coast of Florida primarily in transporting the catch from the fishing grounds to market. In this trade there were three registered motor vessels with a total capacity of 30 net tons. These vessels varied from 5 to 20 net tons.

Wholesale trade.—There were 87 wholesale establishments on the east coast of Florida engaged chiefly in handling fresh or frozen fishery products. This is 60 per cent of the total number of such establishments in the South Atlantic section. These establishments employed 644 persons, who received $273,762 in salaries and wages.

Prepared and by-products trade.—There were five establishments on the east coast of Florida in 1927 engaged in the prepared fishery products and by-products industries. These employed 219 persons, who received $120,160 in salaries and wages. The products manufactured, which were principally canned shrimp and menhaden products, were valued at $666,599. Detailed statistics of most of these manufactured items may be obtained from Fishery Industries of the United States, 1927, Bureau of Fisheries Document No. 1050.

Industries related to the fisheries of the east coast of Florida, 1927

TRANSPORTING

Item	Number
Men on transporting vessels	7
Transporting motor vessels:	
5 to 10 tons	1
11 to 20 tons	2
Total	3
Net tonnage	30

WHOLESALE FISHERY TRADE

Item	Brevard and Volusia	Duval and Clay	Dade and Palm Beach	Indian River and St. Lucie	Martin	Nassau	Putnam	St. John	Total
Establishments	11	13	8	9	7	14	7	18	87
Persons engaged:									
Proprietors or managers	14	17	13	12	7	19	9	23	114
Salaried employees	1	11	8	4	3	2		6	35
Wage earners	18	40	23	17	8	165	18	206	495
Paid to salaried employees	$1,560	$24,975	$14,400	$6,440	$6,200	$2,375		$8,185	$64,135
Paid to wage earners	$14,301	$27,394	$24,812	$14,480	$7,280	$42,540	$14,170	$64,650	$209,627

PREPARED FISHERY PRODUCTS AND BY-PRODUCTS

Item	Number	Item	Amount
Establishments	5	Salaries paid	$16,633
Persons engaged:		Wages paid	103,527
Proprietors or managers	7	Total salaries and wages paid	120,160
Salaried employees	11		
Wage earners	201		

Product	Quantity	Value	Products	Quantity	Value
Canned shrimp, dry and wet packs ....standard cases [1]	40,185	$342,751	Miscellaneous products [2]		$323,848
			Total		666,599

[1] A standard case contains 4 dozen 5¾-ounce cans in the wet pack or 4 dozen 5-ounce cans in the dry pack.
[2] Includes canned oysters, dry and green scrap and oil from menhaden, and smoked mullet.

HISTORICAL REVIEW

During the period 1880 to 1927 there were conducted 11 general statistical surveys of the fisheries of the South Atlantic States. The infrequency of these surveys leaves much to be desired in the making of a thorough statistical analysis, but a rather clear picture of the trend of these fisheries may be obtained from the records published in comparable form herewith. The discussion of the trends of the individual species, which follows, is based on the statistics that are available, but it is pointed out the possibility that in certain of the years for which there are no data there may have been unusual fluctuations. In some of the surveys prior to 1889 the fisheries of certain States were not canvassed, and in certain of the States that were canvassed several species were included with "miscellaneous fish" or "all other species." For this reason totals are not usually shown prior to 1889.

Total catch.—Beginning with a total catch of 42,952,000 pounds for the South Atlantic district in 1880, there were constant increases in production until 1918, when the greatest production was registered for which there are records. It amounted to 332,614,000 pounds, its large size being due mainly to a large catch of menhaden. The production in 1927 amounted to 260,669,000 pounds.

Alewives.—The catch of alewives in the past 48 years has varied from barely 10,000,000 pounds in 1923 to more than 22,000,000 pounds in 1890. The catch in 1880 amounted to 16,055,000 pounds and that in 1927 to 14,124,000 pounds.

Bluefish.—The smallest catch of bluefish on record was that made in 1880, when 830,000 pounds were taken. In the years for which there are complete records since that time the catch has been consistently in excess of 1,000,000 pounds until 1918, when it fell to 892,000 pounds. The largest production was recorded in 1923, when it amounted to 2,005,000 pounds. The catch declined to 1,637,000 pounds in 1927.

Butterfish.—The earliest record for this species was for the year 1897, when 95,000 pounds were taken. The catch varied but little until 1908, when 1,302,000 pounds were taken, which is the largest production on record. The catch decreased considerably in 1918 and recovered but slightly in 1923. In 1927 the second largest catch on record was made, amounting to 1,280,000 pounds.

Croaker.—From a catch of 2,002 pounds in 1902 the trend of the production of croaker has been upward, reaching the peak of 3,987,000 pounds in 1927. An outstanding deviation from this general trend was noted in 1918, when only 533,000 pounds were taken.

Black drum.—Beginning with 228,000 pounds in 1889 the catch varied but little until 1918. In that year it amounted to 536,000 pounds. Since that time very small catches have been recorded. In 1927 the amount taken was 98,000 pounds.

Red drum or redfish.—The trend of this fishery has been downward with but one exception. Beginning with 810,000 pounds in 1889, the smallest catch on record was registered in 1927, when 270,000 pounds were taken. The unparalleled production of 1,421,000 pounds was effected in 1908.

Eels.—The catch of eels in 1889 amounted to only 55,000 pounds. Beginning with this low mark, the catch increased in the following few years, and the highest production on record was effected in 1902, when 512,000 pounds were taken. Since 1902 the trend has been downward, the catch in 1927 amounting to 160,000 pounds.

Flounders.—The smallest catch of flounders was made in 1889, when 48,000 pounds were taken. Increases were constant until the peak was reached in 1908. In that year the catch amounted to 514,000 pounds. In 1918 the catch was barely one-fourth of this amount. Partial recoveries were effected in subsequent years, and in 1927 the catch amounted to 384,000 pounds.

Menhaden.—Beginning with a catch of 8,761,000 pounds in 1889, almost constant increases were made until 1918, when by far the largest catch on record was made, amounting to 257,759,000 pounds. In 1923 production fell to 148,181,000 pounds, but increased in 1927 to 157,965,000 pounds. This fishery is by far the most important among those of the South Atlantic in point of quantity.

Mullet.—The catch of mullet amounted to only 4,369,000 pounds in 1880. During the next few years the catch increased, and by 1902 it amounted to 16,035,000 pounds. Since then somewhat less has been taken annually, in 1927 amounting to 11,378,000 pounds.

Pompano.—Following catches of less than 50,000 pounds in 1889 and 1890, the production in 1897 amounted to 254,000 pounds and continued between 250,000 pounds and 300,000 pounds until 1918, when it dropped to 142,000 pounds. In 1923 the catch was 111,000 pounds, but in 1927 it again climbed, 238,000 pounds being recorded.

Sea bass.—The catch of sea bass in 1889 amounted to 934,000 pounds. This production has not been equalled in subsequent years, a downward trend being noted. The catch in 1927 amounted to 521,000 pounds.

Shad.—Following a catch of 3,933,000 pounds in 1880, the trend was upward until 1897, when the peak of 11,268,000 pounds was reached. Since 1897 the trend has been downward, the catch in 1927 amounting to 3,104,000 pounds.

Sheepshead.—The peak of the production of sheepshead was reached in 1908, when the catch amounted to 1,431,000 pounds. There followed rather consistent increases from 1889, when 495,000 pounds were taken. Since 1908 the catches have decreased to only 77,000 pounds in 1927.

Spanish mackerel.—The catch of this species in 1889 amounted to only 82,000 pounds. Consistent increases were effected until 1918, when 3,211,000 pounds were taken, which is the largest production on record. The production in 1927 decreased to 2,121,000 pounds.

Spot.—There have been constant increases in this fishery since 1902, when 1,031,000 pounds were taken. In 1927 the catch amounted to 2,597,000 pounds.

Squeteagues or "sea trout."—In 1880 the catch of this species amounted to 1,827,000 pounds, reached a high peak of 8,628,000 pounds in 1908, and then decreased to 5,475,000 pounds in 1927.

Striped bass.—Starting with a production of 560,000 pounds in 1889, this fishery grew consistently until 1902, when the peak of 1,187,000 pounds was reached. The production in the next few years was much less, that in 1918 being the smallest on record. The fishery recovered somewhat in 1927, when 745,000 pounds were taken.

Sturgeon.—The general trend of the sturgeon fishery has been downward. In 1880 the catch amounted to 1,055,000 pounds, which is the largest catch on record. This production was nearly reached again in 1897, when 1,042,000 pounds were taken. Except for that year, the production has been less in each survey. In 1927 only 43,000 pounds were taken.

Crabs.—The catch of crabs in 1927 amounted to 1,422,000 pounds, a production that had never been reached previously. The catch that approached nearest to that in 1927 was made in 1897, when 1,216,000 pounds were taken. The general trend has been upward since 1889, when the catch amounted to 182,000 pounds.

Shrimp.—As the most valuable fishery in the South Atlantic States, that for shrimp has increased steadily from a production of 627,000 pounds in 1897 to 29,992,000 pounds in 1927. Prior to 1897 the catch had shown little fluctuation.

Hard clams.—Beginning with a production of 387,000 pounds in 1880 there were minor fluctuations in the catch until 1897, when production amounted to 1,131,000 pounds. In 1902 a yet greater catch was made, amounting to 1,415,000 pounds. Since 1902 the production has decreased, in 1927 amounting to 373,000 pounds.

Oysters, market.—The smallest catch on record was made in 1880, when 2,170,000 pounds were taken. Following this low production large increases were noted until 1908, when 29,973,000 pounds were taken. This was the largest production that has been yet recorded. The production in 1927 amounted to 10,020,000 pounds.

Scallops.—This fishery has shown a steady increase. In 1887 the catch amounted to 4,000 pounds. In 1927 it amounted to 835,000 pounds.

Considered generally, the catches of butterfish, croaker, flounders, menhaden, mullet, pompano, Spanish mackerel, spot, squeteagues or "sea trout," crabs, shrimp, and scallops have increased; the catches of alewives, bluefish, eels, and striped bass have remained fairly constant; and the catches of black drum, red drum or red fish, sea bass, shad, sheepshead, sturgeon, hard clams, and oysters have shown a downward trend.

Fisheries of the South Atlantic States, 1880 to 1927

[Expressed in thousands of pounds and thousands of dollars; that is, 000 omitted]

Year	North Carolina		South Carolina		Georgia		Florida (east coast)		Total	
1880	32,249	$846	6,143	$212	2,273	$120	2,287	$78	42,952	$1,256
1887	45,125	773	4,076	158	1,883	81	(1)	(1)	(1)	(1)
1888	43,023	776	4,181	164	1,958	83	(1)	174	(1)	1,197
1889	45,546	950	4,879	200	2,644	106	5,982	199	59,051	1,455
1890	51,799	1,028	4,945	203	2,994	124	7,464	220	67,202	1,575
1897	64,234	1,316	5,280	210	4,993	171	5,883	136	80,390	1,833
1902	67,585	1,740	8,174	263	11,103	359	19,584	478	106,446	2,840
1908	101,422	1,776	14,104	288	14,828	701	36,521	1,269	166,875	4,034
1918	210,502	2,979	3,747	208	37,164	416	81,211	1,746	332,614	5,349
1923	95,192	2,414	6,763	285	39,896	668	86,896	1,720	228,747	5,087
1927	144,460	2,777	8,374	350	47,607	697	60,222	1,871	260,669	5,695

[1] Figures not available.

CATCH OF CERTAIN SPECIES: BY STATES

[Expressed in thousands of pounds; that is, 000 omitted]

Year	Alewives					Bluefish				
	North Carolina	South Carolina	Georgia	Florida (east coast)	Total	North Carolina	South Carolina	Georgia	Florida (east coast)	Total
1880	15,520	400	125	10	16,055	600	200	5	25	830
1887	23,747		25			761	158	7	(1)	
1888	20,451		24			847	151	6	(1)	
1889	19,316	37	36		19,389	1,078	110		5	1,193
1890	22,112	29	24	10	22,175	1,539	100		7	1,646
1897	20,839	2	25	41	20,907	1,910	40		46	1,996
1902	15,173		22	406	15,601	1,049	1		80	1,130
1908	12,530		32	1,220	13,782	1,258	7		372	1,637
1918	17,356	10		692	18,058	323	3	5	561	892
1923	8,989			1,062	10,051	897	7		1,101	2,005
1927	13,911			213	14,124	852	13		772	1,637

[1] Statistics not available.

Fisheries of the South Atlantic States, 1880 to 1927—Continued

CATCH OF CERTAIN SPECIES: BY STATES—Continued

[Expressed in thousands of pounds; that is, 000 omitted]

Year	Butterfish,[2] North Carolina	Croaker					Drum, black				
		North Carolina	South Carolina	Georgia	Florida (east coast)	Total	North Carolina	South Carolina	Georgia	Florida (east coast)	Total
1887		(1)	(1)	(1)	(1)			90	10	(1)	
1888		(1)	(1)	(1)	(1)			75	11	(1)	
1889		328	(1)	(1)	(1)			170	17	41	228
1890		354	(1)	(1)	(1)			185	15	28	228
1897	95	1,295	(1)	(1)	(1)		51	215	14	17	297
1902	83	1,939	27	29	7	2,002	67	75	25	20	187
1908	1,302	1,177	85	46	92	1,400					
1918	731	387	16	6	124	533		5		531	536
1923	820	2,262	26		22	2,310	2	13		47	62
1927	1,280	3,932	13	3	39	3,987	11	3		84	98

Year	Drum, red, or redfish					Eels		
	North Carolina	South Carolina	Georgia	Florida (east coast)	Total	North Carolina	Georgia	Total
1887	129	55	20	(1)		6		
1888	140	51	21	(1)		7		
1889	515	91	32	172	810	55		55
1890	219	88	39	171	517	161		161
1897	179	110	24	236	549	97	5	102
1902	144	102	35	115	396	507	5	512
1908	[3] 343	109	151	818	1,421	258	6	264
1918	[3] 100	1	2	369	472	175		175
1923	245	31	1	122	399	180		180
1927	99	7	1	163	270	160		160

Year	Flounders					Menhaden			
	North Carolina	South Carolina	Georgia	Florida (east coast)	Total	North Carolina	Georgia	Florida (east coast)	Total
1887				(1)		14,756			
1888				(1)		13,844			
1889	48				48	8,753		8	8,761
1890	49				49	12,410			12,410
1897	174		6		180	11,310			11,310
1902	262	2	3	49	316	18,862			18,862
1908	403	5	7	99	514	57,412			57,412
1918	91	16	11	13	131	179,911	29,485	48,363	257,759
1923	333	28		6	367	63,290	26,973	57,918	148,181
1927	349	14		21	384	98,987	34,102	24,876	157,965

[1] Statistics not available.
[2] Includes harvestfish.
[3] Includes some black drum.

NOTE.—Prior to 1889 some of the above species were often included under the heading "Miscellaneous fish" or "All other fish"; therefore, the total for certain species is not shown for certain years of this period.

Fisheries of the South Atlantic States, 1880 to 1927—Continued

CATCH OF CERTAIN SPECIES: BY STATES—Continued

[Expressed in thousands of pounds; that is, 000 omitted]

Year	Mullet					Pompano			
	North Carolina	South Carolina	Georgia	Florida (east coast)	Total	North Carolina	South Carolina	Florida (east coast)	Total
1880	3,368	232	106	663	4,369	-------	-------	-------	-------
1887	2,461	400	47	(1)	-------	-------	-------	(1)	-------
1888	2,248	341	48	(1)	-------	-------	-------	(1)	-------
1889	4,252	464	57	1,216	5,989	8	-------	12	20
1890	4,890	553	53	1,567	7,063	10	-------	30	40
1897	4,716	61	56	2,449	7,282	53	5	196	254
1902	8,429	139	126	7,341	16,035	20	5	265	290
1908	6,013	708	194	8,573	15,488	11	4	276	291
1918	1,286	272	11	10,418	11,987	9	-------	133	142
1923	1,933	532	4	6,198	8,667	60	-------	61	111
1927	4,325	461	9	6,583	11,378	13	6	219	238

Year	Sea bass					Shad				
	North Carolina	South Carolina	Georgia	Florida (east coast)	Total	North Carolina	South Carolina	Georgia	Florida (east coast)	Total
1880	-------	-------	-------	-------	-------	3,221	208	252	252	3,933
1887	15	889	4	(1)	-------	4,783	366	255	(1)	-------
1888	15	910	7	(1)	-------	5,725	433	263	1,448	7,869
1889	29	886	8	11	934	5,403	577	356	2,051	8,387
1890	33	826	10	10	879	5,815	563	400	2,654	9,432
1897	189	632	-------	6	827	8,968	506	788	1,011	11,268
1902	57	710	76	30	873	6,567	434	1,029	1,819	9,849
1908	72	491	233	110	906	3,942	464	1,333	2,833	8,572
1918	112	132	293	41	578	1,657	167	101	964	2,889
1923	102	218	104	4	428	2,370	184	134	503	3,191
1927	316	125	48	32	521	2,387	182	187	348	3,104

Year	Sheepshead					Spanish mackerel				
	North Carolina	South Carolina	Georgia	Florida (east coast)	Total	North Carolina	South Carolina	Georgia	Florida (east coast)	Total
1887	202	101	8	(1)	-------	-------	-------	-------	(1)	-------
1888	212	111	8	(1)	-------	-------	-------	-------	(1)	-------
1889	187	39	5	264	495	82	-------	-------	-------	82
1890	202	39	5	274	520	100	-------	-------	-------	100
1897	271	36	25	390	722	331	10	18	3	362
1902	155	27	50	404	636	354	-------	-------	659	1,013
1908	249	20	64	1,098	1,431	457	-------	-------	1,228	1,685
1918	26	2	-------	104	132	149	-------	-------	3,062	3,211
1923	52	1	-------	32	85	183	-------	-------	2,469	2,652
1927	23	-------	-------	54	77	290	-------	-------	1,921	2,121

[1] Statistics not available.

NOTE.—Prior to 1889 some of the above species were often included under the heading "Miscellaneous fish" or "All other fish"; therefore, the total for certain species is not shown for certain years of this period.

Fisheries of the South Atlantic States, 1880 to 1927—Continued

CATCH OF CERTAIN SPECIES: BY STATES—Continued

[Expressed in thousands of pounds; that is, 000 omitted]

Year	Spot					Squeteagues or "sea trout"				
	North Carolina	South Carolina	Georgia	Florida (east coast)	Total	North Carolina	South Carolina	Georgia	Florida (east coast)	Total
1880						1,120	470	122	115	1,827
1887	[4] 88	[4] 52	[4] 11	(1)		909	217	67	(1)	
1888	[4] 90	[4] 57	[4] 10	(1)		946	207	67	(1)	
1889	441	[4] 46	[4] 14	[4] 26		1,971	116	130	243	2,460
1890	499	[4] 42	[4] 14	[4] 24		2,131	103	144	235	2,613
1897	917	[4] 49		[4] 23		3,174	80	55	516	3,825
1902	977	22		32	1,031	3,984	86	83	899	5,052
1908	852	66		130	1,048	4,648	183	140	3,657	8,628
1918	1,258	75	1	393	1,727	3,361	59	40	1,645	5,105
1923	1,790	132	1	72	1,995	3,984	70	5	1,198	5,257
1927	1,959	216	1	421	2,597	4,534	54	18	869	5,475

Year	Striped bass					Sturgeon				
	North Carolina	South Carolina	Georgia	Florida (east coast)	Total	North Carolina	South Carolina	Georgia	Florida (east coast)	Total
1880						437	261	354	3	1,055
1887	506	4	11			238	182	192	(1)	
1888	567	3	11			270	251	174	(1)	
1889	536	11	13		560	228	[5] 285	[5] 212	43	768
1890	574	12	9		595	175	[5] 216	[5] 84	30	505
1897	845	10	9		864	[5] 404	[5] 481	[5] 157		1,042
1902	1,175	10	2		1,187	145	94			239
1908	510	5	9	9	533	62		100	55	217
1918	287				287	8	118	39		165
1923	477				477	19	50	32		101
1927	738		5	2	745	27	13	3		43

Year	Crabs					Shrimp				
	North Carolina	South Carolina	Georgia	Florida (east coast)	Total	North Carolina	South Carolina	Georgia	Florida (east coast)	Total
1880	11	42	7			63	630	56	72	821
1887	47	76	45	(1)		120	338	185	(1)	
1888	47	69	44	(1)		124	359	191	(1)	
1889	50	86	43	3	182	135	380	150	78	743
1890	47	93	48	4	192	144	372	162	66	744
1897	1,027	110	75	4	1,216	146	374	68	39	627
1902	203	96	80	6	385	84	370	344	3,013	3,811
1908	390	33	196	146	765	371	452	528	4,346	5,697
1918	379	18	8	52	457	940	55	5,793	8,868	15,656
1923	514	9	120	72	715	1,658	355	10,668	11,024	23,705
1927	1,225	10	59	128	1,422	1,276	1,657	12,280	14,779	29,992

[1] Statistics not available.
[4] Includes croakers.
[5] Includes caviar.

NOTE.—Prior to 1889 some of the above species were often included under the heading "Miscellaneous fish" or "All other fish"; therefore, the total for certain species is not shown for certain years of this period.

Fisheries of the South Atlantic States, 1880 to 1927—Continued

CATCH OF CERTAIN SPECIES: BY STATES—Continued

[Expressed in thousands of pounds; that is, 000 omitted]

Year	Clams, hard					Oysters, market					Scallops, North Carolina
	North Carolina	South Carolina	Georgia	Florida (east coast)	Total	North Carolina	South Carolina	Georgia	Florida (east coast)	Total	
1880	310	48	24	5	387	1,190	350	490	140	2,170	....
1887	78	....	....	(1)	....	1,491	264	771	(1)	....	4
1888	148	....	....	(1)	....	1,433	282	844	(1)	....	4
1889	156	....	3	5	163	7,011	305	1,142	436	8,894	16
1890	226	....	4	6	236	5,651	442	1,570	681	8,344	18
1897	938	185	3	5	1,131	6,012	1,504	3,406	363	11,285	118
1902	1,175	225	10	5	1,415	7,160	4,828	8,568	2,163	22,719	13
1908	726	76	43	57	902	5,275	10,941	10,053	3,704	29,973	(1)
1918	198	1	....	2	201	1,519	2,784	1,110	459	5,872	423
1923	264	86	....	5	355	3,917	5,032	1,720	500	11,169	555
1927	315	47	1	10	373	3,041	5,440	757	782	10,020	835

1 Statistics not available.

NOTE.—Prior to 1889 some of the above species were often included under the heading "Miscellaneous fish" or "All other fish"; therefore, the total for certain species is not shown for certain years of this period.

FISHERIES OF FLORIDA [6]

Commercial fisheries are prosecuted along the entire length of the Florida seacoast from Fernandina south to Key West and from there north and west to Pensacola, and also in Lake Okeechobee. The fisheries and industries related to the fisheries of Florida employed 10,201 persons during 1927. Of the total, 8,437 were fishermen, 58 were employed aboard transporting vessels, 1,084 in the wholesale trade, and 622 in the prepared-products and by-products industries. The catch amounted to 138,423,198 pounds, valued at $6,423,379. This consisted of 116,402,606 pounds of fish, valued at $4,365,756; 21,420,363 pounds of shellfish, etc., valued at $1,022,489; and 600,229 pounds of sponges, valued at $1,035,134. Of the total, 44 per cent were taken along the east coast, 53 per cent along the west coast, and 3 per cent in Lake Okeechobee.

Operating units.—The catch of fishery products during 1927 was made by 8,437 fishermen, who used 109 motor and 17 sail vessels with a combined capacity of 3,887 net tons; 3,029 motor boats; 3,390 other boats; 253 haul seines with a combined length of 125,074 yards; 6 purse seines with a combined length of 1,860 yards; 2,842 gill nets with a combined area of 2,749,614 square yards; 3,931 pound nets and traps; 319 trammel nets with a combined area of 180,323 square yards; 241 stop nets with a combined length of 54,105 yards; 66 dip nets; 16,183 lines having 115,314 hooks or lures; 454 shrimp trawls with a combined length at their mouths of 9,419 yards; 499 crawfish traps; 275 crab traps; 2 steam dredges; 553 tongs, rakes, and forks; 1,555 crab pots; 291 pieces of sponge apparatus, including 48 diving outfits and 243 sponge hooks; and 97 pieces of miscellaneous gear, such as cast nets, crawfish hooks, and spears.

6 Detailed statistics of the fisheries along the east coast of Florida are discussed separately on pp. 504 to 508; those for the fisheries along the west coast on pp. 529 to 536; while those for Lake Okeechobee, as well as the statistics of the Florida sponge fishery, are discussed in this section. Statistics for these districts are combined in this section for the convenience of those readers who are interested in statistics covering the entire State.

Fisheries of Florida, 1927

SUMMARY OF CATCH

Products	East coast		West coast		Lake Okeechobee		Total	
	Pounds	*Value*	*Pounds*	*Value*	*Pounds*	*Value*	*Pounds*	*Value*
Fish	44,256,932	$1,206,312	67,779,259	$2,958,411	4,366,415	$201,033	116,402,606	$4,365,756
Shellfish and miscellaneous products	15,965,091	664,614	6,055,501	1,393,009			22,020,592	2,057,623
Total	60,222,023	1,870,926	73,834,760	4,351,420	4,366,415	201,033	138,423,198	6,423,379

OPERATING UNITS

Items	East coast	West coast	Lake Okeechobee	Total
Fishermen:				
On vessels	148	817		965
On shore or boat fisheries—				
Regular	2,717	4,332	220	7,269
Casual	82	121		203
Total	2,947	5,270	220	8,437
Vessels:				
Motor	19	90		109
Tonnage	312	2,739		3,051
Sail		17		17
Tonnage		836		836
Boats:				
Motor	1,179	1,765	85	3,029
Other	1,075	2,138	177	3,390
Apparatus:				
Haul seines	92	122	39	253
Yards	49,800	41,774	33,500	125,074
Purse seines	4	2		6
Yards	1,260	600		1,860
Gill nets	1,028	1,814		2,842
Square yards	1,200,860	1,548,754		2,749,614
Pound nets and traps	94	12	3,825	3,931
Trammel nets	4	315		319
Square yards	1,000	179,323		180,323
Stop nets		241		241
Yards		54,105		54,105
Dip nets	35	31		66
Lines	6,879	9,299	5	16,183
Hooks, snoods, or baits	95,783	19,011	520	115,314
Shrimp trawls	366	88		454
Yards at mouth	8,539	880		9,419
Crawfish traps	499			499
Crab traps	275			275
Dredges (steam)		2		2
Tongs, rakes, and forks	74	479		553
Crab pots		1,555		1,555
Sponge apparatus		291		291
Minor apparatus [1]	43	54		97

[1] Includes cast nets, crawfish hooks, and spears.

Catch by species.—Based on the value to the fishermen, mullet, with a catch of 31,384,348 pounds, valued at $1,274,653, was the most important of the fish taken. Red snapper was next with a catch of 9,371,867 pounds, valued at $746,089. Spanish mackerel was third with a catch of 6,491,530 pounds, valued at $469,177. Other fishes of importance were squeteague or "sea trout" with 3,452,310 pounds, valued at $340,017; cero and kingfish, 4,584,107 pounds, valued at $309,556; catfish, 4,253,860 pounds, valued at $185,300; groupers, 4,547,561 pounds, valued at $141,834; menhaden, 38,342,694 pounds, valued at $139,988; bluefish, 1,391,806 pounds, valued at $139,709; and pompano, 646,821 pounds, valued at $129,006. Other species of fish taken were individually valued at under $100,000. Among the shellfish, shrimp was of most importance in value, with a catch amounting to 17,168,859 pounds, valued at $687,443. Next were oysters, with a catch of 2,518,453 pounds (359,779 bushels), valued at $207,512; hard clams were third, with a catch of 963,768 pounds, valued at $43,415; and sea crawfish or spiny lobster were fourth, with a catch of 391,253 pounds, valued at $31,707. Other species of shellfish taken were individually valued at less than $15,000. Among the sponges, sheepswool were most important in value, with a catch of 364,914 pounds, valued at $961,366. Of next importance were the yellow sponges, with a catch of 121,250 pounds, valued at $49,598. Grass sponges followed, with a catch of 102,083 pounds, valued at $19,355.

Catch by gear.—On the east coast, where 60,222,023 pounds of fishery products were taken, purse seines made up 42 per cent of the catch; shrimp trawls, 25 per cent; gill nets, 19 per cent; and lines, 8 per cent. The remaining 6 per cent was taken by miscellaneous types of gear. The catch by purse seines consisted principally of menhaden; that by shrimp trawls was principally shrimp; by gill nets chiefly mullet, Spanish mackerel, bluefish, and squeteague or "sea trout"; and by lines mainly kingfish or "king mackerel."

On the west coast, where 73,834,760 pounds of fishery products were taken, gill nets made up 32 per cent of the catch; lines, 23 per cent; purse seines, 18 per cent; and haul seines, 10 per cent. The remainder of the catch (17 per cent) was caught mostly by trammel nets and shrimp trawls. The catch by gill nets was made up largely of mullet, Spanish mackerel, sharks, and squeteague or "sea trout." That of lines consisted mainly of red snapper, groupers, cero or "kingfish," and squeteague or "sea trout." That of purse seines was made up entirely of menhaden, and that of haul seines consisted mostly of mullet, Spanish mackerel, squeteague or "sea trout," blue runner, cigarfish, and bluefish.

In Lake Okeechobee, where 4,366,415 pounds of fish were taken, haul seines made up 93 per cent of the catch; traps, 6 per cent; and trot lines, 1 per cent. Over one-half of the catch of the haul seines was catfish, the remainder being sunfish, crappie, and black bass. Over one-half of the catch by traps was sunfish and the remainder crappie, black bass, and catfish. The catch by trot lines consisted entirely of catfish.

Considering the fisheries of the State as a whole, five types of gear accounted for 92 per cent of the catch. Listed in order of importance these were purse seines, which accounted for 28 per cent of the catch; gill nets, 26 per cent; lines, 16 per cent; shrimp trawls, 12 per cent; and haul seines, 10 per cent.

The catch by purse seines consisted almost entirely of menhaden; that by gill nets principally mullet, Spanish mackerel, squeteague or "sea trout," and sharks; that by lines chiefly red snapper, groupers, cero, and kingfish; that by shrimp trawls almost exclusively shrimp; and that by haul seines mainly mullet, catfish, and Spanish mackerel.

Fisheries of Florida, 1927

CATCH OF FISH

Species	East coast		West coast		Lake Okeechobee		Total	
	Pounds	*Value*	*Pounds*	*Value*	*Pounds*	*Value*	*Pounds*	*Value*
Alewives	212,892	$2,208					212,892	$2,208
Amberfish	9,200	360	11,475	$294			20,675	654
Angelfish or spadefish	11,030	359	47,870	1,802			58,900	2,161
Barracuda			1,000	20			1,000	20
Black bass	118,154	12,862	5,288	585	508,694	$44,351	632,136	57,798
Bluefish	771,800	90,837	620,006	48,862			1,391,806	139,709
Bluerunner or hardtail	88,380	2,602	810,211	19,114			898,591	21,716
Bonito			39,571	951			39,571	951
Butterfish			1,583	39			1,583	39
Catfish	1,925,233	77,048	56,652	3,307	2,271,975	104,945	4,253,860	185,300
Cero and kingfish or "king mackerel"	3,330,810	229,451	1,253,297	80,105			4,584,107	309,556
Cigarfish			310,524	8,796			310,524	8,796
Cobia or crabeater			9,000	460			9,000	460
Crappie	368,059	25,949			654,155	20,634	1,022,214	46,583
Crevalle	207,800	6,425	96,397	2,737			304,197	9,162
Croaker	39,050	1,553	45,342	1,601			84,392	3,154
Drum, black	83,600	2,989	69,967	2,081			153,567	5,070
Drum, red, or redfish	163,300	9,143	776,203	37,360			939,503	46,503
Elops or ten-pounder			2,482	74			2,482	74
Flounders	21,250	985	109,854	6,050			131,104	7,035
Groupers	59,900	2,746	4,487,661	139,088			4,547,561	141,834
Grunts	24,600	922	80,310	3,181			104,910	4,103
Hickory shad	42,246	2,137					42,246	2,137
Hogfish	2,800	154	29,667	968			32,467	1,122
Jewfish	15,100	338	295,159	8,683			310,259	9,021
King whiting or "kingfish"	168,600	8,964	112,824	4,630			281,424	13,594
Ladyfish			152,335	3,999			152,335	3,999
Margatefish	1,100	44					1,100	44
Menhaden	24,876,200	79,604	13,466,494	60,394			38,342,694	139,988
Moonfish	3,500	90	500	20			4,000	110
Mullet	6,582,848	232,778	24,801,500	1,041,875			31,384,348	1,274,653
Permit	8,890	263	52,074	1,695			60,964	1,958
Pigfish	154,650	5,739	35,134	1,384			189,784	7,123
Pilotfish			7,474	224			7,474	224
Pinfish or sailor's choice	304,100	9,236	16,464	616			320,564	9,852
Pompano	218,950	44,710	427,871	84,296			646,821	129,006
Porgies	12,000	470	95,651	3,627			107,651	4,097
Porkfish			12,146	529			12,146	529
Sea bass	31,700	1,962	31,816	2,545			63,516	4,507
Sergeantfish or snook	226,250	10,779	353,831	11,277			580,081	22,056
Shad	347,558	63,668					347,558	63,668
Sharks			1,200,000	9,000			1,200,000	9,000
Sheepshead	54,450	2,234	679,754	27,627			734,204	29,861
Snapper, mangrove	40,800	2,435	186,918	7,095			227,718	9,530
Snapper, mutton	128,900	6,734	32,378	2,530			161,278	9,264
Snapper, red	59,200	5,868	9,312,667	740,221			9,371,867	746,089
Spanish mackerel	1,921,323	149,974	4,570,207	319,203			6,491,530	469,177
Spot	420,750	11,639	139,278	5,394			560,028	17,033
Squeteagues or "sea trout"	868,945	88,794	2,583,365	251,223			3,452,310	340,017
Strawberry bass	5,000	250					5,000	250
Striped bass	1,650	412					1,650	412
Sturgeon			7,669	932			7,669	932
Sunfish	305,264	9,395			931,591	31,103	1,236,855	40,498
Tang			600	24			600	24
Tripletail			178,672	5,436			178,672	5,436
Turbot			1,200	48			1,200	48
Yellowtail	19,100	1,202	160,918	6,409			180,018	7,611
Total	44,256,932	1,206,312	67,779,259	2,958,411	4,366,415	201,033	116,402,606	4,365,756

Fisheries of Florida, 1927—Continued

CATCH OF SHELLFISH AND MISCELLANEOUS PRODUCTS

Products	East coast		West coast		Total	
	Pounds	*Value*	*Pounds*	*Value*	*Pounds*	*Value*
Crabs, hard	121,400	$8,732	12,200	$1,275	133,600	$10,007
Crabs, stone	6,400	576	57,800	9,700	64,200	10,276
Sea crawfish or spiny lobster	260,536	21,250	130,717	10,457	391,253	31,707
Shrimp	14,779,385	592,307	2,389,474	95,136	17,168,859	687,443
Clams, hard	9,600	1,000	954,168	42,415	963,768	43,415
Oysters, market, public	651,182	29,818	1,736,441	166,849	2,387,623	196,667
Oysters, market, private	130,830	10,845			130,830	10,845
Scallops, sea			12,800	4,800	12,800	4,800
Terrapin			3,200	800	3,200	800
Turtles	5,758	86	36,702	2,696	42,460	2,782
Sponges:						
Grass			102,083	19,355	102,083	19,355
Sheepswool			364,914	961,366	364,914	961,366
Velvet			175	66	175	66
Wire			11,807	4,749	11,807	4,749
Yellow			121,250	49,598	121,250	49,598
Conchs			5,200	433	5,200	433
Mullet roe			116,570	23,314	116,570	23,314
Total	15,965,091	664,614	6,055,501	1,393,009	22,020,592	2,057,623

PRODUCTION OF CERTAIN SHELLFISH SHOWN IN NUMBER AND BUSHELS

Products		East coast		West coast		Total	
		Quantity	*Value*	*Quantity*	*Value*	*Quantity*	*Value*
Crabs, hard	number	364,200	$8,732	36,600	$1,275	400,800	$10,007
Crabs, stone	do	8,533	576	77,067	9,700	85,600	10,276
Clams, hard	bushels	1,200	1,000	119,271	42,415	120,471	43,415
Oysters, market, public	do	93,026	29,818	248,063	166,849	341,089	196,667
Oysters, market, private	do	18,690	10,845			18,690	10,845
Scallops, sea				2,133	4,800	2,133	4,800

Fisheries by counties.—According to value, the fisheries of Pinellas County were most important during 1927. During the year 6,506,628 pounds of fishery products were caught, valued at $1,255,236. Sponges, which are taken near Tarpon Springs, constituted the most important fishery item in this county. Other fishery products of importance in value were red snapper, Spanish mackerel, and mullet. Escambia County was second with a catch of 7,076,518 pounds, valued at $465,148. Red snapper, which are taken in the vessel fisheries on the banks in the Gulf of Mexico and landed at Pensacola, contributed to making this county one of the most important in the State. Other fishery products of importance in this county are groupers and mullet. Nassau County was third with a catch of 33,009,565 pounds, valued at $401,312. Shrimp, which are taken in the waters near Fernandina and landed at Fernandina, had the greatest influence in making the fisheries of Nassau County important. The catch of menhaden accounts for most of the remainder. Fourth in importance was Bay County, with a catch of 6,831,669 pounds, valued at $394,073. Fisheries of this county are centered at Panama City, where red snapper is the most important fish landed. Other fish contributing to the county's importance are groupers, mullet, and Spanish mackerel. Franklin County was fifth in importance, with a catch of 6,744,548 pounds, valued at $386,633. Apalachicola is the center of the fisheries in this county, and oysters were the most important fishery product taken there. Others of importance were shrimp, red snapper, and mullet. Other counties where the catch was valued at over $250,000 were Charlotte, in which Punta Gorda is situated; Monroe, in which Key West is situated; and St. John, in which St. Augustine is situated.

INDUSTRIES RELATED TO THE FISHERIES [7]

Transporting trade.—During 1927 there were 58 persons in Florida engaged in transporting the catch of fishery products from the fishing grounds to market. For freighting these products there were 26 motor vessels in use, having a combined capacity of 418 net tons.

Wholesale trade.—During 1927 fresh and frozen fishery products were marketed through 174 wholesale establishments in Florida. These employed 1,084 persons, who received $604,742 in salaries and wages. Of the total number 87 were on the east coast, 81 on the west coast, and 6 at Lake Okeechobee.

Upon receipt of the fish at the wholesale establishments they are sorted and culled. The majority of the fishery products shipped from Florida are carried in barrels. Some of the fish are dressed (head removed and eviscerated), although the majority are shipped in the round. In packing barrels a layer of crushed ice is put on the bottom and then alternate layers of fish and ice, the last layer of crushed ice being heaped about 5 inches above the rim. Within about an hour of the time the barrel is shipped—by this time the ice has melted somewhat and the contents has settled—ice, crushed or in 12-inch blocks, is added and the barrel headed with matting, burlap, or burlap tarred to paper, which is fastened securely with a hoop nailed around the head. The same procedure is followed in packing boxes, except that it is not possible to add blocks of ice.

Shipments are forwarded from production centers by freight, express, or motor truck. By far the greater quantity is shipped by less-than-carload express. Many less-than-carload express shipments are made from certain localities all destined for one certain city. Only in rare instances are these less-than-carload shipments pooled into a carload shipment, whereby advantage can be taken of the lower transportation rate prevailing on carload shipments. Various wholesale dealers in Jacksonville having selling connections in northern markets pool less-than-carload shipments made by producers in the various sections of the State into carload shipments at Jacksonville. Thus, producers in Florida shipping only a few barrels of fish at a time are able to obtain a carload rate on their products from Jacksonville to destination. Producers taking advantage of this arrangement usually ship on consignment, in which case charges for the less-than-carload transportation of their products to Jacksonville and for the carload transportation to destination are deducted from the selling price of the products. The saving made by these producers is considerable compared with what the less-than-carload transportation charges from production points to destination might be.

Motor trucks are becoming an important factor in moving Florida fisheries products to market. Some producers operate their own motor-delivery system, while others sell to firms operating trucks, which call at the producer's establishment and then deliver the fish to various wholesalers and retailers in the State of Florida and in

[7] See pp. 504 and 529, respectively, for detailed statistics on this subject for the east and west coasts of Florida, and for Lake Okeechobee.

near-by States. It has been estimated that 70,000,000 pounds of fresh and frozen fishery products caught in Florida waters are reshipped to points outside the State. These shipments are consigned largely to other Southern States, although a considerable portion goes as far north and east as New York. The species of fish whose volume is largest in interstate shipments are mullet, Spanish mackerel, sea trout, fresh-water bream, shrimp, red snapper, and catfish.

Prepared-products and by-products industries.—During 1927 there were 42 establishments in Florida engaged in canning and curing fishery products and manufacturing by-products. Of the total, 37 were located on the west coast and 5 on the east coast. These employed 622 persons, who received $418,236 in salaries and wages. The total output of these establishments was valued at $1,474,358. The products canned consisted mainly of shrimp and oysters, although quantities of turtle meat and clam meat, prepared in various ways, also were canned. Mullet was the most important species salted, according to value. Other species salted were blue runner, Spanish mackerel, cigarfish, and grouper. Some mullet was smoked but the production was small. A few firms also put up fresh and frozen prepared fishery products in packages. Several firms manufactured menhaden meal and oil, while others produced shark oil, skins, fins, and meat, and crushed oyster shell for poultry feed and lime.

In addition, 853,400 pounds of fish, valued at $68,881, were salted by fishermen. This consisted mostly of mullet.

Industries related to the fisheries

Items	East coast	West coast	Lake Okeechobee	Total
Transporting:				
Persons engaged .... number..	7	51	....	58
Vessels (motor) .... do....	3	23	....	26
Tonnage .... do....	30	388	....	418
Wholesale trade:				
Establishments .... do....	87	81	6	174
Persons engaged .... do....	644	413	27	1,084
Salaries and wages paid .... dollars..	273,762	311,686	19,294	604,742
Prepared products and by-products industries:				
Establishments .... number..	5	37	....	42
Persons engaged .... do....	219	403	....	622
Salaries and wages paid .... dollars..	120,160	298,076	....	418,236
Products .... do....	666,599	807,759	....	1,474,358

LAKE OKEECHOBEE

The first statistical canvass of the fisheries of Lake Okeechobee by the bureau was for the year 1927. During that year these fisheries employed 220 fishermen. Their catch amounted to 4,366,415 pounds of fish, valued at $201,033, which consisted of 2,271,975 pounds of catfish, valued at $104,945; 508,694 pounds of black bass, valued at $44,351; 931,591 pounds of sunfish, valued at $31,103; and 654,155 pounds of crappie, valued at $20,634.

Operating units.—For making the catch the fishermen used 85 motor boats, 177 other boats, 39 haul seines with a combined length of 33,500 yards, 3,825 traps, and 5 lines having 520 hooks or lures.

Catch by gear.—Haul seines accounted for 93 per cent of the catch; traps, 6 per cent; and trot lines, 1 per cent. Over half of the catch of the haul seines was catfish, the remainder being sunfish, crappie, and black bass. Over half of the catch by traps was sunfish, and the remainder was crappie, black bass, and catfish. The catch by trot lines consisted entirely of catfish.

Catch by counties.—The catch of fish in Lake Okeechobee was made in two counties. Glades County accounted for 2,301,480 pounds, valued at $110,890, and Okeechobee County accounted for 2,064,935 pounds, valued at $90,143.

INDUSTRIES RELATED TO THE FISHERIES

During 1927 no transporting trade was conducted on Lake Okeechobee, nor were any prepared-products or by-products industries located there.

Wholesale trade.—There were six wholesale establishments on the shores of Lake Okeechobee in 1927 handling fresh fishery products. These employed 27 persons, who received $19,294 in salaries and wages. Fish marketed through these establishments usually are sent to points in the Southern States, although a considerable portion of the catfish is shipped to middle-western cities, such as St. Louis, Mo. Shipments are made in boxes and barrels, the preference of middle-western purchasers being for boxes. Before being shipped, most of the catfish are beheaded, eviscerated, and skinned.

Fisheries of Lake Okeechobee, Fla., 1927

OPERATING UNITS

Items	Number
Fishermen	220
Motor boats	85
Other boats	177
Apparatus:	
Haul seines	39
Yards	33,500
Fish traps	3,825
Lines	5
Hooks, snoods, or baits	520

CATCH: BY GEAR

Species	Haul seines		Fish traps		Trot lines		Total	
	Pounds	Value	Pounds	Value	Pounds	Value	Pounds	Value
Black bass	472,865	$41,126	35,829	$3,225			508,694	$44,351
Catfish	2,207,449	102,801	6,750	304	57,776	$1,840	2,271,975	104,945
Crappie	574,993	18,103	79,162	2,531			654,155	20,634
Sunfish	792,944	26,410	138,647	4,693			931,591	31,103
Total	4,048,251	188,440	260,388	10,753	57,776	1,840	4,366,415	201,033

Industries related to the fisheries of Lake Okeechobee

Items	Quantity
Wholesale trade:	
Establishments .... number	6
Persons engaged .... do	27
Salaries and wages paid .... dollars	19,294

SPONGE FISHERY

In the waters along the Gulf coast of Florida is located the only commercial sponge fishery in the United States. During 1927 this fishery employed 768 fishermen, and their catch amounted to 600,229 pounds of sponges, valued at $1,035,134. Virtually the entire catch consisted of the sheepswool variety, although there were small quantities of yellow, grass, velvet, and wire sponges.

Operating units.—For making the catch the fishermen employed 123 motor and 176 row boats, 5 motor and 4 sail vessels with a combined capacity of 116 net tons, 48 diving outfits, and 243 sponge hooks.

Sponge fishery of Florida, 1927

Items	Diving outfits		Sponge hooks		Total	
Fishermen:						
On boats or shore	408		310		718	
On vessels			50		50	
Total	408		360		768	
Boats:						
Motor	48		75		123	
Row			176		176	
Vessels:						
Motor—						
5 to 10 tons			2		2	
11 to 20 tons			1		1	
21 to 30 tons			2		2	
Total			5		5	
Net tonnage			65		65	
Sail—						
5 to 10 tons			1		1	
11 to 20 tons			3		3	
Total			4		4	
Net tonnage			51		51	
Grand total			9		9	
Net tonnage			116		116	
Apparatus	48		243		291	
Sponges:	*Pounds*	*Value*	*Pounds*	*Value*	*Pounds*	*Value*
Sheepswool	268,744	$776,939	96,170	$184,427	364,914	$961,366
Yellow	60,130	29,865	61,120	19,733	121,250	49,598
Grass	31,452	7,991	70,631	11,364	102,083	19,355
Velvet			175	66	175	66
Wire	10,005	3,832	1,802	917	11,807	4,749
Total	370,331	818,627	229,898	216,507	600,229	1,035,134

Marketing sponges.—The greater portion of the catch landed at Tarpon Springs is marketed through the exchange located there. During 1927, 414,417 pounds of sponges, valued at $865,510, were handled on the exchange. This is 69 per cent of the volume of the entire catch and 84 per cent of the value. Transactions are made on the exchange at auction, and bidders represent merchants in various sections of this and foreign countries.

In 1928 the quantity of sponges sold on the exchange was 413,198 pounds, valued at $729,918. This is a decrease of less than 1 per cent in amount and 16 per cent in value, compared with the amount and value of the transactions for 1927. Of the amount sold in 1928, 232,208 pounds, valued at $623,776, were large wool; 33,744 pounds, valued at $50,616, were small wool; 61,358 pounds, valued at $28,633, were yellow; 74,698 pounds, valued at $20,925, were grass; and 11,190 pounds, valued at $5,968, were wire.

In April, 1928, the fares of several vessels were shipped direct to wholesalers in the north. Apparently this did not prove successful, for during the remainder of the year the bulk of the fares of the vessels was sold on the exchange. It is estimated that sponges valued at $80,000 were sold outside of the exchange during 1928.

Sponges sold at the exchange, Tarpon Springs, Fla., 1925 to 1928, and the 5-year average 1920–1924

Year	Large wool	Small wool	Yellow	Grass	Wire	Total	
	Pounds	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Value*
1925	242,020	29,968	120,748	28,622	13,314	434,672	$715,097
1926	235,143	26,073	55,205	49,233	2,091	367,745	666,093
1927	252,463	35,413	65,429	50,495	10,617	414,417	865,510
1928	232,208	33,744	61,358	74,698	11,190	413,198	729,918
5-year average, 1920–1924	221,508	61,496	85,524	69,435	9,740	447,705	673,308

FISHERIES OF THE GULF STATES

The latest statistical canvass (prior to that for 1927) of the fisheries and fishery industries of the Gulf States—west coast of Florida, Alabama, Mississippi, Louisiana, and Texas—was that for the calendar year 1923. Complete statistics are published in the report of the division of fishery industries for 1925 and in Statistical Bulletin No. 670.

During 1923 the fisheries and fishery industries of the Gulf States employed 17,793 persons, of whom 11,132 were engaged in fishing operations, 1,785 in the wholesale fishery trade, and 4,876 in the fish-canning and by-products industries. The yield of the fisheries aggregated 160,324,042 pounds, valued at $8,096,650. The products of the canning and by-products industries were valued at $6,264,913.

In the production of marine fishery products the Gulf States rank as one of the most important sections for the production of shrimp and oysters. During 1927 more fishery products were caught in this section than for any year for which there are records since 1880. This was due mainly to greater activity in the shrimp and oyster fisheries. They gave employment to 15,133 fishermen, or 43 per cent more than in 1923, the latest year upon which records are available. Of the total number of fishermen employed in 1927, 2,268 regular fishermen were engaged on vessels and 11,759 regular and 1,106 casual fishermen were employed in the shore and boat fisheries. Their catch amounted to 195,705,355 pounds, valued at $9,965,775. This is an increase of 22 per cent in the catch and 23 per cent in the value of the catch, when compared with the amount of the catch and its value for 1923. Of the total catch in 1927, 84,963,323 pounds, valued at $4,127,137, were fish, and 110,742,032 pounds, valued at $5,838,638, were shellfish and miscellaneous products, including sponges.

Based on the value to the fisherman, shrimp, with a production of 68,876,954 pounds, valued at $2,344,361, was the most important product. Oysters were second, with a production of 36,012,991 pounds of meats, or 5,144,713 bushels, valued at $2,168,648. Other species of importance were mullet, 29,275,275 pounds, valued at $1,198,049; sponges, 600,229 pounds, valued at $1,035,134; red snapper, 11,899,329 pounds, valued at $974,063; squeteagues or "sea trout," 5,829,436 pounds, valued at $580,208; Spanish mackerel, 4,771,866 pounds, valued at $339,377; red drum, 2,872,367 pounds, valued at $237,930; and groupers, 4,723,285 pounds, valued at $148,275.

The industries related to the fisheries of the Gulf States gave employment to 5,651 persons, of whom 136 were engaged in transporting fishery products, 1,644 were in the wholesale trade and received $915,729 in wages, and 3,871 were in the canning and by-products trade and received $1,625,497 in wages. There were 192 establishments in the wholesale fish trade handling primary products and 123 establishments in the prepared-products and by-products trade. The latter manufactured products—mostly canned shrimp and oysters—to the value of $8,107,118. In addition, there were 1,091,443 pounds of fishery products, valued at $83,836, prepared by fishermen of the Gulf States, mostly salt mullet.

Fisheries of the Gulf States, 1927

OPERATING UNITS: BY STATES

Items	Florida (west coast)	Alabama	Mississippi	Louisiana	Texas	Total
Fishermen:						
On vessels	817	140	631	520	160	2,268
On boats or shore—						
Regular	4,332	503	1,447	4,338	1,139	11,759
Casual	121	72	213	309	391	1,106
Total	5,270	715	2,291	5,167	1,690	15,133
Vessels:						
Motor	90	31	41	175	40	377
Tonnage	2,739	362	422	1,222	413	5,158
Sail	17		100		5	122
Tonnage	836		1,529		190	2,555
Motor boats	1,765	235	424	1,507	400	4,331
Other boats	2,138	216	704	709	441	4,208
Apparatus:						
Purse seines	2					2
Yards	600					600
Haul seines	122	10	43	438	118	731
Yards	41,774	3,900	13,850	63,526	23,171	146,221
Gill nets	1,814	36			509	2,359
Square yards	1,548,754	15,600			78,861	1,643,215
Trammel nets	315	97	93	116	66	687
Square yards	179,323	41,975	31,939	25,327	26,096	304,660
Pound nets	12					12
Stop nets	241					241
Yards	54,105					54,105
Shrimp trawls	88	150	323	839	239	1,639
Yards at mouth	880	2,055	5,241	10,489	3,437	22,102
Lines	9,299	258	474	506	1,008	11,545
Hooks, snoods, etc	19,011	23,714	49,729	125,580	32,293	250,327
Dip nets	31		175	6,615	200	7,021
Crab pots	1,555					1,555
Dredges	[1] 2		161	36	61	260
Yards at mouth			172	39	63	274
Tongs	410	294	423	990	276	2,393
Rakes and forks	69					69
Sponge apparatus	291					291
Minor apparatus	54	12	154		130	350

[1] Steam dredges.

Fisheries of the Gulf States, 1927—Continued

CATCH OF FISH

Products	Florida (west coast)		Alabama		Mississippi	
	Pounds	*Value*	*Pounds*	*Value*	*Pounds*	*Value*
Amberfish	11, 475	$294				
Angelfish or spadefish	47, 870	1, 802	3, 432	$160	2, 250	$90
Barracuda	1, 000	20				
Black bass	5, 288	585				
Bluefish	620, 006	48, 862	46, 221	3, 589	30, 350	1, 821
Blue runner or hardtail	810, 211	19, 114	2, 258	90	300	15
Bonito	39, 571	951				
Buffalofish			10, 153	342		
Butterfish	1, 583	39			300	10
Cabio or crab-eater	9, 000	460			450	25
Catfish	56, 652	3, 307	84, 272	5, 353	60, 750	2, 055
Cero and kingfish or "king mackerel"	1, 253, 297	80, 105				
Cigarfish	310, 524	8, 796				
Crevalle	96, 397	2, 737	1, 955	59		
Croaker	45, 342	1, 601	26, 986	830	50, 950	1, 547
Drum, black	69, 967	2, 081	10, 460	466	95, 120	3, 972
Drum, red, or redfish	776, 203	37, 360	55, 149	4, 441	236, 916	21, 011
Elops or ten-pounder	2, 482	74				
Flounders	109, 854	6, 050	26, 680	2, 559	92, 930	9, 388
Groupers	4, 487, 661	139, 088	144, 188	5, 772	38, 185	1, 146
Grunts	80, 310	3, 181	250	9		
Hogfish	29, 667	968				
Jewfish	295, 159	8, 683	200	6	7, 500	225
King whiting or "kingfish"	112, 824	4, 630	4, 269	231	2, 300	135
Ladyfish	152, 335	3, 999	23, 222	569		
Menhaden	13, 466, 494	60, 394				
Moonfish	500	20				
Mullet	24, 801, 500	1, 041, 875	1, 972, 804	78, 443	2, 363, 146	72, 005
Paddlefish or spoonbill cat			5, 825	291		
Permit	52, 074	1, 695				
Pigfish	35, 134	1, 384	100	3		
Pilotfish	7, 474	224				
Pinfish or sailors choice	16, 464	616				
Pompano	427, 871	84. 296	5, 367	1, 224	6, 460	1, 111
Porgies	95, 651	3, 627				
Porkfish	12, 146	529				
Sea bass	31, 816	2, 545			18, 900	2, 179
Sergeantfish or snook	353, 831	11, 277				
Sharks	1, 200, 000	9, 000				
Sheepshead	679, 754	27, 627	46, 599	3, 180	144, 240	11, 509
Snapper, mangrove	186, 918	7, 095				
Snapper, mutton	32, 378	2, 530				
Snapper, red	9, 312, 667	740, 221	1, 058, 650	106, 128	218, 706	19, 099
Spanish mackerel	4, 570, 207	319, 203	22, 207	1, 848	11, 695	1, 247
Spot	139, 278	5, 394	32, 442	1, 031	23, 550	714
Squeteagues or "sea trout"	2, 583, 365	251, 223	118, 237	11, 813	605, 430	58, 226
Sturgeon	7, 669	932	14, 997	5, 209		
Tang	600	24				
Tripletail	178, 672	5, 436				
Turbot	1, 200	48				
Yellowtail	160, 918	6, 409				
Total	67, 779, 259	2, 958, 411	3, 716, 923	233, 646	4, 010, 428	207, 529

Fisheries of the Gulf States, 1927—Continued

CATCH OF FISH—Continued

Products	Louisiana		Texas		Total	
	Pounds	*Value*	*Pounds*	*Value*	*Pounds*	*Value*
Amberfish					11,475	$294
Angelfish or spadefish			520	$29	54,072	2,081
Barracuda					1,000	20
Black bass					5,288	585
Bluefish	5,500	$590	560	112	702,637	54,974
Blue runner or hardtail					812,769	19,219
Bonito					39,571	951
Buffalofish			15,000	450	25,153	792
Butterfish					1,883	49
Cabio or crab-eater					9,450	485
Catfish	784,026	38,423	151,670	7,616	1,137,370	56,754
Cero and kingfish or "king mackerel"			10,130	545	1,263,427	80,650
Cigarfish					310,524	8,796
Crevalle					98,352	2,796
Croaker	185,642	7,950	104,098	3,534	413,018	15,462
Drum, black	182,007	6,837	1,432,355	44,141	1,789,909	57,497
Drum, red, or redfish	555,911	57,163	1,248,188	117,955	2,872,367	237,930
Elops or ten-pounder					2,482	74
Flounders	42,905	4,450	77,580	8,290	349,949	30,737
Groupers	16,000	640	37,251	1,630	4,723,285	148,275
Grunts					80,560	3,190
Hogfish					29,667	968
Jewfish			11,175	614	314,034	9,528
King whiting or "kingfish"			18,865	981	138,258	5,977
Ladyfish					175,557	4,568
Menhaden					13,466,494	60,394
Moonfish					500	20
Mullet	132,400	5,464	5,425	262	29,275,275	1,198,049
Paddlefish or spoonbill cat					5,825	291
Permit					52,074	1,695
Pigfish			940	57	36,174	1,444
Pilotfish					7,474	224
Pinfish or sailors choice					16,464	616
Pompano	10,355	1,198	5,420	1,172	455,473	89,001
Porgies					95,651	3,627
Porkfish					12,146	529
Sea bass					50,716	4,724
Seagar	10,000	600			10,000	600
Sergeantfish or snook			116,665	7,014	470,486	18,291
Sharks					1,200,000	9,000
Sheepshead	182,615	18,809	48,033	3,223	1,101,241	64,348
Snapper, mangrove					186,918	7,095
Snapper, mutton					32,378	2,530
Snapper, red	72,000	7,920	1,237,306	100,695	11,899,329	974,063
Spanish mackerel	23,477	2,411	144,280	14,668	4,771,866	339,377
Spot	59,000	2,836			254,270	9,975
Squeteagues or "sea trout"	822,430	85,343	1,699,974	173,603	5,829,436	580,208
Sturgeon					22,666	6,141
Tang					600	24
Tripletail					178,672	5,436
Tuna or horse mackerel			520	26	520	26
Turbot					1,200	48
Yellowtail	6,500	300			167,418	6,709
Total	3,090,768	240,934	6,365,945	486,617	84,963,323	4,127,137

Fisheries of the Gulf States, 1927—Continued

CATCH OF SHELLFISH AND MISCELLANEOUS PRODUCTS

Products	Florida (west coast)		Alabama		Mississippi	
	Pounds	*Value*	*Pounds*	*Value*	*Pounds*	*Value*
Crabs, hard	12,200	$1,275	31,920	$1,200	2,426,080	$62,090
Crabs, soft					8,400	1,800
Crabs, stone	57,800	9,700				
Sea crawfish or spiny lobster	130,717	10,457				
Shrimp	2,389,474	95,136	5,161,850	154,858	9,234,457	318,583
Clams, hard	954,168	42,415				
Oysters, market, public	1,736,441	166,849	1,072,862	39,698	5,813,738	268,553
Oysters, market, private			91,876	7,476	[1] 13,001,345	398,574
Scallops, sea	12,800	4,800				
Terrapin	3,200	800			8,800	2,200
Turtles	36,702	2,696				
Sponges:						
Grass	102,083	19,355				
Sheepswool	364,914	961,366				
Velvet	175	66				
Wire	11,807	4,749				
Yellow	121,250	49,598				
Conchs	5,200	433				
Mullet roe, fresh	22,400	4,480				
Mullet roe, salted	94,170	18,834				
Sturgeon roe			451	351		
Total	6,055,501	1,393,009	6,358,958	203,583	30,492,820	1,051,800

Products	Louisiana		Texas		Total	
	Pounds	*Value*	*Pounds*	*Value*	*Pounds*	*Value*
Crabs, hard	1,090,500	$50,868	120,800	$8,540	3,681,500	$123,973
Crabs, soft	136,960	48,179			145,360	49,979
Crabs, stone					57,800	9,700
Sea crawfish or spiny lobster					130,717	10,457
Shrimp	40,259,140	1,406,366	11,832,033	369,418	68,876,954	2,344,361
Clams, hard					954,168	42,415
Oysters, market, public	1,765,050	158,188	2,744,329	187,915	13,132,420	821,203
Oysters, market, private	9,768,801	939,645	18,550	1,750	22,880,571	1,347,445
Scallops, sea					12,800	4,800
Terrapin	76,090	18,267			88,090	21,267
Turtles	21,000	1,050	1,500	60	59,202	3,806
Sponges:						
Grass					102,083	19,355
Sheepswool					364,914	961,366
Velvet					175	66
Wire					11,807	4,749
Yellow					121,250	49,598
Conchs					5,200	433
Mullet roe, fresh					22,400	4,480
Mullet roe, salted					94,170	18,834
Sturgeon roe					451	351
Total	53,117,541	2,622,563	14,717,212	567,683	110,742,032	5,838,638

[1] Includes 12,587,092 pounds (1,798,156 bushels), valued at $374,791, taken from Louisiana beds by Mississippi vessels.

PRODUCTION OF CERTAIN SHELLFISH SHOWN IN NUMBER AND BUSHELS

Products		Florida (west coast)		Alabama		Mississippi	
		Quantity	*Value*	*Quantity*	*Value*	*Quantity*	*Value*
Crabs, hard	number	36,600	$1,275	95,760	$1,200	7,278,240	$62,090
Crabs, soft	do					25,200	1,800
Crabs, stone	do	77,067	9,700				
Clams, hard	bushels	119,271	42,415				
Oysters, market, public	do	248,063	166,849	153,266	39,698	830,534	268,553
Oysters, market, private	do			13,125	7,476	[1] 1,857,335	398,574
Scallops, sea	do	2,133	4,800				

[1] Includes 1,798 bushels taken from beds in Louisiana by Mississippi vessels.

Fisheries of the Gulf States, 1927—Continued

PRODUCTION OF CERTAIN SHELLFISH—Continued

Products	Louisiana		Texas		Total	
	Quantity	*Value*	*Quantity*	*Value*	*Quantity*	*Value*
Crabs, hard .... number..	3,271,500	$50,868	362,400	$8,540	11,044,500	$123,973
Crabs, soft .... do....	410,880	48,179			436,080	49,979
Crabs, stone .... do....					77,067	9,700
Clams, hard .... bushels..					119,271	42,415
Oysters, market, public .... do....	252,150	158,188	392,047	187,915	1,876,060	821,203
Oysters, market, private .... do....	1,395,543	939,645	2,650	1,750	3,268,663	1,347,445
Scallops, sea .... do....					2,133	4,800

Industries related to the fisheries

Items	Florida (west coast)	Alabama	Mississippi	Louisiana	Texas	Total
Transporting:						
Persons engaged .... number..	51	20	10	55		136
Vessels—						
Motor .... do....	23	13	1	26		63
Tonnage .... do....	388	112	22	273		795
Sail .... do....			4	1		5
Tonnage .... do....			61	16		77
Wholesale trade:						
Establishments .... do....	81	8	27	32	44	192
Persons engaged .... do....	413	81	365	303	482	1,644
Salaries and wages paid .... dollars..	311,686	40,073	153,007	218,501	192,462	915,729
Prepared products and by-products industries:						
Establishments .... number..	37	7	24	45	10	123
Persons engaged .... do....	403	302	1,097	1,583	486	3,871
Salaries and wages paid .... dollars..	298,076	153,755	457,188	614,535	101,943	1,625,497
Products .... do....	807,759	831,405	2,285,576	3,720,935	461,443	8,107,118

PRODUCTS PREPARED BY FISHERMEN

Items	Florida (west coast)		Mississippi		Louisiana		Total	
	Pounds	*Value*	*Pounds*	*Value*	*Pounds*	*Value*	*Pounds*	*Value*
Salted:								
Catfish	1,400	$76					1,400	$76
Mullet	757,830	49,971	222,779	$11,139			980,609	61,110
Mullet roe	94,170	18,834					94,170	18,834
Total	853,400	68,881	222,779	11,139			1,076,179	80,020
Dried shrimp					15,264	$3,816	15,264	3,816

WEST COAST OF FLORIDA [7]

The west coast of Florida in 1927 was foremost among the States bordering on the Gulf of Mexico in the importance of its fisheries, employing 35 per cent of the total number of fishermen and accounting for 38 per cent of the total catch. The fisheries and industries related to the fisheries employed 6,137 persons, which is 5 per cent more than the number employed in 1923. Of the total, 5,270 were fishermen, 51 were employed on transporting vessels, 413 in the wholesale trade, and 403 in the prepared-products and by-products industries.

[7] See pp. 515–524 for complete statistics for Florida.

The catch amounted to 73,834,760 pounds, valued at $4,351,420. This is an increase of 1 per cent in amount and 8 per cent in the value of the catch, compared with the catch and its value in 1923. Of the total value of the catch, that for mullet accounted for 24 per cent, sponges 24 per cent, red snapper 17 per cent, Spanish mackerel 7 per cent, squeteagues or "sea trout" 6 per cent, and oysters 4 per cent. Of the total production, that of mullet accounted for 34 per cent, menhaden 18 per cent, red snapper 13 per cent, Spanish mackerel 6 per cent, groupers 6 per cent, and squeteagues or "sea trout" 3 per cent.

Operating units.—The catch of fishery products along the west coast of Florida during 1927 was taken by 5,270 fishermen, who used 3,903 motor and row boats, 90 motor vessels, 17 sailing vessels, and 17 types of gear. The motor and sailing vessels had a combined net tonnage of 3,575.

Fisheries of the west coast of Florida, 1927

OPERATING UNITS: BY GEAR

Items	Purse seines	Haul seines	Gill nets	Pound nets	Trammel nets	Stop nets	Lines	Dip nets	Shrimp trawls
Fishermen:									
On boats or shore—									
Regular		615	1,954	27	432	100	1,047	62	168
Casual		40					59		
On vessels	60		6				690		8
Total	60	655	1,960	27	432	100	1,796	62	176
Boats:									
Motor		128	893	9	146	23	623	31	84
Other		131	1,521	15	312	55	110	31	
Vessels:									
Motor—									
5 to 10 tons			2				12		4
11 to 20 tons							25		
21 to 30 tons							6		
31 to 40 tons	1						4		
41 to 50 tons							7		
51 to 60 tons							6		
61 to 70 tons	1						12		
71 to 80 tons							2		
91 to 100 tons							1		
101 to 110 tons							1		
Total	2		2				76		4
Net tonnage	96		17				2,529		26
Sail—									
5 to 10 tons							1		
11 to 20 tons							1		
31 to 40 tons							3		
51 to 60 tons							3		
61 to 70 tons							3		
131 to 140 tons							1		
141 to 150 tons							1		
Total							13		
Net tonnage							785		
Grand total	2		2				89		4
Net tonnage	96		17				3,314		26
Apparatus:									
Number	2	122	1,814	12	315	241	9,299	31	88
Length, yards	600	41,774				54,105			
Square yards			1,548,754		179,323				
Yards at mouth									880
Hooks, snoods, or baits							19,011		

Fisheries of the west coast of Florida, 1927—Continued

OPERATING UNITS: BY GEAR—Continued

Items	Dredges	Tongs	Rakes and forks	Crab pots	Sponge apparatus	Cast nets, spears, and craw-fish hooks	By hand	Total, exclusive of duplication
Fishermen:								
On boats or shore—								
Regular	20	382	69	25	718	58	36	4,332
Casual		18				4		121
On vessels		10			50			817
Total	20	410	69	25	768	62	36	5,270
Boats:								
Motor	2	156	13	8	123	16	12	1,765
Other	4	95	69	16	176	20	25	2,138
Vessels:								
Motor—								
5 to 10 tons		5			2			21
11 to 20 tons					1			26
21 to 30 tons					2			8
31 to 40 tons								5
41 to 50 tons								7
51 to 60 tons								6
61 to 70 tons								13
71 to 80 tons								2
91 to 100 tons								1
101 to 110 tons								1
Total		5			5			90
Net tonnage		31			65			2,739
Sail—								
5 to 10 tons					1			2
11 to 20 tons					3			4
31 to 40 tons								3
51 to 60 tons								3
61 to 70 tons								3
131 to 140 tons								1
141 to 150 tons								1
Total					4			17
Net tonnage					51			836
Grand total		5			9			107
Net tonnage		31			116			3,575
Apparatus:								
Number	2	410	69	1,555	291	54		

Catch by gear.—Four types of gear caught 83 per cent of the fish taken in the marine fisheries of the west coast of Florida during 1927. Listed in order of importance they were gill nets, which accounted for 32 per cent of the catch; lines, 23 per cent; purse seines, 18 per cent; and haul seines, 10 per cent.

The catch by gill nets was made up largely of mullet, Spanish mackerel, sharks, and squeteagues or "sea trout"; that of lines consisted largely of red snapper, groupers, cero and kingfish, and squeteagues or "sea trout"; that of purse seines was made up entirely of menhaden; and that of haul seines consisted mainly of mullet, Spanish mackerel, squeteagues or "sea trout," blue runner, cigarfish, and bluefish.

Fisheries of the west coast of Florida, 1927

CATCH: BY GEAR

Species	Haul and purse seines		Gill nets		Pound nets		Trammel nets	
	Pounds	*Value*	*Pounds*	*Value*	*Pounds*	*Value*	*Pounds*	*Value*
Angelfish or spadefish	11,993	$420	27,175	$1,045	3,537	$159	735	$33
Black bass			2,788	335				
Bluefish	282,719	15,015	278,537	26,274	29,796	4,469	23,395	2,443
Blue runner or hardtail	320,080	8,010	196,169	5,017	263,016	5,340	21,616	558
Bonito	12,096	316			23,025	461		
Butterfish	1,583	39						
Catfish							2,800	76
Cero and kingfish or "king mackerel"	8,360	418	5,300	340	39,748	5,642		
Cigarfish	310,524	8,796						
Cobia or crab eater	900	36			5,000	300		
Crevalle	36,738	838	47,517	1,504	852	38		
Croaker	13,634	474	19,426	644			9,350	394
Drum, black	14,189	547	26,082	853	2,100	42	11,450	306
Drum, red, or redfish	71,794	3,007	209,527	10,290	3,100	217	155,572	9,216
Elops or ten-pounder	2,482	74						
Flounders	28,187	1,366	22,729	1,023	1,200	72	18,079	1,068
Groupers	1,804	54			900	36		
Grunts	2,260	82	8,923	405				
Hogfish	2,894	99	11,269	359				
Jewfish	2,434	49			800	16		
King whiting or "kingfish"	38,018	1,565	41,734	1,460			5,450	255
Ladyfish	108,584	3,033	18,928	457	14,948	299	9,875	210
Menhaden	[1] 13,407,771	58,654	58,723	1,740				
Mullet	4,659,448	183,549	16,104,673	695,874	17,504	788	3,492,225	140,558
Mullet roe, fresh			22,400	4,480				
Mullet roe, salted	45,270	9,054					48,900	9,780
Permit	9,399	321	31,089	1,007	490	22		
Pigfish	4,155	153	20,312	776	500	23	8,200	373
Pilotfish	850	25	5,148	155				
Pinfish or sailors choice	1,637	58	10,185	382	460	21		
Pompano	69,242	13,961	173,507	33,853	19,149	4,787	132,605	25,021
Porkfish	2,520	99	5,826	265			1,300	65
Sergeantfish or snook	86,464	2,838	203,164	6,513				
Sharks			1,200,000	9,000				
Sheepshead	83,727	3,452	256,534	10,546	11,915	536	90,320	4,298
Snapper, mangrove	17,784	609	107,503	3,768	1,288	58	7,762	359
Snapper, red	1,552	124						
Spanish mackerel	866,628	68,611	3,416,200	227,694	60,562	7,873	49,070	4,381
Spot	19,418	697	72,822	2,722	18,500	843	20,698	896
Squeteagues or "sea trout"	360,364	33,310	891,443	90,404	50,535	6,014	300,166	31,927
Sturgeon			7,669	932				
Tripletail	24,086	774	118,696	3,578			400	20
Yellowtail	14,365	431	85,693	3,001				
Turtles	8,202	416	28,500	2,280				
Total	[1] 20,954,155	421,374	23,736,191	1,148,976	568,925	38,056	4,409,968	232,237

Species	Stop nets		Lines		Dip nets		Shrimp trawls	
	Pounds	*Value*	*Pounds*	*Value*	*Pounds*	*Value*	*Pounds*	*Value*
Amberfish			11,475	$294				
Angelfish or spadefish	3,180	$95	1,250	50				
Barracuda			1,000	20				
Black bass			2,500	250				
Bluefish	815	92	4,744	569				
Blue runner or hardtail	9,330	189						
Bonito			4,450	174				
Catfish			53,852	3,231				
Cero and kingfish or "king mackerel"			1,199,889	73,705				
Cobia or crab eater			3,100	124				
Crevalle	9,490	285	1,800	72				
Croaker	2,932	89						
Drum, black	4,893	98	11,253	235				
Drum, red, or redfish	14,237	443	321,973	14,187				
Flounders	6,746	202	10,395	367			3,718	$298
Groupers	5,100	154	4,479,857	138,844				
Grunts	1,173	35	67,954	2,659				
Hogfish	1,422	43	14,082	467				
Jewfish	9,972	200	281,953	8,418				
King whiting or "kingfish"	27,622	1,350						
Moonfish			500	20				
Mullet	519,650	20,786						

[1] Of this amount, 13,275,800 pounds of menhaden, valued at $54,776, was taken by purse seines.

Fisheries of the west coast of Florida, 1927—Continued

CATCH BY GEAR—Continued

Species	Stop nets		Lines		Dip-nets		Shrimp trawls	
	Pounds	*Value*	*Pounds*	*Value*	*Pounds*	*Value*	*Pounds*	*Value*
Permit	9,846	295	$1,250	$50				
Pigfish	1,967	59						
Pilotfish	1,476	44						
Pinfish or sailors' choice	1,182	35	3,000	120				
Pompano	30,870	6,174	2,498	500				
Porgies			95,651	3,627				
Porkfish			2,500	100				
Sea bass			31,816	2,545				
Sergeantfish or snook	64,203	1,926						
Sheepshead	53,943	1,632	183,315	7,163				
Snapper, mangrove	29,085	880	23,496	1,421				
Snapper, mutton			32,378	2,530				
Snapper, red			9,311,115	740,097				
Spanish mackerel	20,667	1,341	157,080	9,303				
Spot	7,840	236						
Squeteagues or "sea trout"	128,026	10,691	852,831	78,877				
Tang			600	24				
Tripletail	35,490	1,064						
Turbot			1,200	48				
Yellow tail	15,860	477	45,000	2,500				
Crabs, hard			5,000	375				
Crabs, stone					1,000	$100		
Sea crawfish or spiny lobster					106,151	8,492		
Shrimp							2,389,474	95,136
Total	1,017,017	48,915	17,220,757	1,092,966	107,151	8,592	2,393,192	95,434

Species	Dredges		Tongs		Rakes and forks		Crab pots	
	Pounds	*Value*	*Pounds*	*Value*	*Pounds*	*Value*	*Pounds*	*Value*
Crabs, hard							7,200	$900
Crabs, stone							55,800	9,500
Clams, hard	715,256	$26,822			194,272	$12,209		
Oysters, market, public			1,698,641	$160,099	37,800	6,750		
Total	715,256	26,822	1,698,641	160,099	232,072	18,959	63,000	10,400

Species	Sponge apparatus		Cast nets, spears, and crawfish hooks		By hand	
	Pounds	*Value*	*Pounds*	*Value*	*Pounds*	*Value*
Flounders			18,800	$1,654		
Mullet			8,000	320		
Crabs, stone			1,000	100		
Sea crawfish or spiny lobster			24,566	1,965		
Clams, hard					44,640	$3,384
Scallops, sea					12,800	4,800
Conchs					5,200	433
Terrapin					3,200	800
Sponges, grass	102,083	$19,355				
Sponges, sheepswool	364,914	961,366				
Sponges, velvet	175	66				
Sponges, wire	11,807	4,749				
Sponges, yellow	121,250	49,598				
Total	600,229	1,035,134	52,366	4,039	65,840	9,417

Fisheries by counties.—Fishing was prosecuted in the marine waters of 23 counties on the west coast of Florida in 1927. Ranked according to value, the fisheries of Pinellas County were most important, accounting for 9 per cent of the total catch and 29 per cent of the total value. Escambia County was next in value of catch, accounting for 10 per cent of the total and 11 per cent of the total value. Bay, Franklin, Charlotte, and Monroe Counties followed in the order named, although the catch and its value in each county differed but little from each of the others in this group.

Fisheries of the west coast of Florida, 1927

OPERATING UNITS AND CATCH: BY COUNTIES

County	Fishermen		Vessels		Motor boats	Other boats	Products	
	Regular	Casual						
	Number	*Number*	*Number*	*Net tonnage*	*Number*	*Number*	*Pounds*	*Value*
Bay	512		24	659	124	52	6,831,669	$394,073
Charlotte	505				325	353	6,523,912	325,163
Citrus	157				58	157	2,279,611	125,172
Collier	132				50	102	1,986,908	89,383
Dixie	24	10			8	34	469,820	24,226
Escambia	538	15	40	2,155	52	30	7,076,518	465,148
Franklin	562		13	120	163	159	6,744,548	386,633
Gulf	83		2	96	15	13	13,527,600	66,912
Hernando	3					3	54,750	2,903
Hillsborough	157	4	4	60	64	89	1,666,230	75,803
Jefferson	10	20			2	30	337,900	16,543
Lee	121				91	78	1,272,290	59,268
Levy	140	10			67	123	3,480,420	214,732
Manatee	136	4			55	104	2,619,228	129,101
Monroe	548		9	194	238	217	4,711,874	318,240
Okaloosa	125				26	22	1,525,322	92,201
Pasco	28				6	25	334,752	17,749
Pinellas	919		15	291	201	211	6,506,628	1,255,236
Santa Rosa	41				11	13	181,285	11,371
Sarasota	241				164	142	1,667,519	97,839
Taylor	39	10			15	49	782,380	43,211
Wakulla	114	48			22	120	3,147,413	135,451
Walton	14				3	7	106,123	5,062
Total	5,149	121	107	3,575	1,760	2,183	73,834,760	4,351,420

INDUSTRIES RELATED TO THE FISHERIES

Transporting trade.—There were 51 persons in 1927 engaged on the west coast of Florida primarily in transporting the catch from the fishing grounds to market. In this trade 23 registered motor vessels were in operation, with a total net tonnage of 388. The size of vessel in most popular use ranged from 11 to 20 net tons.

Wholesale trade.—There were 81 wholesale establishments along the west coast of Florida engaged chiefly in handling fresh and frozen fishery products. This is 42 per cent of the total number of such establishments in the Gulf section. Virtually the entire catch of fishery products taken along the west coast of Florida consisted of market fish, which accounts for the large percentage of wholesale fish establishments there. These establishments employed 413 persons, who received $311,686 in salaries and wages. Pinellas County had 24 wholesale establishments. Other counties of importance were Franklin with 10 and Monroe with 9 establishments.

Prepared and by-products trade.—There were 37 establishments along the west coast of Florida in 1927 engaged in canning and curing fishery products and in the manufacture of fishery by-products. This is 30 per cent of the total number in the Gulf section. They employed 403 persons, who received $298,076 in salaries and wages. The products manufactured were valued at $807,759. Detailed statistics of most of the items manufactured may be obtained from "Fishery Industries of the United States, 1927," Bureau of Fisheries Document No. 1050.

In addition to the above, 853,400 pounds of fish, valued at $68,881, were salted by fishermen. This consisted mostly of salted mullet.

Industries related to the fisheries of the west coast of Florida, 1927

TRANSPORTING

Items	Number
Men on transporting vessels	51
Transporting vessels (motor):	
5 to 10 tons	5
11 to 20 tons	13
21 to 30 tons	2
31 to 40 tons	3
Total	23
Net tonnage	388

WHOLESALE FISHERY TRADE

Items	Bay	Charlotte and Sarasota	Citrus	Escambia and Santa Rosa	Franklin	Hillsborough and Pasco
Establishments	4	5	5	6	10	6
Persons engaged:						
Proprietors or managers	5	6	5	7	11	8
Salaried employees	7	8	3	26	18	
Wage earners	7	39	10	13	45	6
Paid to salaried employees	$10, 872	$14, 507	$3, 120	$43, 477	$10, 929	
Paid to wage earners	6, 488	35, 936	9, 988	11, 412	19, 053	$4, 524

Items	Lee and Collier	Levy	Manatee	Monroe	Pinellas	Total
Establishments	4	3	5	9	24	81
Persons engaged:						
Proprietors or managers	4	3	5	10	28	92
Salaried employees	3	1		6	5	77
Wage earners	8	6	6	27	77	244
Paid to salaried employees	$5, 700	$300		$9, 300	$14, 550	$112, 755
Paid to wage earners	8, 611	3, 480	$5, 004	23, 256	71, 179	198, 931

PREPARED FISHERY PRODUCTS AND BY-PRODUCTS

Items	Number	Items	Amount
Establishments	37	Salaries paid	$117, 802
Persons engaged:		Wages paid	180, 274
Proprietors or managers	57		
Salaried employees	97	Total salaries and wages paid	298, 076
Wage earners	249		

Products	Quantity	Value	Products	Quantity	Value
Salted:			Canned shrimp:		
Mullet ...pounds	811, 951	$61, 928	Dry pack standard cases [1]	1, 008	$6, 233
Other species ...do	33, 880	2, 156	Wet pack ...do	28, 591	218, 808
Mullet roe ...do	113, 683	35, 290	Miscellaneous products [2]		483, 344
			Total		807, 759

[1] A standard case contains 4 dozen 5-ounce cans in the dry pack or 4 dozen 5¾-ounce cans in the wet pack.
[2] Includes smoked mullet, shark products, oyster-shell products, menhaden products, canned oysters, canned clam products, and canned turtle products.

Industries related to the fisheries of the west coast of Florida, 1927—Continued

PRODUCTS PREPARED BY THE FISHERMEN

Salted fish	Pounds	Value
Catfish	1,400	$76
Mullet	757,830	49,971
Mullet roe	94,170	18,834
Total	853,400	68,881

ALABAMA

The fisheries and related fishery industries of Alabama employed 1,118 persons, which is 8 per cent less than the number employed in 1923. Of the total, 715 were fishermen, 20 were employed on transporting vessels, 81 in the wholesale trade, and 302 in the prepared-products and by-products industries.

The catch amounted to 10,075,881 pounds, valued at $437,229. This is an increase of 32 per cent in amount and 28 per cent in value compared with the catch and its value for 1923. Of the total value of the catch, shrimp accounted for 35 per cent, red snapper 24 per cent, mullet 18 per cent, and oysters 11 per cent. Of the total production, shrimp accounted for 51 per cent, mullet 20 per cent, oysters 12 per cent, and red snapper 11 per cent.

Operating units.—The catch of fishery products in Alabama during 1927 was taken by 715 fishermen, who used 451 motor and row boats, 31 motor vessels with a net tonnage of 362, and 7 types of gear.

Fisheries of Alabama, 1927

OPERATING UNITS: BY GEAR

Items	Haul seines	Gill nets	Trammel nets	Lines	Shrimp trawls	Spears	Tongs	Total, exclusive of duplication
Fishermen:								
On boats or shore:								
Regular	46	12	128		257	6	273	503
Casual		11		24		6		72
On vessels	4		13	90	37		11	140
Total	50	23	141	114	294	12	284	715
Boats:								
Motor	9	10	51	19	131	6	130	235
Other	7	3	90	71		12	122	216
Vessels (motor):								
5 to 10 tons	1		1	2	16		5	20
11 to 20 tons			2	6	2			9
31 to 40 tons				1				1
61 to 70 tons				1				1
Total	1		3	10	18		5	31
Net tonnage	8		30	193	142		35	362
Apparatus:								
Number	10	36	97	258	150	12	294	
Length, yards	3,900							
Square yards		15,600	41,975					
Yards at mouth					2,055			
Hooks, snoods, or baits				23,714				

Catch by gear.—Four types of gear caught 91 per cent of the catch of marine fishery products in Alabama during 1927. Listed in order of importance, they are shrimp trawls, which accounted for 51 per cent of the catch; trammel nets, 16 per cent; lines, 13 per cent; and tongs, 11 per cent. The catch by shrimp trawls was made up entirely of shrimp, that of trammel nets consisted almost entirely of mullet, lines took chiefly red snapper, and tongs took mostly oysters.

Fisheries of Alabama, 1927

CATCH: BY GEAR

Species	Haul seines		Gill nets		Trammel nets		Lines	
	Pounds	*Value*	*Pounds*	*Value*	*Pounds*	*Value*	*Pounds*	*Value*
Angelfish or spadefish	1,562	$85			1,870	$75		
Bluefish	31,421	2,721	10,000	$600	4,800	268		
Blue runner or hardtail	2,258	90						
Buffalofish					10,153	342		
Catfish	1,066	84			16,096	611	67,110	$4,658
Crevalle	1,955	59						
Croakers	428	13			26,558	817		
Drum, black	1,217	51			9,243	415		
Drum, red, or redfish	22,597	1,503			29,112	2,594	3,440	344
Flounders	7,600	758			4,080	401		
Groupers							144,188	5,772
Grunts					250	9		
Jewfish							200	6
King whiting or "kingfish"	2,126	110			2,143	121		
Ladyfish	22,762	555			460	14		
Mullet	526,085	21,662	80,000	2,800	1,366,719	53,981		
Paddlefish or spoonbill cat							5,825	291
Pigfish	100	3						
Pompano	3,725	856			1,642	368		
Sheepshead	24,017	1,682			21,332	1,423	1,250	75
Snapper, red							1,058,650	106,128
Spanish mackerel	11,842	1,011	10,000	800	365	37		
Spot	21,750	703			10,692	328		
Squeteagues or "sea trout"	32,045	3,289	6,500	590	69 932	6,958	9,760	976
Sturgeon			7,429	2,600	7,568	2,609		
Sturgeon roe			200	160	251	191		
Crabs, hard							31,920	1,200
Shrimp	48,000	1,440						
Total	762,556	36,675	114,129	7,550	1,583,266	71,562	1,322,343	119,450

Species	Shrimp trawls		Spears		Tongs	
	Pounds	*Value*	*Pounds*	*Value*	*Pounds*	*Value*
Flounders			15,000	$1,400		
Shrimp	5,113,850	$153,418				
Oysters, market, public					1,024,037	$32,723
Oysters, market, private					91,875	7,476
Total	5,113,850	153,418	15,000	1,400	1,115,912	40,199

Fisheries by counties.—Fishing was prosecuted in the marine waters of Mobile and Baldwin Counties in Alabama during 1927. The former county was by far the most important, accounting for virtually the entire catch.

OPERATING UNITS AND CATCH: BY COUNTIES

County	Fishermen		Vessels		Motor boats	Other boats	Products	
	Regular	Casual						
	Number	*Number*	*Number*	*Net tonnage*	*Number*	*Number*	*Pounds*	*Value*
Baldwin	85	33	7	59	55	89	1,479,673	$69,790
Mobile	418	39	24	303	180	127	8,596,208	367,439
Total	503	72	31	362	235	216	10,075,881	437,229

INDUSTRIES RELATED TO THE FISHERIES

Transporting trade.—In 1927 there were 20 persons engaged in transporting the catch of fishery products in Alabama. In this trade 13 motor vessels were in operation, having a net tonnage of 112. Virtually all of these were 5 to 10 net tons in size.

Wholesale trade.—There were eight wholesale establishments in Alabama in 1927 engaged chiefly in handling fresh and frozen fishery products. These employed 81 persons, who received $40,073 in salaries and wages.

Prepared and by-products trade.—Seven establishments were engaged in canning and curing fishery products and in the manufacture of fishery by-products. These employed 302 persons, who received $153,755 in salaries and wages. The products (mostly canned oysters and shrimp) were valued at $831,405. Detailed statistics of most of these items may be obtained from Fishery Industries of the United States, 1927, Bureau of Fisheries Document No. 1050.

Industries related to the fisheries of Alabama, 1927

TRANSPORTING

Items	Number
Men on transporting vessels	20
Transporting vessels (motor):	
5 to 10 tons	11
11 to 20 tons	2
Total	13
Net tonnage	112

WHOLESALE FISHERY TRADE

Items	Number
Establishments	8
Persons engaged:	
Proprietors or managers	12
Salaried employees	18
Wage earners	51
Paid to salaried employees	$18,954
Paid to wage earners	$21,119

PREPARED FISHERY PRODUCTS AND BY-PRODUCTS

Items	Number	Products	Quantity	Value
Establishments	7	Canned:		
Persons engaged:		Oysters.....standard cases [1]	23,032	$119,052
Proprietors or managers	19	Shrimp:		
Salaried employees	16	Dry pack.....do	81,040	489,822
Wage earners	267	Wet pack.....do	28,411	167,294
Salaries paid	$34,540	Oyster shell products: Poultry		
Wages paid	$119,215	feed.....tons	5,938	49,480
		Other products [2]		5,757
Total salaries and wages paid	$153,755	Total		831,405

[1] A standard case contains 4 dozen 5-ounce cans in the dry pack or 4 dozen 5¾-ounce cans in the wet pack of shrimp, or 4 dozen 5-ounce cans of oysters.
[2] Includes lime and salted mullet.

MISSISSIPPI

The fisheries and related fishery industries of Mississippi employed 3,763 persons in 1927, which is 8 per cent more than the number employed in 1923. Of the total, 2,291 were fishermen, 10 were employed on transporting vessels, 365 in the wholesale trade, and 1,097 in the prepared-products and by-products industries.

The catch amounted to 34,503,248 pounds, valued at $1,259,329. This is 18 per cent of the total production of the Gulf fisheries, and is an increase of 38 per cent in amount and 28 per cent in value compared with the catch and its value for 1923. Of the total value of the catch, oysters accounted for 53 per cent, shrimp 25 per cent, mullet 6 per cent, and crabs 5 per cent. Of the total production, oysters accounted for 55 per cent, shrimp 27 per cent, crabs 7 per cent, and mullet 7 per cent.

Operating units.—The catch of fishery products in Mississippi during 1927 was taken by 2,291 fishermen, who used 1,123 motor and row boats, 41 motor vessels, 100 sailing vessels, and 9 types of gear. The motor and sailing vessels had a combined net tonnage of 1,951.

Fisheries of Mississippi, 1927

OPERATING UNITS: BY GEAR

Items	Haul seines	Trammel nets	Lines	Cast nets	Dip nets	Shrimp trawls
Fishermen:						
On boats or shore—						
Regular	164	114	275	5		530
Casual			2	63	5	
On vessels	84	4	14			222
Total	248	118	291	68	5	752
Boats:						
Motor	31	44	45			265
Other	31	84	198	31	4	
Vessels:						
Motor—						
5 to 10 tons	2	1	1			18
11 to 20 tons	2		1			11
21 to 30 tons						1
Total	4	1	2			30
Net tonnage	48	10	23			314
Sail—						
5 to 10 tons	2					9
11 to 20 tons	6					16
21 to 30 tons						2
31 to 40 tons						1
Total	8					28
Net tonnage	112					394
Grand total	12	1	2			58
Net tonnage	160	10	23			708
Accessory motor boats	1					
Accessory rowboats		4				
Apparatus:						
Number	43	93	474	37	175	323
Length, yards	13,850					
Square yards		31,939				
Yards at mouth						5,241
Hooks, snoods, or baits			49,729			

Fisheries of Mississippi, 1927—Continued

OPERATING UNITS: BY GEAR—Continued

Items	Dredges	Tongs	Spears	By hand	Total, exclusive of duplication
Fishermen:					
On boats or shore—					
Regular	163	603	8	10	1,447
Casual			109	75	213
On vessels	568				631
Total	731	603	117	85	2,291
Boats:					
Motor	22	54			423
Other	20	504			700
Vessels:					
Motor—					
5 to 10 tons	16				26
11 to 20 tons	9				14
21 to 30 tons	1				1
Total	25				41
Net tonnage	262				422
Sail—					
5 to 10 tons	18				20
11 to 20 tons	68				71
21 to 30 tons	7				7
31 to 40 tons	1				1
41 to 50 tons	1				1
Total	95				100
Net tonnage	1,464				1,529
Grand total	120				141
Net tonnage	1,726				1,951
Accessory motor boats					1
Accessory rowboats					4
Apparatus:					
Number	161	423	117		
Yards at mouth	517				

Catch by gear.—Four types of gear caught 87 per cent of the catch of the marine fishery products taken in Mississippi during 1927. Listed in order of importance they are dredges, which accounted for 44 per cent of the catch; shrimp trawls, 23 per cent; tongs, 11 per cent; and lines, 9 per cent. The catch by dredges was made up entirely of oysters; that of shrimp trawls, entirely of shrimp; that of tongs, almost entirely of oysters; and that of lines consisted mainly of hard crabs, with large quantities of squeteagues and red snapper.

Fisheries of Mississippi, 1927

CATCH: BY GEAR

Species	Haul seines		Trammel nets		Lines		Cast nets	
	Pounds	*Value*	*Pounds*	*Value*	*Pounds*	*Value*	*Pounds*	*Value*
Angelfish or spadefish			2, 250	$90				
Bluefish	12, 300	$738	18, 050	1, 083				
Blue runner or hardtail			300	15				
Butterfish			300	10				
Cabio			450	25				
Catfish	9, 600	388	39, 000	1, 251	12, 150	$416		
Croakers	6, 250	184	15, 300	481	29, 400	882		
Drum, black	21, 920	1, 235	47, 250	1, 850	25, 950	887		
Drum, red, or redfish	36, 466	2, 477	149, 950	13, 228	39, 300	4, 186	11, 200	$1, 120
Flounders	10, 480	1, 048	20, 350	2, 110	9, 300	950	11, 800	1, 180
Groupers					38, 185	1, 145		
Jewfish					7, 500	225		
King whiting or "kingfish"	2, 300	135						
Mullet	1, 032, 496	28, 816	1, 292, 250	41, 887			38, 400	1, 302
Pompano	3, 160	474	2, 550	471	750	166		
Sea bass	500	50	6, 300	737	12, 100	1, 392		
Sheepshead	34, 490	2, 099	70, 350	5, 370	22, 000	2, 198	17, 400	1, 842
Snapper, red					218, 706	19, 099		
Spanish mackerel	5, 970	597	3, 825	410	1, 900	240		
Spot			4, 550	144	19, 000	570		
Squeteagues	37, 700	3, 820	308, 630	32, 337	249, 100	20, 961	10, 000	1, 108
Crabs, hard					2, 411, 680	61, 370		
Shrimp	1, 195, 930	38, 356						
Terrapin	1, 600	400						
Total	2, 411, 162	80, 817	1, 981, 655	101, 499	3, 097, 021	114, 687	88, 800	6, 552

Species	Dip nets		Shrimp trawls		Dredges	
	Pounds	*Value*	*Pounds*	*Value*	*Pounds*	*Value*
Crabs, hard	14, 400	$720				
Shrimp			8, 038, 527	$280, 227		
Oysters, market:						
Public, Mississippi					2, 536, 450	$97, 073
Private, Louisiana					12, 587, 092	374, 791
Total	14, 400	720	8, 038, 527	280, 227	15, 123, 542	471, 864

Species	Tongs		Spears		By hand	
	Pounds	*Value*	*Pounds*	*Value*	*Pounds*	*Value*
Flounders			41, 000	$4, 100		
Crabs, soft					8, 400	$1, 800
Terrapin	3, 600	$900			3, 600	900
Oysters, market:						
Public, Mississippi	3, 277, 288	171, 480				
Private, Mississippi	414, 253	23, 783				
Total	3, 695, 141	196, 163	41, 000	4, 100	12, 000	2, 700

Fisheries by counties.—Fishing was prosecuted in the marine waters of Harrison, Jackson, and Hancock Counties in Mississippi during 1927. The first was by far the most important, accounting for virtually the entire catch.

Fisheries of Mississippi, 1927

OPERATING UNITS AND CATCH: BY COUNTIES

County	Fishermen		Vessels		Motor boats	Other boats	Products	
	Regular	Casual						
	Number	*Number*	*Number*	*Net tonnage*	*Number*	*Number*	*Pounds*	*Value*
Hancock	67	15			17	43	608,000	$30,626
Harrison	1,736	168	137	1,912	340	510	29,185,197	1,054,405
Jackson	275	30	4	39	66	147	4,710,051	174,298
Total	2,078	213	141	1,951	423	700	34,503,248	1,259,329

INDUSTRIES RELATED TO THE FISHERIES

Transporting trade.—In 1927 there were 10 persons engaged in transporting the catch of fishery products in Mississippi. In this trade one motor vessel and four sail vessels were in operation. These vessels had a combined net tonnage of 83.

Wholesale trade.—There were 27 wholesale establishments in Mississippi during 1927 engaged chiefly in handling fresh and frozen fishery products. Of the total, 20 were located in Harrison County and 7 in Jackson and Hancock Counties. These establishments employed 365 persons, who received $153,007 in salaries and wages.

Prepared and by-products trade.—There were 24 establishments in Mississippi during 1927 engaged in canning and curing fishery products and in the manufacture of fishery by-products. These employed 1,097 persons, who received $457,188 in salaries and wages. The products, which were principally canned shrimp and oysters and oyster-shell products, were valued at $2,285,576. This is 28 per cent of the total production of prepared fishery products and by-products manufactured in the Gulf States, thereby making the State second in importance among these States in this trade. Detailed statistics of most of the items manufactured may be obtained from Fishery Industries of the United States, 1927, Bureau of Fisheries Document No. 1050.

In addition to the above, 222,779 pounds of salted mullet, valued at $11,139, were prepared by fishermen.

Industries related to the fisheries of Mississippi, 1927

TRANSPORTING

Items	Number
Men on transporting vessels	10
Transporting vessels:	
Motor	1
Net tonnage	22
Sail—	
5 to 10 tons	2
11 to 20 tons	1
31 to 40 tons	1
Total	4
Net tonnage	61
Grand total	5
Net tonnage	83

Industries related to the fisheries of Mississippi, 1927—Continued

WHOLESALE FISHERY TRADE

Items	Harrison	Jackson and Hancock	Total
Establishments	20	7	27
Persons engaged:			
Proprietors or managers	23	8	31
Salaried employees	24	5	29
Wage earners	216	89	305
Paid to salaried employees	$19,431	$5,930	$25,361
Paid to wage earners	$91,214	$36,432	$127,646

PREPARED FISHERY PRODUCTS AND BY-PRODUCTS

Items	Number	Items	Amount
Establishments	24	Salaries paid	$82,780
Persons engaged:		Wages paid	374,408
Proprietors or managers	44		
Salaried employees	68	Total salaries and wages paid	457,188
Wage earners	985		

Products [1]	Quantity	Value	Products [1]	Quantity	Value
Canned:			Oyster shell products:		
Oysters..standard cases [2]	229,800	$1,217,538	Poultry feed........tons	22,686	201,254
Shrimp—			Lime........do	1,476	1,554
Dry pack......do	56,225	336,782	Other products [3]		14,301
Wet pack......do	87,246	514,147	Total		2,285,576

[1] In addition to the products shown here, 222,779 pounds of mullet, valued at $11,139, were salted by the fishermen.
[2] A standard case contains 4 dozen 5-ounce cans of oysters, 4 dozen 5-ounce cans in the dry pack, or 4 dozen 5¾-ounce cans in the wet pack of shrimp.
[3] Includes shrimp bran and salted mullet.

LOUISIANA

During 1927 the fisheries of Louisiana were second in importance among the States prosecuting fishing in the Gulf of Mexico. Its fisheries and related fishery industries employed 7,108 persons, which is 49 per cent greater than the number employed in 1923 and 47 per cent of the total persons employed in the Gulf fisheries in 1927. Of the total, 5,167 were fishermen, 55 were employed on transporting vessels, 303 in the wholesale trade, and 1,583 in the prepared-products and by-products industries.

The catch amounted to 56,208,309 pounds, valued at $2,863,497. This is 29 per cent of the total production of the Gulf fisheries in 1927 and is an increase of 61 per cent in amount and 46 per cent in value compared with the catch and its value for 1923. Of the total value of the catch, shrimp accounted for 49 per cent, oysters 38 per cent, crabs 3 per cent, and squeteagues or "sea trout" 3 per cent. Of the total production shrimp accounted for 72 per cent, oysters 21 per cent, crabs 2 per cent, and squeteagues or "sea trout" 1 per cent.

Operating units.—The catch of fishery products in Louisiana during 1927 was taken by 5,167 fishermen, who used 2,216 motor and row boats, 175 motor vessels with a net tonnage of 1,222, and 7 types of gear.

Fisheries of Louisiana, 1927

OPERATING UNITS: BY GEAR

Items	Haul seines	Trammel nets	Lines	Dip nets	Shrimp trawls	Dredges	Tongs	Total, exclusive of duplication
Fishermen:								
On boats or shore—								
Regular	1,907	230	361	144	1,494	19	633	4,338
Casual	132	6	69	10	6		88	309
On vessels	8	2			198	123	284	520
Total	2,047	238	430	154	1,698	142	1,005	5,167
Boats:								
Motor	262	113	232	10	750	3	254	1,507
Other	352	4	121	134		3	171	709
Vessels (motor):								
5 to 10 tons	1				83	21	86	160
11 to 20 tons		1			6	9	5	15
Total	1	1			89	30	91	175
Net tonnage	6	14			586	285	612	1,222
Apparatus:								
Number	438	116	506	6,615	839	36	990	
Length, yards	63,526							
Square yards		25,327						
Yards at mouth					10,489	39		
Hooks, snoods, or baits			125,580					

Catch by gear.—Three types of gear caught 91 per cent of the catch of marine fishery products in Louisiana during 1927. Listed in order of importance they are shrimp trawls, which accounted for 59 per cent of the catch; haul seines, 16 per cent; and tongs, 16 per cent.

The catch of shrimp trawls was made up almost entirely of shrimp; that of haul seines, almost entirely shrimp with lesser quantities of squeteagues or "sea trout," catfish, redfish or drum, and black drum; and that of tongs entirely of oysters.

Fisheries of Louisiana, 1927

CATCH: BY GEAR

Species	Haul seines		Trammel nets		Lines		Dip nets	
	Pounds	*Value*	*Pounds*	*Value*	*Pounds*	*Value*	*Pounds*	*Value*
Bluefish			5,500	$590				
Catfish	545,556	$26,568	228,270	11,141	10,200	$714		
Croaker	91,290	3,906	94,352	3,984				
Drum, black	103,052	3,991	78,955	2,846				
Drum, red, or redfish	381,158	39,126	174,753	18,037				
Flounders	34,158	3,538	8,747	912				
Groupers					16,000	640		
Mullet	78,950	3,258	53,450	2,206				
Pompano	5,192	592	5,163	606				
Sea gar	10,000	600						
Sheepshead	99,308	10,275	83,307	8,534				
Snapper, red					72,000	7,920		
Spanish mackerel	14,992	1,524	8,485	887				
Spot	39,700	1,992	19,300	844				
Squeteagues or "sea trout"	569,543	58,764	252,887	26,579				
Yellowtail	4,500	220	2,000	80				
Crabs, hard	5,000	675			996,100	41,513	89,400	$8,680
Crabs, soft							136,960	48,179
Shrimp	7,111,684	249,257						
Terrapin	76,090	18,267						
Total	9,170,173	422,613	1,015,169	77,246	1,094,300	50,787	226,360	56,859

Fisheries of Louisiana, 1927—Continued

CATCH; BY GEAR—Continued

Species	Shrimp trawls		Dredges		Tongs	
	Pounds	*Value*	*Pounds*	*Value*	*Pounds*	*Value*
Shrimp	33,147,456	$1,157,109				
Turtles	21,000	1,050				
Oysters, market, public			414,750	$38,588	1,350,300	$119,600
Oysters, market, private			2,265,928	217,806	7,502,873	721,839
Total	33,168,456	1,158,159	2,680,678	256,394	8,853,173	841,439

Fisheries by parishes.—Fishing was prosecuted in the marine waters of 15 parishes of Louisiana in 1927. From the standpoint of the value of the catch, La Fourche Parish was most important, accounting for 21 per cent of the catch and 20 per cent of the value. Terrebonne Parish followed closely, accounting for 20 per cent of the catch and 20 per cent of the value. Orleans Parish was third, accounting for 16 per cent of the catch and 17 per cent of the value. Other parishes whose fisheries were important were Jefferson, Plaquemines and St. Bernard.

Fisheries of Louisiana, 1927

OPERATING UNITS AND CATCH: BY PARISHES

Parish	Fishermen		Vessels		Motor boats	Other boats	Products	
	Regular	Casual						
	Number	*Number*	*Number*	*Net tonnage*	*Number*	*Number*	*Pounds*	*Value*
Ascension	8				3		67,200	$7,200
Calcasieu		2				2	4,200	294
Cameron	6	15			3	6	67,160	5,756
Iberia	26	6	1	14	12	5	212,900	15,479
Jeff Davis	2	10			1	10	24,650	1,928
Jefferson	986	40	6	45	274	111	10,179,055	386,722
Lafayette	5		1	15			21,000	1,800
La Fourche	816	20	55	360	270	48	11,939,658	579,280
Orleans	716		17	140	182	95	8,946,057	499,952
Plaquemines	660		25	168	171	84	6,459,668	364,952
St. Bernard	530				188	126	4,069,782	226,161
St. Mary	163	20	14	119	60	42	2,460,641	157,897
St. Tammany	76		2	22	9	37	214,700	40,145
Terrebonne	860	144	54	339	312	137	11,376,746	568,187
Vermilion	4	52			22	6	164,892	7,744
Total	4,858	309	175	1,222	1,507	709	56,208,309	2,863,497

INDUSTRIES RELATED TO THE FISHERIES

Transporting trade.—During 1927 there were 55 persons engaged in transporting the catch of fishery products in Louisiana. In this trade 26 motor and 1 sail vessel were in operation. These vessels had a net tonnage of 289. Motor vessels with a net tonnage of 5 to 10 were in most general use.

Wholesale trade.—There were 32 wholesale establishments in Louisiana during 1927 engaged chiefly in handling fresh and frozen fishery products. Sixteen of these were in Orleans Parish, in which the city of New Orleans is situated. There were 303 persons employed in all the wholesale establishments in Louisiana, who received $218,501 in salaries and wages.

Prepared and by-products trade.—There were 45 establishments in Louisiana during 1927 engaged in canning and curing fishery products and in the manufacture of fishery by-products. These employed 1,583 persons, who received $614,535 in salaries and wages. The products, which were principally canned shrimp and oysters and oyster-shell products, were valued at $3,720,935. This is 46 per cent of the total production of prepared fishery products and by-products in the Gulf States, thereby making Louisiana first in importance among these States in this trade. Detailed statistics of most of the items manufactured may be obtained from "Fishery Industries of the United States, 1927," Bureau of Fisheries Document No. 1050.

In addition to the above, 15,264 pounds of dried shrimp, valued at $3,816, were prepared by fishermen.

Industries related to the fisheries of Louisiana, 1927

TRANSPORTING

Items	Number
Men on transporting vessels	55
Transporting vessels:	
Motor—	
5 to 10 tons	18
11 to 20 tons	6
21 to 30 tons	1
41 to 50 tons	1
Total	26
Net tonnage	273
Sail	1
Net tonnage	16
Grand total	27
Net tonnage	289

WHOLESALE FISHERY TRADE

Items	Jefferson and St. Bernard	Orleans	St. Mary and Iberia	Terrebonne	Total
Establishments	5	16	3	8	32
Persons engaged:					
Proprietors or managers	5	33	7	9	54
Salaried employees	6	48	4	20	78
Wage earners	5	93	17	56	171
Paid to salaried employees	$6,130	$49,744	$3,959	$20,992	$80,825
Paid to wage earners	$4,536	$90,862	$11,172	$31,106	$137,676

PREPARED FISHERY PRODUCTS AND BY-PRODUCTS

Items	Number	Items	Amount
Establishments	45	Salaries paid	$128,026
Persons engaged:		Wages paid	486,509
Proprietors or managers	56		
Salaried employees	100	Total salaries and wages paid	614,535
Wage earners	1,427		

Products [1]	Quantity	Value	Products [1]	Quantity	Value
Canned:			Oyster-shell products—Con.		
Oysters, standard cases [2]	27,047	$136,052	Lime, tons	2,067	$5,175
Shrimp—			Shrimp bran, do	1,368	42,976
Dry pack, do	147,280	903,722	Dried shrimp, do	653	327,948
Wet pack, do	211,336	1,222,937			
Oyster-shell products:			Total		3,720,935
Poultry feed, tons	123,183	1,082,125			

[1] In addition to these products, 15,264 pounds of shrimp, valued at $3,816, were dried by the fishermen.
[2] A standard case contains 4 dozen 5-ounce cans of oysters, 4 dozen 5-ounce cans in the dry pack, or 4 dozen 5¾-ounce cans in the wet pack of shrimp.

NOTE.—One of the above firms also handles fresh and frozen fishery products.

TEXAS

The fisheries and related fishery industries of Texas during 1927 employed 2,658 persons, which is 27 per cent greater than the number employed in 1923 and is 18 per cent of the total persons in the Gulf fisheries in 1927. Of the total, 1,690 were fishermen, 482 were employed in the wholesale trade, and 486 in the prepared-products and by-products industries.

The catch amounted to 21,083,157 pounds, valued at $1,054,300. This is 11 per cent of the total production of the Gulf fisheries in 1927 and is an increase of 8 per cent in amount and 35 per cent in value compared with the catch and its value for 1923. Of the total value of the catch, shrimp accounted for 35 per cent, oysters 18 per cent, squeteagues or "sea trout" 16 per cent, redfish or red drum 11 per cent, and red snapper 10 per cent. Of the total production, shrimp accounted for 56 per cent, oysters 13 per cent, squeteagues or "sea trout" 8 per cent, and black drum 7 per cent.

Operating units.—During 1927 the catch of fishery products in Texas was taken by 1,690 fishermen, 841 motor and row boats, 40 motor vessels, 5 sail vessels, and 9 types of gear. The motor and sail vessels had a combined net tonnage of 603.

Fisheries of Texas, 1927

OPERATING UNITS: BY GEAR

Items	Haul seines	Gill nets	Trammel nets	Lines	Dip nets
Fishermen:					
On boats or shore—	*Number*	*Number*	*Number*	*Number*	*Number*
Regular	448	120	102	80	32
Casual	151	33	24	158	6
On vessels	10		4	89	
Total	609	153	130	327	38
Boats:					
Motor	50	57	62	82	
Other	238	69	30	152	28
Vessels:					
Motor—					
5 to 10 tons	2		1	3	
11 to 20 tons				4	
41 to 50 tons				2	
Total	2		1	9	
Net tonnage	10		7	178	
Sail—					
5 to 10 tons			1		
31 to 40 tons				1	
51 to 60 tons				1	
71 to 80 tons				1	
Total			1	3	
Net tonnage			6	178	
Grand total	2		2	12	
Net tonnage	10		13	356	
Apparatus:					
Number	118	509	66	1,008	200
Length, yards	23,171				
Square yards		78,861	26,096		
Hooks, snoods, or baits				32,293	

Fisheries of Texas, 1927—Continued

OPERATING UNITS: BY GEAR—Continued

Items	Shrimp trawls	Dredges	Tongs	Spears	By hand	Total, exclusive of duplication
Fishermen:						
On boats or shore—	*Number*	*Number*	*Number*	*Number*	*Number*	*Number*
Regular	428	99	288	77	6	1,139
Casual		15	30	53		391
On vessels	60	14	10			160
Total	488	128	328	130	6	1,690
Boats:						
Motor	211	46	66	23		400
Other			178	38		441
Vessels:						
Motor—						
5 to 10 tons	23	6	3			29
11 to 20 tons	5	1	1			9
41 to 50 tons						2
Total	28	7	4			40
Net tonnage	225	61	31			413
Sail—						
5 to 10 tons			1			2
31 to 40 tons						1
51 to 60 tons						1
71 to 80 tons						1
Total			1			5
Net tonnage			6			190
Grand total	28	7	5			45
Net tonnage	225	61	37			603
Apparatus:						
Number	239	61	276	130		
Yards at mouth	3,437	63				

Catch by gear.—Three types of gear caught 79 per cent of the catch of marine fishery products in Texas during 1927. Listed in order of importance they are shrimp trawls, which accounted for 56 per cent of the catch; haul seines, 14 per cent; and lines, 9 per cent.

The catch by shrimp trawls consisted almost entirely of shrimp; that of haul seines, mainly of black drum, squeteagues or "sea trout," and redfish or red drum; and that of lines, mainly of red snapper, with lesser quantities of squeteagues, Spanish mackerel, and redfish or red drum.

Fisheries of Texas, 1927

CATCH: BY GEAR

Species	Haul seines		Gill nets		Trammel nets		Lines	
	Pounds	*Value*	*Pounds*	*Value*	*Pounds*	*Value*	*Pounds*	*Value*
Angelfish or spadefish	520	$29						
Bluefish	235	47					325	$65
Buffalofish	15,000	450						
Catfish	35,590	1,463	19,975	$845	68,745	$4,041	27,360	1,267
Croaker	83,483	2,668	6,245	251	9,210	430	5,160	185
Drum, black	1,182,798	35,957	161,332	5,165	61,990	1,977	26,235	1,042
Drum, red, or redfish	631,571	52,835	223,117	20,857	302,900	35,064	90,600	9,199
Flounders	6,150	605	340	58	1,550	243	2,590	279
Groupers							37,251	1,630
Jewfish							11,175	614
Kingfish or "king mackerel"							10,130	545
King whiting or "kingfish"	12,365	602	795	46	1,700	92	4,005	241
Mullet	3,100	140	400	22	1,925	100		
Pigfish			90	5	850	52		
Pompano	2,875	574	600	148	735	147	1,210	303
Red snapper							1,237,306	100,095
Sergeantfish or snook	90,625	5,452	17,980	1,079	7,500	450	550	33
Sheepshead	23,383	1,105	4,390	315	15,165	1,477	5,095	326
Spanish mackerel	1,730	328					142,550	14,340
Squeteagues or "sea trout"	818,204	73,274	293,120	30,169	421,120	53,223	167,530	16,937
Tuna or horse mackerel	520	26						
Crabs, hard							36,800	3,140
Shrimp	76,500	2,000						
Total	2,984,649	177,555	728,384	58,960	893,390	97,296	1,805,872	150,841

Species	Dip nets		Shrimp trawls		Dredges	
	Pounds	*Value*	*Pounds*	*Value*	*Pounds*	*Value*
Crabs, hard	55,200	$3,600	28,800	$1,800		
Shrimp			11,755,533	367,418		
Turtles			1,500	60		
Oysters, market, public					1,451,394	$101,502
Oysters, market, private					8,400	660
Total	55,200	3,600	11,785,833	369,278	1,459,794	102,162

Species	Tongs		Spears		By hand	
	Pounds	*Value*	*Pounds*	*Value*	*Pounds*	*Value*
Flounders			66,950	$7,105		
Oysters, market, public	1,284,535	$86,013			8,400	$400
Oysters, market, private	10,150	1,090				
Total	1,294,685	87,103	66,950	7,105	8,400	400

Fisheries by counties.—Fishing was prosecuted in the marine waters of 13 counties of Texas during 1927. From the standpoint of value of catch Galveston County was most important, accounting for 34 per cent of the catch and 34 per cent of the value. Neuces County follows, accounting for 22 per cent of the total catch and 20 per cent of the total value. Calhoun County was third with 14 per cent of the catch and 14 per cent of the value. Other counties of importance were Aransas, San Patricio, and Matagorda.

Fisheries of Texas, 1927

OPERATING UNITS AND CATCH: BY COUNTIES

County	Fishermen		Vessels		Motor boats	Other boats	Products	
	Regular	Casual						
	Number	*Number*	*Number*	*Net tonnage*	*Number*	*Number*	*Pounds*	*Value*
Aransas	68		1	7	21	43	1,523,365	$90,429
Brazoria	8	10			4	14	42,568	3,342
Calhoun	162	33	12	92	68	49	2,994,613	147,436
Cameron	110					94	1,258,419	59,698
Chambers	4	5			2	3	28,850	2,512
Galveston	403	255	17	383	145	29	7,178,801	359,774
Harris	18	21	1	11	5	17	144,572	10,003
Jefferson	3	18	1	8		2	59,275	7,922
Matagorda	121	16	5	42	37	48	1,067,814	75,157
Nueces	325	30	5	40	80	115	4,604,517	208,998
Orange		3				3	6,000	360
Refugio	9				3	6	19,395	1,820
San Patricio	68		3	20	35	18	2,154,968	86,849
Total	1,299	391	45	603	400	441	21,083,157	1,054,300

INDUSTRIES RELATED TO THE FISHERIES

Wholesale trade.—During 1927 there were 44 wholesale establishments in Texas engaged chiefly in handling fresh and frozen fishery products. Eleven of these were in Galveston County, where the city of Galveston is situated. There were 482 persons employed in all the wholesale establishments, who received $192,462 in salaries and wages.

Prepared and by-products trade.—Ten establishments were engaged in canning and curing fishery products and in the manufacture of fishery by-products. These employed 486 persons, who received $101,943 in salaries and wages. The products, which were mainly canned oysters and shrimp, were valued at $461,443. Detailed statistics of most of these items may be obtained from Fishery Industries of the United States, 1927, Bureau of Fisheries Document No. 1050.

Industries related to the fisheries of Texas, 1927

WHOLESALE FISHERY TRADE

Items	Aransas	Calhoun	Cameron	Galveston	Harris, Jefferson, and Orange	Matagorda and Brazoria	Nueces	San Patricio	Total
Establishments	3	8	4	11	4	7	4	3	44
Persons engaged:									
Proprietors or managers	3	15	7	20	4	9	7	8	73
Salaried employees	5	15	11	22	2	13	12	4	84
Wage earners	21	73	6	111	6	77	20	11	325
Paid to salaried employees	$4,740	$11,762	$7,440	$36,425	$2,860	$11,133	$8,011	$2,640	$85,011
Paid to wage earners	$3,950	$26,408	$4,000	$41,668	$4,850	$20,413	$4,062	$2,100	$107,451

Industries related to the fisheries of Texas, 1927—Continued

PREPARED FISHERY PRODUCTS AND BY-PRODUCTS

Items	Number	Products	Quantity	Value
Establishments	10	Canned shrimp:		
Persons engaged:		Dry pack..standard cases [1]	12,257	$72,742
Proprietors or managers	22	Wet pack..........do....	49,872	328,826
Salaried employees	22	Poultry feed from crushed oyster shells.........tons..	4,026	34,215
Wage earners	442	Other products [2]		25,660
Salaries paid	$29,030			
Wages paid	$72,913			
Total salaries and wages paid	$101,943	Total		461,443

[1] A standard case contains 4 dozen 5-ounce cans in the dry pack or 4 dozen 5¾-ounce cans in the wet pack of shrimp.
[2] Includes canned oysters and lime from crushed oyster shells.

HISTORICAL REVIEW

Eleven general surveys have been made for statistics of the fisheries of the Gulf States during the 48 years from 1880 to 1927. These have not been as frequent as might be desired, but a rather clear statistical picture of the trend of the fisheries in this district is obtainable from the records, which are published in comparable form herewith. Those years for which statistical surveys have been made are used as a basis for the following discussions of the trend of individual species. It should be borne in mind, however, that in certain of those years when surveys were not made there may have been unusual fluctuations. In some of the surveys prior to 1889 the fisheries of certain States were not canvassed, and in certain of the States that were canvassed several of the species were included with "miscellaneous fish" or "all other species." For this reason totals are not usually shown prior to 1889.

Total catch.—The most recent records for the Gulf States, which are for the year 1927, show a larger catch than in any year during the period 1880 to 1927. With the exception of a slight decline in 1897, the increase has been continuous from a catch of 23,561,000 pounds in 1880 to a catch of 195,705,000 pounds in 1927.

Bluefish.—The catch of bluefish amounted to 549,000 pounds in 1889. In the following years the catch fluctuated from 265,000 pounds to 611,000 pounds until 1927, when 703,000 pounds were taken, which was a new peak for this species.

Cero and kingfish.—Due to the similarity of these species they have been combined in the accompanying statistics. The first available statistics for these species are for 1889, when 456,000 pounds were taken. A sharp decline began in 1902, and in 1908 the catch amounted to only 37,000 pounds. In more recent years the production has increased steadily, and in 1927 the catch amounted to 1,263,000 pounds, which is more than twice that in any other year for which there are records.

Crevalle.—The first available record of the catch of crevalle was for the year 1889, when 281,000 pounds were taken. The catch varied in subsequent years from 46,000 to 561,000 pounds until 1927, when 911,000 pounds were taken, this being the largest production of any year on record.

Croaker.—Statistics of the catch of croaker are not available prior to 1889. In that year 491,000 pounds were taken. The peak of the production was reached in 1908, when there was a catch of 776,000 pounds. Since 1908 the production has consistently decreased. The lowest production on record appeared in 1927, when the catch amounted to 368,000 pounds.

Drum, black.—Beginning with a production of 126,000 pounds in 1889, the first year for which statistics are available, the catch remained fairly constant until 1902, when there was a considerable increase. The largest production on record was made in 1918, when 2,010,000 pounds were taken. This was nearly five times the production of the largest preceding year's catch. The catch in 1927 amounted to 1,789,000 pounds.

Drum, red, or redfish.—The production of this species has remained comparatively constant through the period 1889 to 1927. These years mark the limits of available statistics. In 1889 the catch amounted to 2,019,000 pounds, and in 1927 it amounted to 2,872,000 pounds. The largest catch was made in 1923, when 3,133,000 pounds were taken.

Groupers.—Following a production of 446,000 pounds in 1889, this fishery decreased, and in 1890 the low mark of 428,000 pounds was reached. Following this depressed period the production climbed to 5,936,000 pounds in 1918, which is the largest production for any year for which there is a record. A catch of 4,723,000 pounds was made in 1927.

Menhaden.—Statistics for this species, which is used almost exclusively for reduction to oil and fish scrap, are available only since 1902. In that year 2,000 pounds were taken. In 1918 the catch amounted to 14,413,000 pounds, the increased production being due to the establishment of reduction plants on the Gulf coast. The peak of this fishery was reached in 1923 when 19,473,000 pound were taken. A nominal reduction was noted in 1927, when the catch amounted to 13,466,000 pounds.

Mullet.—Beginning with a catch of 2,218,000 pounds in 1880, this fishery made rapid strides in the following few years, in 1889 amounting to 15,048,000 pounds. Another large increase was effected in 1902, when 28,582,000 pounds were taken. In 1908 there was a considerable decrease in the catch, but in 1918 a catch that was in excess of that of 1902 was made. The catch in 1923, which amounted to 31,022,000 pounds, was the largest on record. There was a slight decrease in 1927, when 29,275,000 pounds were taken.

Pompano.—In 1889 the catch of pompano amounted to 483,000 pounds and remained over 400,000 pounds until 1908. The largest catch on record was made in 1902, when 487,000 pounds were taken. From 1908 to 1923 the catch fluctuated between 200,000 pounds and 300,000 pounds. A recovery was effected in 1927, when the catch amounted to 454,000 pounds.

Sheepshead.—A downward trend is noted in this fishery since 1889, when the first complete catch records were obtained. In that year the catch amounted to 1,819,000 pounds. The largest production, 2,075,000 pounds, was made in 1902. The catch in 1927 amounted to 1,102,000 pounds, which is the smallest catch of any year on record.

Red snapper.—Starting with a catch of 3,792,000 pounds in 1889, there was a continuous increase, according to available records, until 1902, when the largest catch on record was made, amounting to 13,608,000 pounds. In the intervening years until 1927 comparatively small fluctuations were noticeable. In the latter year the production amounted to 11,900,000 pounds.

Spanish mackerel.—The first available records are for the year 1889, when a smaller catch than that of any succeeding year was registered. It amounted to 635,000 pounds. Increases have been virtually continuous, the catch in 1927 amounting to 4,771,000 pounds, which has been unprecedented.

Squeteagues or "sea trout."—No records prior to 1889 are available. In that year the production amounted to 2,983,000 pounds. Since that time there has been a consistent upward trend, and the production in 1927, which amounted to 5,828,000 pounds, was the largest that has yet been reported in the Gulf district.

Sturgeon.—The Gulf States comprise primarily a salt-water fishing district, and the catch of fresh-water species, such as sturgeon, is small. In 1897, which is the first year for which statistics are available, the catch amounted to 9,000 pounds. In 1902 there occurred an exceptional increase, 349,000 pounds being taken. In 1908 the production fell to 7,000 pounds and remained practically constant until 1927, when 23,000 pounds were taken, which is the largest production of any year with the exception of 1902.

Crabs.—In the years from 1889 to and including 1908 the production of crabs fluctuated between 1,200,000 pounds and 1,800,000 pounds. Catches of between 800,000 pounds and 1,000,000 pounds were made in the years 1918 to 1923. By far the largest catch on record was registered in 1927, when 3,884,000 pounds were taken.

Shrimp.—As the most important single fishery, the catch of shrimp has consistently increased during the past 31 years from a production of 6,792,000 pounds in 1897 to 68,876,000 pounds in 1927. During the eight years prior to 1897 the catch had remained comparatively constant.

Sea crawfish or spiny lobster.—The first available statistics for sea crawfish are for 1897, when 158,000 pounds were taken. Only about one-third of this quantity was taken in 1902 and 1908. In 1918 the production amounted to 322,000 pounds, which is the largest catch recorded. In 1927 the production had declined to 131,000 pounds.

Oysters.—The oyster fishery of the Gulf States is second in importance only to that for shrimp. Starting with a production of 19,425,000 pounds in 1889, there was an upward trend until 1908, when the production amounted to 44,403,000 pounds. In the years following, until 1918, the trend was downward. In 1923 a slight recovery was made, and in 1927 the production had climbed to 36-013,000 pounds.

Sponges.—Beginning with a production of 207,000 pounds in 1880, when the first records are available, the tendency of the production of sponges has been upward, reaching the highest point on record in 1927, when 600,000 pounds were produced.

Considered in general terms, the catches of bluefish, cero and kingfish, crevalle, black drum, groupers, menhaden, mullet, red snapper, Spanish mackerel, squeteagues or "sea trout," crabs, shrimps, oysters, and sponges have increased in size, while those of croaker, red drum, pompano, sheepshead, sturgeon, and sea crawfish have remained fairly constant. The catch of no species appears to have shown a definite downward trend.

Fisheries of the Gulf States, 1880 to 1927

[Expressed in thousands of pounds and thousands of dollars; that is, 000 omitted]

Year	Florida (west coast)		Alabama		Mississippi	
	Pounds	*Value*	*Pounds*	*Value*	*Pounds*	*Value*
1880	8,376	$565	3,542	$119	788	$23
1887	(1)	(1)	(1)	(1)	6,548	190
1888	19,597	802	1,634	76	7,883	232
1889	23,597	949	4,560	147	8,933	251
1890	27,419	1,064	4,777	155	8,131	246
1897	28,255	945	4,699	134	7,830	192
1902	48,120	1,462	9,351	267	23,427	553
1908	37,566	2,120	10,665	387	17,302	459
1918	54,754	3,420	5,609	231	20,592	763
1923	73,266	4,026	7,631	342	25,032	986
1927	73,835	4,351	10,076	437	34,503	1,259

Year	Louisiana		Texas		Total	
	Pounds	*Value*	*Pounds*	*Value*	*Pounds*	*Value*
1880	6,996	$393	3,859	$128	23,561	$1,228
1887	18,455	580	6,282	256	(1)	(1)
1888	19,121	613	6,609	271	54,844	1,994
1889	20,947	621	7,358	297	65,395	2,265
1890	20,789	660	7,959	314	69,075	2,439
1897	17,402	714	7,175	287	65,301	2,272
1902	24,754	858	8,044	354	113,696	3,494
1908	42,302	1,448	10,439	446	118,274	4,860
1918	24,954	1,419	25,015	677	130,924	6,510
1923	34,835	1,961	19,560	782	160,324	8,097
1927	56,208	2,863	21,083	1,054	195,705	9,964

CATCH OF CERTAIN SPECIES: BY STATES

[Expressed in thousands of pounds; that is, 000 omitted]

Year	Bluefish						Cero and kingfish or "king mackerel"		
	Florida (west coast)	Alabama	Mississippi	Louisiana	Texas	Total	Florida (west coast)	Texas	Total
1880	44								
1887	(1)	(1)	73	13	7		(1)		
1888	(1)		78	15	6		(1)		
1889	364	58	90	13	24	549	456		456
1890	420	56	96	13	26	611	292		292
1897	265					265	440		440
1902	353					353	152		152
1908	580					580	37		37
1918	271					271	466		466
1923	418					418	564		564
1927	620	46	30	6	1	703	1,253	10	1,263

1 Figures not available.

Fisheries of the Gulf States, 1880 to 1927—Continued

CATCH OF CERTAIN SPECIES: BY STATES—Continued

[Expressed in thousands of pounds; that is, 000 omitted]

Year	Crevalle [2]				Croaker					
	Florida (west coast)	Alabama	Texas	Total	Florida (west coast)	Alabama	Mississippi	Louisiana	Texas	Total
1887	(1)	(1)	63	-----	(1)	(1)	[3] 75	[3] 54	107	-----
1888	(1)	-----	60	-----	(1)	-----	[3] 79	[3] 55	110	-----
1889	185	44	52	281	36	103	54	150	148	491
1890	333	41	56	430	43	98	57	158	176	532
1897	46	-----	-----	46	-----	(1)	(1)	(1)	(1)	-----
1902	85	-----	-----	85	-----	58	273	155	58	544
1908	227	-----	-----	227	-----	72	176	369	159	776
1918	561	-----	-----	561	-----	94	41	383	198	716
1923	508	-----	-----	508	-----	37	45	219	68	369
1927	907	4	-----	911	45	27	51	186	104	308

Year	Drum, black						Drum, red, or redfish					
	Florida (west coast)	Alabama	Mississippi	Louisiana	Texas	Total	Florida (west coast)	Alabama	Mississippi	Louisiana	Texas	Total
1887	(1)	(1)	2	-----	-----	-----	(1)	(1)	141	289	1,005	-----
1888	(1)	-----	2	-----	-----	-----	(1)	-----	165	288	944	-----
1889	102	7	2	11	4	126	393	64	185	314	1,063	2,019
1890	122	7	3	18	4	154	458	54	201	339	1,108	2,160
1897	38	6	5	19	50	118	236	213	199	465	1,144	2,257
1902	194	5	12	51	157	419	1,104	70	93	442	898	2,607
1908	-----	-----	-----	-----	-----	-----	[4] 608	[4] 151	[4] 244	[4] 716	[4] 1,309	3,028
1918	57	12	14	54	1,873	2,010	958	23	116	566	1,337	3,000
1923	95	9	39	60	1,028	1,231	1,398	15	177	605	878	3,133
1927	70	10	95	182	1,432	1,789	776	55	237	556	1,248	2,872

Year	Grouper						Menhaden		
	Florida (west coast)	Alabama	Mississippi	Louisiana	Texas	Total	Florida (west coast)	Texas	Total
1880	1,764	-----	-----	-----	-----	-----	-----	-----	-----
1887	(1)	(1)	-----	-----	4	-----	(1)	-----	-----
1888	(1)	-----	-----	-----	7	-----	(1)	-----	-----
1889	418	10	-----	18	-----	446	-----	-----	-----
1890	399	11	-----	18	-----	428	-----	-----	-----
1897	781	69	-----		3	853	-----	-----	-----
1902	437	635	-----	-----	40	1,112	2	-----	2
1908	1,231	394	-----	-----	-----	1,625	-----	-----	-----
1918	5,626	244	25	20	21	5,936	295	14,118	14,413
1923	4,266	305	26	10	33	4,640	10,956	8,517	19,473
1927	4,488	144	38	16	37	4,723	13,466	-----	13,406

[1] Figures not available.
[2] Includes blue runner or jurel.
[3] Includes spots.
[4] Probably includes some black drum.

NOTE.—Prior to 1889 some of the above species were included under the heading "Miscellaneous fish" or "All other species"; therefore, the total for certain species is not shown for certain years of this period.

Fisheries of the Gulf States, 1880 to 1927—Continued

CATCH OF CERTAIN SPECIES: BY STATES—Continued

[Expressed in thousands of pounds; that is, 000 omitted]

Year	Mullet						Pompano					
	Florida (west coast)	Alabama	Mississippi	Louisiana	Texas	Total	Florida (west coast)	Alabama	Mississippi	Louisiana	Texas	Total
1880	2,028	125	2	55	8	2,218	14					
1887	(1)	(1)	233	253	31		(1)	(1)	11	30	2	
1888	(1)	262	233	253	32		(1)		12	31	2	
1889	13,348	613	722	283	82	15,048	420	18	14	29	2	483
1890	15,556	588	305	288	83	16,820	342	17	15	32	2	408
1897	15,575	600	241	166		16,582	406					406
1902	26,310	1,546	603	123		28,582	487					487
1908	16,145	1,656	1,035	133		18,969	232					232
1918	26,380	1,703	1,565	325		29,973	242					242
1923	28,454	648	1,739	181		31,022	282					282
1927	24,802	1,973	2,363	132	5	29,275	428	5	6	10	5	454

Year	Sheepshead						Snapper, red					
	Florida (west) coast)	Alabama	Mississippi	Louisiana	Texas	Total	Florida (west coast)	Alabama	Mississippi	Louisiana	Texas	Total
1880							223	360		900		
1887	(1)	(1)	124	362	695		(1)	(1)		131	75	
1888	(1)		128	366	647		(1)	86		150	65	
1889	527	33	156	364	739	1,819	3,469	51		250	22	3,792
1890	544	35	173	391	779	1,922	4,173	62		240	5	4,480
1897	663	87	110	238	468	1,566	5,314	335			465	6,114
1902	1,374	75	70	839	217	2,075	8,074	3,466			2,068	13,608
1908	473	24	81	249	298	1,125	7,659	2,635			2,252	12,546
1918	989	28	68	277	198	1,560	7,230	798	98	60	1,243	9,429
1923	1,025	21	91	193	141	1,471	9,471	970	104	175	1,009	11,729
1927	680	47	144	183	48	1,102	9,313	1,059	219	72	1,237	11,900

Year	Spanish mackerel						Squeteagues or "sea trout"					
	Florida (west coast)	Alabama	Mississippi	Louisiana	Texas	Total	Florida (west coast)	Alabama	Mississippi	Louisiana	Texas	Total
1887	(1)	(1)	30	119	11		(1)	(1)	258	524	941	
1888	(1)		34	126	11		(1)	228	280	522	872	
1889	382	58	44	134	17	635	712	205	370	619	1,077	2,983
1890	448	44	46	144	25	707	654	209	372	656	1,120	3,011
1897	503	86	65	56	41	751	830	296	453	567	1,012	3,158
1902	1,513	34	7	6	64	1,624	1,913	259	473	1,078	1,119	4,842
1908	1,419	13	7	5	42	1,446	1,207	208	517	1,103	1,055	4,090
1918	3,463	4	12	2	41	3,522	1,694	139	356	1,190	1,613	4,992
1923	3,772	1	10	3	79	3,795	1,591	49	410	783	1,524	4,357
1927	4,570	22	12	23	144	4,771	2,583	118	605	822	1,700	5,828

Year	Sturgeon			Crabs					
	Florida (west coast)	Alabama	Total	Florida (west coast)	Alabama	Mississippi	Louisiana	Texas	Total
1880							288	36	
1887	(1)	(1)		(1)	(1)	53	971	111	
1888	(1)			(1)	96	57	994	115	
1889						67	989	189	1,245
1890						47	981	191	1,219
1897	9		9	6	24	153	1,459	138	1,780
1902	349		349	13	75	265	1,312	43	1,708
1908	7		7	64	246	427	322	200	1,259
1918	5		5	24	96	225	282	194	821
1923	7		7	7	84	443	316	109	959
1927	8	15	23	70	32	2,434	1,227	121	3,884

[1] Figures not available.

Fisheries of the Gulf States, 1880 to 1927—Continued

CATCH OF CERTAIN SPECIES: BY STATES—Continued

[Expressed in thousands of pounds; that is, 000 omitted]

Year	Shrimp					
	Florida (west coast)	Alabama	Mississippi	Louisiana	Texas	Total
1880	----------	----------	----------	534	638	----------
1887	----------	(1)	1,145	6,810	255	----------
1888	(1)	44	1,093	6,943	259	----------
1889	----------	30	794	7,238	242	8,304
1890	----------	----------	614	6,662	176	7,452
1897	----------	41	1,903	4,487	361	6,792
1902	17	----------	4,424	7,635	291	12,350
1908	8	37	4,121	8,581	118	12,865
1918	3,250	1,266	9,147	18,520	164	32,347
1923	2,881	3,182	9,879	27,753	3,422	47,117
1927	2,389	5,162	9,234	40,259	11,832	68,876

Year	Sea crawfish or spiny lobster	Oysters [4]						Sponges
	Florida (west coast)	Florida (west coast)	Alabama	Mississippi	Louisiana	Texas	Total	Florida (west coast)
1880	----------	410	732	175	2,065	669	----------	207
1887	(1)	(1)	(1)	4,068	4,748	1,793	----------	(1)
1888	(1)	(1)	533	5,370	5,040	2,389	----------	254
1889	----------	2,064	3,069	5,919	5,849	2,524	19,425	317
1890	----------	2,598	3,367	5,645	5,891	3,086	20,587	367
1897	158	1,258	1,785	4,408	6,714	2,491	16,656	333
1902	56	4,057	2,432	16,836	8,389	2,402	34,116	347
1908	53	3,764	4,132	7,473	25,554	3,480	44,403	545
1911	----------	1,312	3,093	4,604	31,530	3,043	43,582	(1)
1918	322	2,616	1,032	8,907	7,855	3,344	23,754	452
1923	321	1,642	2,262	11,875	7,155	2,520	25,454	575
1927	131	1,736	1,165	18,815	11,534	2,763	36,013	600

[1] Figures not available. [4] Shown on the basis of 7 pounds of meat to the bushel.

FISHERIES OF THE PACIFIC COAST STATES

Surveys of the fisheries of the Pacific Coast States—Washington, Oregon, and California—have been made annually, beginning with the calendar year 1922. The survey for 1922 included statistics of fishing gear employed and statistics of the wholesale and prepared-products industries. Since 1922 these items have been omitted, except that statistics of the commodities prepared in the canned fishery products and by-products industries have been obtained for all years since 1922, and fishing gear is included for 1927. The statistics for 1926, as well as a summary of all statistics for this section from 1888, are published in the report of the division of fishery industries for 1927, and the 1926 statistics alone, and in condensed form in Statistical Bulletin No. 820.

There were 18,597 fishermen in the Pacific Coast States in 1926. The catch of the fishery products in that year amounted to 521,286,418 pounds, valued at $18,914,733.

The fisheries of the Pacific Coast States are especially important for the production of salmon, tuna and tunalike fishes, pilchard or sardine, and halibut. The catch in 1927 was larger than in any other year for which there is a record. The fisheries in these States gave employment to 20,514 fishermen in 1927, or 10 per cent more than in 1926. Of the total number, 4,897 were on vessels and 15,617 in the shore and boat fisheries. Their catch amounted to 651,196,982 pounds, valued at $22,306,576. This is an increase of 25 per cent in quantity and 18 per cent in value when compared with the catch and value for the year 1926. Of the total catch in 1927, there were 627,-511,658 pounds of fish, valued at $20,341,430, 18,519,394 pounds of shellfish, etc., valued at $1,638,171, and 5,165,930 pounds of whale products, valued at $326,975.

Based on the value to the fishermen, salmon, with a production of 131,792,907 pounds, valued at $9,691,887, was by far the most important of the fishery products in the Pacific Coast States. Pilchard or sardine ranked second with a production of 342,275,289 pounds, valued at $1,826,785. Other important species, the catch of which exceeded $500,000 in value, were halibut, 11,654,831 pounds, valued at $1,557,267; yellowfin tuna, 25,933,966 pounds, valued at $1,304,002; skipjack or striped tuna 33,807,011 pounds, valued at $1,260,847; barracuda 6,199,739 pounds, valued at $595,997; and albacore, 4,579,367 pounds, valued at $517,354.

Fisheries of the Pacific Coast States, 1927

OPERATING UNITS: BY STATES

Item	Washington				Oregon		
	Puget Sound district	Coastal district	Columbia River district	Total	Columbia River district	Coastal district	Total
Fishermen:							
On vessels	2,219	10		2,229	62	12	74
On boats and shore	2,154	2,582	1,944	6,680	3,230	1,268	4,498
Total	4,373	2,592	1,944	8,909	3,292	1,280	4,572
Vessels:							
Steam	2			2			
Net tonnage	16			16			
Motor	319	5		324	21	6	27
Net tonnage	6,080	46		6,126	194	49	243
Sail	3			3			
Net tonnage	1,055			1,055			
Total vessels	324	5		329	21	6	27
Total net tonnage	7,151	46		7,197	194	49	243
Boats:							
Motor	1,127	290	1,113	2,530	1,404	842	2,246
Other	283	178	35	496	37	166	203
Apparatus:							
Troll lines	1,932		544	2,476	752	233	985
Hooks	7,728		2,176	9,904	3,008	932	3,940
Trawl, set, and hand lines	27,458		57	27,515	282	108	390
Hooks	1,386,146		5,700	1,391,846	16,200	5,400	21,600
Purse seines—							
Salmon	176			176			
Yards	52,800			52,800			
Haul seines	134		49	183	49		49
Yards	11,970		16,596	28,566	28,667		28,667
Drift gill nets, salmon	396	107	559	1,062	1,042	374	1,416
Square yards	463,300	128,880	1,159,500	1,751,680	2,856,000	561,000	3,417,000
Set gill nets, salmon	18	300	314	632	240	963	1,203
Square yards	3,600	60,000	62,800	126,400	48,000	192,600	240,600
Beam trawls	31			31			
Yards at mouth	207			207			
Drag bag nets	88	1		89			
Yards	7,157	100		7,257			
Pound nets	102	258	391	751	60		60
Brush weirs	10			10			
Reef nets	9			9			
Dip nets	3		124	127	183		183
Fish wheels			34	34	20		20
Traps—							
Crab	2,080	1,575		3,655	585	1,785	2,370
Crawfish					380		380
Shovels	293	2,133		2,426	352	40	392
Tongs	107	16		123		3	3

Fisheries of the Pacific Coast States, 1927—Continued

OPERATING UNITS: BY STATES—Continued

Item	California						Grand total
	Northern district	San Francisco district	Monterey district	Southern district		Total	
				San Pedro section	San Diego section		
Fishermen:							
On vessels	50	305	49	1,699	491	2,594	4,897
On boats and shore	668	1,003	1,121	1,354	293	4,439	15,617
Total	718	1,308	1,170	3,053	784	7,033	20,514
Vessels:							
Steam		4				4	6
Net tonnage		241				241	257
Motor	20	19	6	249	108	402	753
Net tonnage	187	272	74	3,980	1,459	5,972	12,341
Sail		5				5	8
Net tonnage		1,782				1,782	2,837
Total vessels	20	28	6	249	108	411	767
Total net tonnage	187	2,295	74	3,980	1,459	7,995	15,435
Boats:							
Motor	165	566	331	716	183	1,961	6,737
Other	283	18	10	39		350	1,049
Apparatus:							
Troll lines	751	1,160	456	5,301	1,700	9,368	12,829
Hooks	3,892	5,798	2,736	5,301	1,700	19,427	33,271
Trawl, set, and hand lines	331	877	1,007	1,345	718	4,278	32,183
Hooks	40,910	117,194	126,325	300,436	109,422	694,287	2,107,733
Purse seines—							
Barracuda				25		25	25
Yards				11,075		11,075	11,075
Salmon							176
Yards							52,800
Sardine			2	71		73	73
Yards			620	27,382		28,002	28,002
Tuna				35		35	35
Yards				18,424		18,424	18,424
Haul seines	1	2		1		4	236
Yards	100	360		100		560	57,793
Lampara nets—							
Sardine		24	73	92	50	239	239
Yards		2,880	23,908	36,860	9,610	83,258	83,258
Squid			55			55	55
Yards			12,958			12,958	12,958
Drift gill nets, salmon	262	307				569	3,047
Square yards	178,815	753,685				932,500	6,101,180
Set gill nets, salmon							1,835
Square yards							367,000
Gill nets—							
Barracuda			1	54	28	83	83
Square yards			3,200	466,312	190,210	659,722	659,722
Sea bass		5	34	29	22	90	90
Square yards		12,400	119,893	150,280	116,830	399,403	399,403
Shad		261				261	261
Square yards		620,136				620,136	620,136
Striped bass		176				176	176
Square yards		373,824				373,824	373,824
Other	18	31	72	7	11	139	139
Square yards	5,250	32,395	200,576	8,000	14,246	260,467	260,467
Paranzella nets	1	9		4		14	14
Yards at mouth	17	150		60		227	227
Beam trawls		21				21	52
Yards at mouth		126				126	333
Drag bag nets							89
Yards							7,257
Pound nets							811
Brush weirs							10
Reef nets							9
Fyke nets		816				816	816
Trammel nets				42	19	61	61
Square yards				238,700	327,350	566,050	566,050
Dip nets	22					22	332
Fish wheels							54

Fisheries of the Pacific Coast States, 1927—Continued

OPERATING UNITS: BY STATES—Continued

Item	California						Grand total
	Northern district	San Francisco district	Monterey district	Southern district		Total	
				San Pedro section	San Diego section		
Apparatus—Continued.							
Traps—							
Crab	560	4,920	40			5,520	11,545
Crawfish							380
Lobster				3,370	2,540	5,910	5,910
Octopus			31			31	31
Shovels	7	16		78		101	2,919
Rakes		1	8			9	9
Tongs		6				6	132
Abalone outfits			11	5		16	16
Harpoons—							
Whale		4				4	4
Swordfish				7	8	15	15

CATCH: BY STATES

Species	Washington		Oregon		California [1]		Total	
FISH	*Pounds*	*Value*	*Pounds*	*Value*	*Pounds*	*Value*	*Pounds*	*Value*
Albacore					4,579,367	$517,354	4,579,367	$517,354
Anchovies					368,201	3,909	368,201	3,909
Barracuda					6,199,739	595,997	6,199,739	595,997
Bonito					1,716,957	49,997	1,716,957	49,997
Carp	922,337	$27,670	68,000	$2,040	63,014	1,617	1,053,351	31,327
Catfish					371,303	55,849	371,303	55,849
Cod, fresh	2,678	214					2,678	214
Cod, dry salted	2,587,255	117,000			2,746,880	186,644	5,334,135	303,644
Cod tongues	17,600	1,500					17,600	1,500
Eels					5	1	5	1
Flounders:								
"California halibut"					1,302,283	187,268	1,302,283	187,268
"Sole"	223,992	8,971	640	25	10,298,290	467,227	10,522,922	476,223
Other	97,903	2,000			1,467,982	76,317	1,565,885	78,317
Grayfish	89,707	449			324,903	5,822	414,610	6,271
Hake					84,553	2,144	84,553	2,144
Halibut	10,713,348	1,437,161	371,546	54,478	569,937	65,628	11,654,831	1,557,267
Hardhead					32,898	2,838	32,898	2,838
Herring	811,660	8,117	54,000	1,080	1,168,321	23,253	2,033,981	32,450
Horse mackerel					467,376	18,489	467,376	18,489
Kingfish					529,267	16,365	529,267	16,365
"Lingcod"	1,017,443	38,812	67,598	2,729	555,078	23,284	1,640,119	64,825
Mackerel					4,740,639	121,389	4,740,639	121,389
Mullet					39,976	3,787	39,976	3,787
Perch	59,949	3,598			262,893	13,025	322,842	16,623
Pilchard or sardine					342,275,289	1,826,785	342,275,289	1,826,785
Pompano					55,127	6,408	55,127	6,408
Rock bass					525,840	36,956	525,840	36,956
Rockfishes	476,852	20,523	44,164	1,786	6,377,179	292,631	6,898,195	314,940
Sablefish	2,784,363	183,452	335,896	15,440	992,354	43,616	4,112,613	242,508
Salmon	97,211,405	6,302,108	28,069,573	2,745,604	6,511,929	644,175	131,792,907	9,691,887
Sculpin					114,209	9,956	114,209	9,956
Sea bass:								
Black					467,595	20,787	467,595	20,787
White, or squeteague					2,273,407	217,744	2,273,407	217,744
Shad	325,701	4,886	1,516,056	22,741	4,103,423	148,201	5,945,180	175,828
Sheepshead					159,397	6,282	159,397	6,282
Skates	1,156	24			232,740	5,184	263,896	5,208
Skipjack or striped tuna					33,807,011	1,260,847	33,807,011	1,260,847
Smelt	1,334,488	29,979	412,237	4,137	965,921	55,794	2,712,646	89,910
Splittail					10,601	636	10,601	636
Squawfish					7,865	629	7,865	629
Steelhead trout	2,166,821	154,187	2,196,062	157,396			4,362,883	311,583
Striped bass			1,852	185	647,594	92,036	649,446	92,221

[1] Taken off California and off Mexico.

Fisheries of the Pacific Coast States, 1927—Continued

CATCH: BY STATES—Continued

Species	Washington		Oregon		California		Total	
FISH—continued	*Pounds*	*Value*	*Pounds*	*Value*	*Pounds*	*Value*	*Pounds*	*Value*
Sturgeon	81, 460	$4, 991	133, 377	$8, 205			214, 837	$13, 196
Suckers					1, 020	$20	1, 020	20
Swordfish					130, 288	12, 287	130, 288	12, 287
Tomcod	230	11			690	21	920	32
Tuna:								
Bluefin					4, 898, 465	311, 517	4, 898, 465	311, 517
Yellowfin					25, 933, 966	1, 304, 002	25, 933, 966	1, 304, 002
Whitebait					134, 149	11, 198	134, 149	11, 198
Whitefish					313, 102	27, 521	313, 102	27, 521
Yellowtail					4, 224, 853	195, 463	4, 224, 853	195, 463
Other fish	23, 280	499			207, 153	10, 533	230, 433	11, 032
Total	120, 949, 628	8, 340, 152	33, 271, 001	3, 015, 846	473, 291, 029	8, 979, 432	627, 511, 658	20, 341, 430
SHELLFISH, ETC.								
Crabs	1, 711, 146	125, 067	599, 852	35, 254	2, 960, 352	217, 933	5, 271, 350	378, 254
Crawfish			138, 200	17, 275			138, 200	17, 275
Sea crawfish or spiny lobster					1, 490, 958	275, 351	1, 490, 958	275, 351
Shrimp	38. 781	5, 817			1, 697, 365	28, 007	1, 736, 146	33, 824
Abalone					563, 306	112, 822	563, 306	112, 822
Clams:								
Cockle					788	608	788	608
Hard	249, 862	37, 479					249, 862	37, 479
Pismo					33, 250	15, 441	33, 250	15, 441
Razor	1, 858, 432	283, 927	164, 356	25, 110			2, 022, 788	309, 037
Soft					25, 231	12, 975	25, 231	12, 975
Mixed [1]			18, 486	7, 184	9, 700	5, 012	28, 186	12, 196
Mussels					2, 963	394	2, 963	394
Octopus	101, 796	6, 112			36, 693	3, 837	138, 489	9, 949
Oysters:								
Eastern market	113, 360	53, 060			55, 492	23, 782	168, 852	76, 842
Native market	615, 792	284, 351	2, 700	2, 250			618, 492	286, 601
Scallops	11, 065	3, 121					11, 065	3, 121
Squid					6, 014, 113	55, 734	6, 014, 113	55, 734
Trepang or sea cucumber	5, 355	268					5, 355	268
Total	4. 705, 589	799, 202	923, 594	87, 073	12, 890, 211	751, 896	18, 519, 394	1, 638, 171
WHALE PRODUCTS								
Whale oil					5, 165, 930	326, 975	5, 165, 930	326, 975
Grand total	125, 655, 217	9, 145. 354	34, 194, 595	3, 102, 919	491, 347, 170	10, 058, 303	651, 196, 982	22, 806, 576

[1] Consisted mostly of soft clams.

Fisheries of the Pacific Coast States, 1888 to 1927

[Expressed in thousands of pounds and thousands of dollars; that is, 000 omitted. Salt fish, except cod, has been converted to the equivalent of fresh fish]

Year	Washington		Oregon		California		Total	
	Quantity	*Value*	*Quantity*	*Value*	*Quantity*	*Value*	*Quantity*	*Value*
1888	23, 721	$811	26, 268	$734	41, 255	$2, 465	91, 244	$4, 010
1892	36, 706	932	28, 828	872	58, 396	3, 023	123, 928	4, 827
1895	59, 158	1, 402	38, 197	1, 284	50, 524	1, 787	147, 879	4, 473
1899	122, 085	2, 871	22, 802	856	77, 985	2, 552	222, 872	6, 279
1904	88, 954	2, 973	27, 534	1, 185	57, 024	2, 523	173, 512	6, 681
1908	100, 352	3, 513	28, 216	1, 356	46, 486	1, 970	175, 054	6, 839
1915	158, 546	5, 321	34, 693	1, 479	88, 981	2, 506	282, 220	9, 306
1922	67, 564	4, 954	22, 134	1, 256	191, 439	6, 774	281, 137	12, 984
1923	111, 261	7, 801	32, 883	3, 504	260, 804	7, 737	404, 948	19, 042
1924	89, 223	7, 123	39, 578	3, 204	344, 894	9, 725	473, 695	20, 052
1925	130, 687	9, 477	40, 008	3, 442	440, 301	11, 662	610, 996	24, 581
1926	89, 637	7, 943	32, 998	3, 068	398, 651	7, 904	521, 286	18, 915
1927	125, 655	9, 146	34, 195	3, 103	491, 347	10, 058	651, 197	22, 307

WASHINGTON

In 1927 Washington ranked second among the Pacific Coast States in the importance of its fisheries, employing 44 per cent of the total number of fishermen and accounting for 19 per cent of the total catch. There were 8,909 fishermen employed, which is 15 per cent more than in 1926. Of this total, 2,229 were employed on fishing vessels and 6,680 in the shore and boat fisheries.

The catch amounted to 125,655,217 pounds, valued at $9,145,354. This is an increase of 40 per cent in quantity and 15 per cent in the value of the catch as compared with the catch and its value in 1926. Of the total value of the catch, salmon accounted for 69 per cent, halibut 16 per cent, oysters 4 per cent, and clams 3 per cent. Of the total quantity, salmon accounted for 77 per cent, halibut 9 per cent, and sablefish, dry-salted cod, and clams each accounted for 2 per cent.

Operating units.—The catch of fishery products from Puget Sound, the coastal district of Washington, and that part of the Columbia River under the jurisdiction of Washington was taken by 8,909 fisherman, 3,026 motor and other small boats, 2 steam vessels, 324 motor vessels, 3 sailing vessels, and 14 major types of gear. The vessels had a combined capacity of 7,197 net tons.

Fisheries of Washington, 1927

CATCH: BY DISTRICTS:

Species	Puget Sound district		Coastal district		Columbia River district	
	Pounds	*Value*	*Pounds*	*Value*	*Pounds*	*Value*
FISH						
Carp					922,337	$27,670
Cod, fresh	2,678	$214				
Cod, dry-salted	2,587,255	117,000				
Cod tongues	17,600	1,500				
Flounders:						
Sole	223,992	8,971				
Other	97,903	2,000				
Grayfish	89,707	449				
Halibut	10,713,348	1,437,161				
Herring	811,660	8,117				
"Lingcod"	1,017,443	38,812				
Perch	59,949	3,598				
Rockfishes	476,852	20,523				
Sablefish	2,784,363	183,452				
Salmon:						
Blueback or sockeye	7,264,248	1,037,749	334,507	$27,876	214,631	30,048
Chinook	11,680,764	1,182,464	992,649	64,036	8,564,438	1,046,688
Chum	5,275,680	184,775	3,509,574	97,929	2,361,235	47,225
Humpback	41,370,178	1,362,620				
Silver	12,940,520	1,045,871	1,106,245	53,688	1,596,741	121,139
Shad					325,701	4,880
Skates	1,156	24				
Smelt	184,818	18,482			1,149,670	11,497
Steelhead trout	83,493	10,205	63,723	3,988	2,019,605	139,994
Sturgeon	784	118			80,676	4,873
Tomcod	230	11				
Other fish	22,739	456	541	43		
Total	97,707,355	6,664,572	6,007,239	247,560	17,235,034	1,434,020
SHELLFISH						
Crabs	479,386	32,685	1,231,760	92,382		
Shrimp	38,781	5,817				
Clams:						
Hard	249,862	37,479				
Razor			1,858,432	283,927		
Octopus	101,596	6,096	200	16		
Oysters:						
Eastern market	74,720	28,034	38,640	25,026		
Native market	582,000	274,456	33,792	9,895		
Scallops	11,065	3,121				
Trepang or sea cucumber	5,355	268				
Total	1,542,765	387,956	3,162,824	411,246		
Grand total	99,250,120	7,052,528	9,170,063	658,806	17,235,034	1,434,020

PUGET SOUND DISTRICT

The catch in this district in 1927 amounted to 99,250,120 pounds, valued at $7,052,528. Of the more important species comprising this catch, salmon amounted to 78,531,385 pounds, valued at $4,813,479; halibut, 10,713,348 pounds, valued at $1,437,161; sablefish, 2,784,363 pounds, valued at $183,452; dry-salted cod, 2,587,255 pounds, valued at $117,000; and oysters, 656,720 pounds, valued at $302,490.

Operating units.—The catch of fishery products in the Puget Sound District was taken by 4,373 fishermen, who used 1,410 motor and other small boats, 2 steam vessels, 319 motor vessels, 3 sailing vessels, and 13 major types of gear. The motor and sailing vessels had a combined capacity of 7,151 net tons.

Catch by gear.—Four types of gear accounted for 94 per cent of the fishery products taken in the Puget Sound fisheries during 1927. Listed in the order of their importance they were purse seines, which accounted for 37 per cent of the catch; pound nets, 30 per cent; trawl lines, 18 per cent; and troll lines, 9 per cent. The catch by purse seines, pound nets, and troll lines consisted almost entirely of salmon, and that by trawl lines was principally halibut, sablefish, and cod.

Fisheries of the Puget Sound district of Washington, 1927

OPERATING UNITS: BY GEAR

Items	Purse seines (salmon)	Haul seines	Beam trawls	Troll lines	Trawl, set, or hand lines	Gill nets		Pound nets
						Drift (salmon)	Set (salmon)	
Fishermen:								
On vessels	1,412	53	37	94	765	12		
On boats and shore	5	230	34	533	64	543	18	197
Total	1,417	283	71	627	829	555	18	197
Vessels:								
Steam			2					
Net tonnage			16					
Motor	175	19	12	44	103	6		
Net tonnage	3,886	269	145	320	2,002	42		
Sail					3			
Net tonnage					1,055			
Total vessels	175	19	14	44	106	6		
Total net tonnage	3,886	269	161	820	3,057	42		
Boats:								
Motor	1	67	17	428	18	390		81
Other	1	48			46		18	
Apparatus:								
Number	176	134	31	1,932	27,458	396	18	102
Length, yards	52,800	11,970						
Square yards						463,300	3,600	
Yards at mouth			207					
Hooks				7,728	1,386,146			

Fisheries of the Puget Sound district of Washington, 1927—Continued

OPERATING UNITS: BY GEAR—Continued

Items	Brush weirs	Reef nets	Drag bag nets	Dip nets	Traps, crab	Shovels	Tongs	Total, exclusive of duplication
Fishermen:								
On vessels			37		27			2,219
On boats and shore	12	18	150	3	120	293	107	2,154
Total	12	18	187	3	147	293	107	4,373
Vessels:								
Steam								2
Net tonnage								16
Motor			13		10			319
Net tonnage			227		174			6,080
Sail								3
Net tonnage								1,055
Total vessels			13		10			324
Total net tonnage			227		174			7,151
Boats:								
Motor	6	9	55	3	94		15	1,127
Other			20				165	283
Apparatus:								
Number	10	9	88	3	2,080	293	107	
Length, yards			7,157					

CATCH: BY GEAR

Species	Purse seines		Haul seines		Beam trawls		Troll lines	
FISH	*Pounds*	*Value*	*Pounds*	*Value*	*Pounds*	*Value*	*Pounds*	*Value*
Cod, fresh					2,523	$202		
Flounders:								
"Sole"	55	$2	5,638	$226	214,721	8,589		
Other	150	3	12,811	256	80,799	1,658		
Grayfish			42,000	210				
Halibut	32	1						
Herring			276,665	2,767				
"Lingcod"	325	10	1,829	55	3,205	96		
Perch			45,376	2,722	391	24		
Rockfishes	278	20	7,248	507	6,405	448		
Salmon:								
Blueback or sockeye	3,399,851	485,693	42,707	6,101			707	$101
Chinook	554,140	56,333	29,326	2,999			5,241,140	524,207
Chum	3,992,490	139,829	2,410	84				
Humpback	24,650,950	789,390	272,349	9,338			7,707	264
Silver	4,349,808	350,183	15,840	1,386			3,387,928	240,444
Skates			644	13	458	9		
Smelt	578	58	121,866	12,187				
Steelhead trout	1,557	190					54	7
Tomcod			230	11				
Other fish	1,760	35	8,347	167	6,280	126		
Total	36,951,974	1,821,747	885,286	39,029	314,782	11,152	8,637,536	765,023
SHELLFISH, ETC.								
Shrimp					38,781	5,817		
Octopus			55	3	90	6		
Scallops					11,065	3,121		
Trepang or sea cucumber					5,355	268		
Total			55	3	55,291	9,212		
Grand total	36,951,974	1,821,747	885,341	39,032	370,073	20,364	8,637,536	765,023

Fisheries of the Puget Sound district of Washington, 1927—Continued

CATCH: BY GEAR—Continued

Species	Trawl lines		Set and hand lines		Drift gill nets		Set gill nets	
FISH	*Pounds*	*Value*	*Pounds*	*Value*	*Pounds*	*Value*	*Pounds*	*Value*
Cod, fresh			155	$12				
Cod, dry salted	2,587,255	$117,000						
Cod tongues	17,600	1,500						
Flounders:								
"Sole"			68	8			3,161	$136
Other							316	6
Grayfish			30,507	153			4,200	21
Halibut	10,607,956	1,426,356	105,000	10,750				
"Lingcod"	977,089	37,620	22,143	664			10,605	318
Perch			2,267	137			2,950	177
Rockfishes	442,756	18,136	13,176	923			2,405	168
Sablefish	2,784,013	183,424	350	28				
Salmon:								
Blueback or sockeye					26,187	$3,741		
Chinook					826,760	84,555		
Chum					282,450	9,921	70	2
Humpback					203,422	6,974		
Silver					866,880	75,852	2,112	185
Skates			54	2				
Smelt					1,024	102		
Steelhead trout					18,810	2,299		
Other fish			818	17				
Total	17,417,269	1,784,036	174,538	12,689	2,225,533	183,444	25,819	1,013
SHELLFISH, ETC.								
Octopus			99,792	5,987			550	33
Grand total	17,417,269	1,784,036	274,330	18,676	2,225,533	183,444	26,369	1,046

Species	Pound nets		Brush weirs		Reef nets		Drag bag nets	
FISH	*Pounds*	*Value*	*Pounds*	*Value*	*Pounds*	*Value*	*Pounds*	*Value*
Flounders:								
"Sole"	9	$1					340	$14
Other	3,808	76					19	1
Grayfish			13,000	$65				
Halibut	360	54						
Herring	61,810	618	322,600	3,226			149,550	1,496
"Lingcod"	1,647	49						
Perch	76	5	260	15			8,629	518
Rockfishes	4,584	321						
Salmon:								
Blueback or sockeye	3,753,134	536,162			29,449	$4,207	12,208	1,744
Chinook	5,013,998	512,795			968	99	14,432	1,476
Chum	994,720	34,815			2,650	93	890	31
Humpback	16,062,233	550,705			144,007	4,937	29,510	1,012
Silver	4,295,496	375,856			19,528	1,709	2,928	256
Smelt							60,920	6,092
Steelhead trout	63,072	7,709						
Sturgeon	784	118						
Other fish	4,434	89					1,100	22
Total	30,260,165	2,019,873	335,860	3,306	196,602	11,045	280,526	12,662
SHELLFISH, ETC.								
Octopus	1,109	67						
Grand total	30,261,274	2,019,440	335,860	3,306	196,602	11,045	280,526	12,662

Fisheries of the Puget Sound district of Washington, 1927—Continued

CATCH: BY GEAR—Continued

Species	Dip nets		Traps		Shovels		Tongs	
	Pounds	*Value*	*Pounds*	*Value*	*Pounds*	*Value*	*Pounds*	*Value*
FISH								
Herring	1,035	$10						
Smelt	430	43						
Total	1,465	53						
SHELLFISH, ETC.								
Crabs			479,386	$32,685				
Clams, hard					249,862	$37,479		
Oysters:								
Eastern market							74,720	$28,034
Native market							582,000	274,456
Total			479,386	32,685	249,862	37,479	656,720	302,490
Grand total	1,465	53	479,386	32,685	249,862	37,479	656,720	302,490

COASTAL DISTRICT

The catch in the coastal district amounted to 9,170,063 pounds, valued at $658,806. Considered according to quantity, the important species comprising this catch were salmon, 5,942,975 pounds, valued at $243,529; razor clams, 1,858,432 pounds, valued at $283,927; and crabs, 1,231,760 pounds, valued at $92,382.

Operating units.—The catch of fishery products in the coastal district of Washington during 1927 was taken by 2,592 fishermen, who used 468 motor and other small boats, 5 motor vessels, and 6 major types of gear. The vessels had a combined capacity of 46 net tons.

Catch by gear.—Five types of gear accounted for 98 per cent of the fishery products taken in this district during 1927. In the order of their importance they were pound nets, which accounted for 40 per cent of the catch; shovels, 20 per cent; set gill nets, 15 per cent; crab traps, 13 per cent; and drift gill nets, 10 per cent. The catch by pound nets and set and drift gill nets consisted almost entirely of salmon, that by shovels entirely of razor clams, and that by crab traps exclusively crabs.

Fisheries of the coastal district of Washington, 1927

OPERATING UNITS: BY GEAR

Items	Gill nets		Pound nets	Drag bag nets	Traps (crab)	Shovels	Tongs	Total, exclusive of duplication
	Drift (salmon)	Set (salmon)						
Fishermen:								
On vessels					10			10
On boats and shore	147	209	270	2	57	2,133	16	2,582
Total	147	209	270	2	67	2,133	16	2,592
Vessels, motor					5			5
Net tonnage					46			46
Boats:								
Motor	107	42	135	1	57		5	290
Other		152					26	178
Apparatus:								
Number	107	300	258	1	1,575	2,133	16	
Length, yards				100				
Square yards	128,880	60,000						

Fisheries of the coastal district of Washington, 1927—Continued

CATCH: BY GEAR

Species	Drift gill nets		Set gill nets		Pound nets		Drag bag nets	
FISH	*Pounds*	*Value*	*Pounds*	*Value*	*Pounds*	*Value*	*Pounds*	*Value*
Salmon:								
Blueback or sockeye			334, 507	$27, 876				
Chinook	382, 674	$24, 957	79, 572	4, 488	515, 545	$33, 622	14, 858	$969
Chum	315, 000	9, 450	670, 770	12, 764	2, 515, 224	75, 458	8, 580	257
Silver	219, 630	10, 981	269, 235	11, 838	615, 760	30, 788	1, 620	81
Steelhead trout	4, 510	361	43, 853	2, 398	15, 360	1, 229		
Other fish	514	41			27	2		
Total	922, 328	45, 790	1, 397, 937	59, 364	3, 661, 916	141, 099	25, 058	1, 307
SHELLFISH, ETC.								
Octopus			200	16				
Grand total	922, 328	45, 790	1, 398, 137	59, 380	3, 661, 916	141, 099	25, 058	1, 307

Species	Crab traps		Shovels		Tongs	
SHELLFISH, ETC.	*Pounds*	*Value*	*Pounds*	*Value*	*Pounds*	*Value*
Crabs	1, 231, 760	$92, 382				
Clams, razor			1, 858, 432	$283, 927		
Oysters:						
Eastern market					38, 640	$25, 026
Native market					33, 792	9, 895
Total	1, 231, 760	92, 382	1, 858, 432	283, 927	72, 432	34, 921

COLUMBIA RIVER DISTRICT

The catch in this district amounted to 17,235,034 pounds, valued at $1,434,020. Considered according to quantity, the more important species comprising this catch were salmon, 12,737,045 pounds, valued at $1,245,100; steelhead trout, 2,019,605 pounds valued at $139,994; smelt, 1,149,670 pounds valued at $11,497; and carp, 922,337 pounds valued at $27,670.

Operating units.—The catch of fishery products in the Columbia River District of Washington during 1927 was taken by 1,944 fisherman, who used 1,148 motor and other small boats and 6 major type of gear.

Catch by gear.—Four types of gear accounted for 91 per cent of the fishery products taken in this district during 1927. In the order of their importance they were drift gill nets, which accounted for 37 per cent of the catch; pound nets, 33 per cent; haul seines, 14 per cent; and dip nets, 7 per cent. The catch by drift gill nets and pound nets was principally salmon, that by haul seines chiefly salmon and carp, and that by dip nets almost exclusively smelt.

Fisheries of the Columbia River district of Washington, 1927

OPERATING UNITS: BY GEAR

Items	Haul seines	Troll lines	Set lines	Gill nets: Drift (salmon)	Gill nets: Set (salmon)	Pound nets	Dip nets	Fish wheels	Total, exclusive of duplication
Fishermen, on boats and shore	455	166	22	762	180	335	124	34	1,944
Boats:									
Motor	44	136	22	559	186	190	62		1,113
Other	35								35
Apparatus:									
Number	49	544	57	559	314	391	124	34	
Length, yards	16,596								
Square yards				1,159,500	62,800				
Hooks		2,176	5,700						

CATCH: BY GEAR

Species	Haul seines: Pounds	Haul seines: Value	Troll lines: Pounds	Troll lines: Value	Set lines: Pounds	Set lines: Value	Drift gill nets: Pounds	Drift gill nets: Value
Carp	922,337	$27,670						
Salmon:								
Blueback or sockeye	21,856	3,060					83,764	$11,727
Chinook	732,495	97,378	269,086	$38,177			4,241,207	543,935
Chum	27,216	544					1,229,382	24,588
Silver	12,043	930	528,405	31,476			248,899	20,907
Shad	179,828	2,697					61,514	923
Steelhead trout	467,689	33,842	37	3			443,988	29,991
Sturgeon	693	41			6,534	$423	49,383	2,954
Total	2,364,157	166,162	797,528	69,656	6,534	423	6,358,137	635,025

Species	Set gill nets: Pounds	Set gill nets: Value	Pound nets: Pounds	Pound nets: Value	Dip nets: Pounds	Dip nets: Value	Fish wheels: Pounds	Fish wheels: Value
Salmon:								
Blueback or sockeye	9,736	$1,363	36,417	$5,098			62,858	$8,800
Chinook	92,336	12,927	2,932,649	312,738			296,665	41,533
Chum	19,092	382	1,085,545	21,711				
Silver	6,912	587	800,402	67,234			80	5
Shad	3,379	51	45,188	678			35,792	537
Smelt					1,149,670	$11,497		
Steelhead trout	287,506	22,138	769,926	50,992	8,411	505	42,048	2,523
Sturgeon	5,212	365	7,878	436			10,976	654
Total	424,173	37,813	5,678,005	458,887	1,158,081	12,002	448,419	54,052

OREGON

In 1927 Oregon employed 22 per cent of the total number of fishermen and accounted for 5 per cent of the total catch of the Pacific Coast States. There were 4,572 fishermen employed, which is 7 per cent less than in 1926. Of this total, 74 were on fishing vessels and 4,498 in the shore and boat fisheries.

The catch amounted to 34,194,595 pounds, valued at $3,102,919. This is an increase of 4 per cent in quantity and 1 per cent in the value of the catch as compared with the catch and its value in 1926. Of the total value of the catch, salmon accounted for 88 per cent, steelhead trout 5 per cent, and halibut 2 per cent. Other species individually amounted to less than $50,000 in value. Of the total quantity, salmon accounted for 82 per cent, steelhead trout 6 per cent, and shad 4 per cent.

Operating units.—The catch of fishery products from the Columbia River district and coastal district of Oregon was taken by 4,572 fishermen, 2,449 motor and other small boats, 27 motor vessels, and 10 major types of gear. The vessels had a combined capacity of 243 net tons.

Fisheries of Oregon, 1927

CATCH: BY DISTRICTS

Species	Columbia River District		Coastal District	
	Pounds	*Value*	*Pounds*	*Value*
FISH				
Carp	68,000	$2,040		
Flounders ("sole")			640	$25
Halibut	196,744	30,856	174,802	23,622
Herring			54,000	1,080
"Lingcod"	31,310	1,263	36,288	1,466
Rockfishes	25,721	1,048	18,443	738
Sablefish	335,896	15,440		
Salmon:				
Blueback or sockeye	237,436	33,241		
Chinook	14,641,110	1,877,175	2,490,826	283,791
Chum	1,588,753	31,775	2,090,301	41,806
Silver	2,444,091	166,588	4,577,056	311,228
Shad	785,495	11,783	730,561	10,958
Smelt	411,732	4,117	505	20
Steelhead trout	1,724,982	115,492	471,080	41,904
Striped bass			1,852	185
Sturgeon	130,835	8,109	2,542	96
Total	22,622,105	2,298,927	10,648,896	716,919
SHELLFISH, ETC.				
Crabs	103,048	7,026	496,804	28,228
Crawfish	138,200	17,275		
Clams, razor	164,356	25,110		
Clams, mixed			18,486	7,184
Oysters, native market			2,700	2,250
Total	405,604	49,411	517,990	37,662
Grand total	23,027,709	2,348,338	11,166,886	754,581

COLUMBIA RIVER DISTRICT

The catch in the Columbia River district of Oregon amounted to 23,027,709 pounds, valued at $2,348,338. Considered according to quantity, the more important species comprising this catch were salmon, 18,911,390 pounds, valued at $2,108,779; steelhead trout, 1,724,982 pounds, valued $115,492; and sablefish, 335,896 pounds, valued at $15,440.

Operating units.—The catch of fishery products in the Columbia River district of Oregon during 1927 was taken by 3,292 fishermen, who used 1,441 motor and other small boats, 21 motor vessels, and 9 major types of gear. The combined capacity of the vessels amounted to 194 net tons.

Catch by gear.—Four types of gear accounted for 91 per cent of the fishery products taken in this district during 1927. In the order of their importance they were gill nets, which accounted for 63 per cent of the catch; haul seines, 13 per cent; troll lines, 12 per cent; and pound nets, 3 per cent. The catch by these gears was principally salmon and steelhead trout.

Fisheries of the Columbia River district of Oregon, 1927

OPERATING UNITS: BY GEAR

Items	Haul seines	Troll lines	Set lines	Gill nets		Pound nets	Dip nets	Fish wheels	Traps		Shovels	Total exclusive of duplication
				Drift (salmon)	Set (salmon)				Crab	Crawfish		
Fishermen:												
On vessels		24	41									62
On boats and shore	693	191	23	1,629	98	72	183	20	39	19	352	3,230
Total	693	215	64	1,629	98	72	183	20	39	19	352	3,292
Vessels, motor		12	10									21
Net tonnage		84	124									194
Boats:												
Motor	53	173	23	1,042	98	36			39	19		1,404
Other	27						10					37
Apparatus:												
Number	49	752	282	1,042	240	60	183	20	585	380	352	
Length, yards	28,667											
Square yards				2,856,000	48,000							
Hooks		3,008	16,200									

CATCH: BY GEAR

Species	Haul seines		Troll lines		Set lines		Gill nets	
FISH	*Pounds*	*Value*	*Pounds*	*Value*	*Pounds*	*Value*	*Pounds*	*Value*
Carp	68,000	$2,040						
Halibut					196,744	$30,856		
"Lingcod"					31,310	1,263		
Rockfishes					25,721	1,048		
Sablefish					335,896	15,440		
Salmon:								
Blueback or sockeye	28,916	4,048					184,885	$25,884
Chinook	2,027,772	258,511	1,126,935	$147,536			10,839,129	1,395,393
Chum	14,921	298	9	1			1,467,062	29,341
Silver	98,095	8,251	1,672,353	101,186			503,438	42,738
Shad	345,919	5,189					371,007	5,565
Steelhead trout	507,246	31,988	692	42			1,028,657	70,719
Sturgeon	2,690	147			118	8	109,679	6,807
Total	3,093,559	310,472	2,799,989	248,765	589,789	48,615	14,503,857	1,576,447

Species	Pound nets		Dip nets		Fish wheels		Traps		Shovels	
FISH										
Salmon:	*Pounds*	*Value*	*Pounds*	*Value*	*Pounds*	*Value*	*Pounds*	*Value*	*Pounds*	*Value*
Blueback or sockeye	10,308	$1,443	1,344	$188	11,983	$1,678				
Chinook	272,990	23,335	32,990	4,619	341,294	47,781				
Chum	106,761	2,135								
Silver	170,199	14,412	6	1						
Shad	63,331	950			5,238	79				
Smelt			411,732	4,117						
Steelhead trout	168,642	11,427	11,821	841	7,924	475				
Sturgeon	1,573	110	12,911	767	3,864	270				
Total	793,804	53,812	470,804	10,533	370,303	50,283				
SHELLFISH, ETC.										
Crabs							103,048	$7,026		
Crawfish							138,200	17,275		
Clams, razor									164,356	$25,110
Total							241,248	24,301	164,356	25,110
Grand total	793,804	53,812	470,804	10,533	370,303	50,283	241,248	24,301	164,356	25,110

COASTAL DISTRICT

The catch in the coastal district of Oregon amounted to 11,166,886 pounds, valued at $754,581. Considered according to quantity, the more important species comprising the catch were salmon, 9,158,183 pounds, valued at $636,825; crabs, 496,804 pounds, valued at $28,228; steelhead trout, 471,080 pounds, valued at $41,904; and halibut, 174,802 pounds, valued at $23,622.

Operating units.—The catch of fishery products in the coastal district of Oregon during 1927 was taken by 1,280 fishermen, who used 1,008 motor and other small boats, 6 motor vessels, and 5 major types of gear. The combined capacity of the vessels amounted to 49 net tons.

Catch by gear.—Three types of gear accounted for 98 per cent of the fishery products taken in this district during 1927. In the order of their importance they were gill nets, which accounted for 81 per cent of the catch; troll lines, 13 per cent; and traps, 4 per cent. The catch by gill nets and troll lines was principally salmon, and that by traps was exclusively crabs.

Fisheries of the coastal district of Oregon, 1927

OPERATING UNITS: BY GEAR

Items	Troll lines	Set lines	Gill nets		Crab traps	Shovels	Tongs	Total, exclusive of duplication
			Drift (salmon)	Set (salmon)				
Fishermen:								
On vessels	10	2						12
On boats and shore	65	12	602	513	119	40	3	1,268
Total	75	14	602	513	119	40	3	1,280
Vessels, motor	5	1						6
Net tonnage	41	8						49
Boats:								
Motor	52	8	374	350	119		1	842
Other				163			3	166
Apparatus:								
Number	233	108	374	963	1,785	40	3	
Square yards			561,000	192,600				
Hooks	932	5,400						

CATCH: BY GEAR

Fish	Troll lines		Set lines		Gill nets	
	Pounds	*Value*	*Pounds*	*Value*	*Pounds*	*Value*
Flounders ("sole")			640	$25		
Halibut			174,802	23,622		
Herring					54,000	$1,080
"Lingcod"			36,288	1,466		
Rockfishes			18,443	738		
Salmon:						
Chinook	560,553	$63,296			1,930,273	220,495
Chum					2,090,301	41,806
Silver	836,558	53,134			3,740,498	258,094
Shad					730,561	10,958
Smelt					505	20
Steelhead trout	355	24			470,725	41,880
Striped bass					1,852	185
Sturgeon					2,542	96
Total	1,397,466	116,454	230,173	25,851	9,021,257	574,614

Fisheries of the coastal district of Oregon, 1927—Continued

CATCH: BY GEAR—Continued

Shellfish, etc.	Traps		Shovels		Tongs	
	Pounds	*Value*	*Pounds*	*Value*	*Pounds*	*Value*
Crabs	496,804	$28,228				
Clams, mixed			18,486	$7,184		
Oysters, native market					2,700	$2,250
Total	496,804	28,228	18,486	7,184	2,700	2,250

CALIFORNIA

In 1927 California was by far the most important among the Pacific Coast States in the importance of its fisheries, employing 34 per cent of the total number of fishermen and accounting for 76 per cent of the total catch. There were 7,033 fishermen employed, which is 18 per cent more than in 1926. Of this total, 2,594 were employed on fishing vessels and 4,439 in the shore and boat fisheries.

The catch amounted to 491,347,170 pounds, valued at $10,058,303. This is an increase of 23 per cent in quantity and 27 per cent in the value of the catch as compared with the catch and its value in 1926. Of the total value of the catch, that for pilchard or sardine accounted for 18 per cent; yellowfin tuna, 13 per cent; skipjack or striped tuna, 13 per cent; flounders, 7 per cent; salmon, 6 per cent; barracuda, 6 per cent; and albacore, 5 per cent. Other species were valued individually at less than $500,000. Of the total quantity, pilchard or sardine accounted for 70 per cent, skipjack or striped tuna 7 per cent, yellowfin tuna 5 per cent, and flounders 3 per cent. Of the total catch, 429,219,429 pounds, valued at $6,978,065, were taken off the coast of California; the remainder was taken off the coast of Mexico, except the salted cod, which was taken in Alaska waters.

Operating units.—The catch of fishery products from the northern, San Francisco, Monterey, and southern districts of California was taken by 7,033 fishermen, 2,311 motor and small boats, 4 steam vessels, 402 motor vessels, 5 sailing vessels, and 19 major types of gear. The vessels had a combined capacity of 7,995 net tons.

Fisheries of California, 1927

CATCH: BY DISTRICTS

Species	Northern district		San Francisco district		Monterey district	
	Pounds	*Value*	*Pounds*	*Value*	*Pounds*	*Value*
FISH						
Albacore					1,051	$158
Anchovies			278,125	$2,781	56,600	529
Barracuda					2,644	260
Bonito					3,677	168
Carp	2,896	$65	57,517	1,422		
Catfish	79,152	11,873	292,151	43,976		
Cod, dry salted			[1] 2,746,880	186,644		
Eels			5	1		
Flounders:						
"California halibut"					10,577	1,426
"Sole"	204,999	8,101	8,987,680	404,507	870,311	43,481
Other	96,713	5,283	1,158,702	60,767	196,302	9,110
Grayfish			187,444	3,749	10,400	52
Hake			75,951	1,929	8,602	215
Halibut	557,140	64,098	12,797	1,530		
Hardhead			32,898	2,838		
Herring	50,294	797	1,098,560	21,971	2,980	89
Horse mackerel					56,088	2,342
Kingfish			47,521	2,425	133,621	7,046
"Lingcod"	64,451	1,777	320,356	14,162	159,977	7,296
Mackerel			138	6	1,040,245	31,776
Perch	43,065	1,885	96,722	3,666	40,181	1,440
Pilchard or sardine	168	5	18,741,812	116,580	173,956,587	877,021
Pompano					177	108
Rockfishes	124,346	3,177	901,811	36,072	1,798,298	71,219
Sablefish	392,674	13,865	403,797	19,880	193,889	9,771
Salmon	3,385,349	320,153	2,409,532	237,058	717,027	86,961
Sculpin					752	22
Sea bass:						
Black					100	4
White or squeteague			23,956	2,995	47,511	5,330
Shad			4,103,423	148,201		
Skates	390	4	221,928	4,438	21,052	330
Skipjack or striped tuna					1,051	52
Smelt	35,305	2,593	123,630	10,809	179,764	12,007
Split-tail			10,601	636		
Squawfish			7,865	629		
Striped bass			647,594	92,036		
Suckers			1,020	20		
Tomcod			690	21		
Whitebait	101,272	7,560	30,975	3,485	1,902	153
Other fish	1,925	38	25,661	996	17,180	609
Total	5,140,139	441,274	43,056,742	1,426,230	179,528,555	1,168,981
SHELLFISH, ETC.						
Crabs	161,712	10,196	2,539,320	190,449	259,320	17,288
Shrimp			1,697,365	28,007		
Abalone	17,200	3,440			542,489	108,498
Clams:						
Cockle	173	80	615	528		
Soft			25,231	12,975		
Mixed	1,702	696	7,102	4,058		
Mussels			419	64	2,533	329
Octopus	519	42	3,389	362	32,434	3,384
Oysters, eastern			55,492	23,782		
Squid					5,985,482	54,288
Total	181,306	14,454	4,328,933	260,225	6,822,258	183,787
WHALE PRODUCTS						
Whale oil			5,165,930	326,975		
Grand total	5,321,445	455,728	52,551,605	2,013,430	186,350,813	1,352,768

[1] The catch of cod was made in Alaska waters.

Fisheries of California—Continued

CATCH: BY DISTRICTS—Continued

Species	Southern district—Off California			
	San Pedro section		San Diego section	
	Pounds	*Value*	*Pounds*	*Value*
FISH				
Albacore	3,719,880	$425,108	734,441	$78,923
Anchovies	32,126	575	1,350	24
Barracuda	3,518,483	283,721	834,456	62,834
Bonito	730,723	21,929	386,025	10,098
Carp	2,601	130		
Flounders:				
"California halibut"	744,516	112,962	62,148	8,583
"Sole"	231,519	10,693	3,759	443
Other	16,265	1,157		
Grayfish	90,872	1,845	36,187	176
Herring	542	16	15,945	380
Horse mackerel	406,451	15,812		
Kingfish	342,904	6,770	5,221	124
"Lingcod"	1,294	49		
Mackerel	3,131,462	77,778	557,058	11,369
Mullet	6,415	556	7,171	772
Perch	73,368	5,401	1,793	77
Pilchard or sardine	143,548,925	789,520	6,027,797	43,659
Pompano	3,758	1,796	790	225
Rock bass	336,429	24,411	149,353	9,917
Rockfishes	2,395,717	126,801	1,149,151	54,923
Sablefish	1,994	100		
Salmon	21	3		
Sculpin	75,404	6,830	38,053	3,104
Sea bass:				
Black	65,061	3,385	117,565	4,928
White or squeteague	560,520	64,195	174,572	16,995
Sheepshead	112,753	4,469	46,034	1,794
Skates	19,370	412		
Skipjack or striped tuna	4,791,589	204,239	1,011,009	42,963
Smelt	604,550	28,864	22,352	1,498
Swordfish	10,206	704	120,082	11,583
Tuna:				
Bluefin	4,362,235	281,696	536,151	29,816
Yellowfin	549,999	34,351	45,248	2,715
Whitefish	202,398	21,333	85,196	4,043
Yellowtail	403,796	23,466	1,031,660	49,162
Other fish	126,812	6,362		
Total	171,220,958	2,587,439	13,200,567	451,728
SHELLFISH, ETC.				
Sea crawfish or spiny lobster	346,421	71,898	161,702	27,231
Abalone	3,617	884		
Clams:				
Pismo	33,250	15,441		
Mixed	58	22		
Mussels	11	1		
Octopus	351	49		
Squid	28,329	1,416	302	30
Total	412,037	89,711	162,004	27,261
Grand total	171,632,995	2,677,150	13,362,571	478,989

Fisheries of California—Continued

CATCH: BY DISTRICTS—Continued

Species	Southern district—Off Mexico				Total	
	San Pedro section		San Diego section			
	Pounds	*Value*	*Pounds*	*Value*	*Pounds*	*Value*
FISH						
Albacore	23,073	$2,423	100,922	$10,742	4,578,316	$517,196
Anchovies					33,476	599
Barracuda	1,569,186	211,326	274,970	37,850	6,197,095	595,731
Bonito	561,238	16,829	35,294	973	1,713,280	49,829
Carp					2,601	130
Flounders:						
"California halibut"	1,469	234	483,573	64,063	1,291,706	185,842
"Sole"			22	2	235,300	11,138
Other					16,265	1,157
Grayfish					127,059	2,021
Herring					16,487	396
Horse mackerel	4,837	335			411,288	16,147
Kingfish					348,125	6,894
"Lingcod"					1,294	49
Mackerel	308	3	11,428	457	3,700,256	89,607
Mullet	9,074	925	17,316	1,534	39,976	3,787
Perch	6,989	519	775	37	82,925	6,034
Pilchard or sardine					149,576,722	833,179
Pompano	33,247	2,519	17,155	1,760	54,950	6,360
Rock bass	4,672	423	35,386	2,204	525,840	36,955
Rockfishes	1,059	66	6,797	373	3,552,724	182,163
Sablefish					1,994	100
Salmon					21	3
Sculpin					113,457	9,934
Sea bass:						
Black	14,445	718	270,424	11,752	467,495	20,783
White or squeteague	847,102	76,165	619,746	52,064	2,201,940	209,419
Sheepshead			610	19	159,397	6,282
Skates					19,370	412
Skipjack or striped tuna	13,321,014	445,981	14,682,348	567,632	33,805,960	1,260,795
Smelt			320	23	627,222	30,385
Swordfish					130,288	12,287
Tuna:						
Bluefin			79	5	4,898,465	311,517
Yellowfin	12,783,271	604,185	12,555,448	662,751	25,933,966	1,304,002
Whitefish	9,878	741	15,630	804	313,102	27,521
Yellowtail	1,239,508	45,809	1,549,889	77,026	4,224,853	195,463
Other fish	16,343	1,329	19,223	1,199	162,378	8,890
Total	30,446,713	1,410,510	30,697,355	1,493,270	245,565,593	5,942,947
SHELLFISH, ETC.						
Sea crawfish or spiny lobster			982,835	176,222	1,490,958	275,351
Abalone					3,617	884
Clams:						
Pismo					33,250	15,441
Mixed	838	236			896	258
Mussels					11	1
Octopus					351	49
Squid					28,631	1,446
Total	838	236	982,835	176,222	1,557,714	293,430
Grand total	30,447,551	1,410,746	31,680,190	1,669,492	247,123,307	6,236,377

Fisheries of California, 1927—Continued

TOTAL CATCH

Species	Off California		Off Mexico	
	Pounds	*Value*	*Pounds*	*Value*
FISH				
Albacore	4,455,372	$504,189	123,995	$13,165
Anchovies	368,201	3,909		
Barracuda	4,355,583	346,821	1,844,156	249,176
Bonito	1,120,425	32,195	596,532	17,802
Carp	63,014	1,617		
Catfish	371,303	55,849		
Cod, dry salted	[1] 2,746,880	186,644		
Eels	5	1		
Flounders:				
"California halibut"	817,241	122,971	485,042	64,297
"Sole"	10,298,268	467,225	22	2
Other	1,467,982	76,317		
Grayfish	324,903	5,822		
Hake	84,553	2,144		
Halibut	569,937	65,628		
Hardhead	32,898	2,838		
Herring	1,168,321	23,253		
Horse mackerel	462,539	18,154	4,837	335
Kingfish	529,267	16,355		
"Lingcod"	555,078	23,284		
Mackerel	4,728,903	120,929	11,736	460
Mullet	13,586	1,328	26,390	2,459
Perch	255,129	12,469	7,704	556
Pilchard or sardine	342,275,289	1,826,785		
Pompano	4,725	2,129	50,402	4,279
Rock bass	485,782	34,328	40,058	2,627
Rockfishes	6,369,323	292,192	7,856	439
Sablefish	992,354	43,616		
Salmon	6,511,929	644,175		
Sculpin	114,209	9,956		
Sea bass:				
Black	182,726	8,317	284,869	12,470
White or squeteague	806,559	89,515	1,466,848	128,229
Shad	4,103,423	148,201		
Sheepshead	158,787	6,263	610	19
Skates	262,740	5,184		
Skipjack or striped tuna	5,803,649	247,254	28,003,362	1,013,593
Smelt	965,601	55,771	320	23
Splittail	10,601	636		
Squawfish	7,865	629		
Striped bass	647,594	92,036		
Suckers	1,020	20		
Swordfish	130,288	12,287		
Tomcod	690	21		
Tuna:				
Bluefin	4,898,386	311,512	79	5
Yellowfin	595,247	37,066	25,338,719	1,266,936
Whitebait	134,149	11,198		
Whitefish	287,594	25,976	25,508	1,545
Yellowtail	1,435,456	72,628	2,789,397	122,835
Other fish	171,587	8,005	35,566	2,528
Total	412,146,961	6,075,652	61,144,068	2,903,780
SHELLFISH, ETC.				
Crabs	2,960,352	217,933		
Sea crawfish or spiny lobster	508,123	99,129	982,835	176,222
Shrimp	1,697,365	28,007		
Abalone	563,306	112,822		
Clams:				
Cockle	788	608		
Pismo	33,250	15,441		
Soft	25,231	12,975		
Mixed	8,802	4,776	838	236
Mussels	2,963	394		
Octopus	36,693	8,837		
Oysters, eastern market	55,492	23,782		
Squid	6,014,113	55,734		
Total	11,906,538	575,438	983,673	176,458
WHALE PRODUCT				
Whale oil	5,165,930	326,975		
Grand total	429,219,429	6,978,065	62,127,741	3,080,238

[1] The catch of cod was made in Alaska waters.

NORTHERN DISTRICT

The catch in the northern district of California amounted to 5,321,445 pounds, valued at $455,728. Considered according to quantity, the more important species comprising this catch were salmon 3,385,349 pounds, valued at $320,153; halibut, 557,140 pounds, valued at $64,098; sablefish, 392,674 pounds, valued at $13,865; and flounders, 301,712 pounds, valued at $13,384.

Operating units.—The catch of fishery products in this district during 1927 was taken by 718 fishermen, who used 448 motor and other small boats, 20 motor vessels, and 7 major types of gear. The combined capacity of the vessels amounted to 187 net tons.

Catch by gear.—Three types of gear accounted for 95 per cent of the fishery products taken in this district during 1927. In the order of their importance, they were lines, which accounted for 76 per cent of the catch; gill nets, 13 per cent; and paranzella nets, 6 per cent. The catch by gill nets consisted principally of salmon, that by lines chiefly salmon, halibut, and sablefish, and that by paranzella nets mainly flounders.

Fisheries of the northern district of California, 1927

OPERATING UNITS: BY GEAR

Items	Haul seines	Paranzella nets	Troll lines	Trawl lines	Gill nets: Drift (salmon)	Gill nets: Other	Dip nets	Crab traps	Shovels	Total, exclusive of duplication
Fishermen:										
On vessels		7	30	25						50
On boats and shore	3		192	180	447	18	22	34	7	668
Total	3	7	222	205	447	18	22	34	7	718
Vessels: Motor		2	15	9						20
Net tonnage		14	123	94						187
Boats:										
Motor	1		161	134		18	22	31		165
Other	1			20	262					283
Apparatus:										
Number	1	1	751	331	262	18	22	560	7	
Length, yards	100									
Square yards					178,815	5,250				
Yards at mouth		17								
Hooks			3,892	40,910						

NOTE.—Abalone outfits also were operated in this district by fishermen from the Monterey district.

Fisheries in the northern district of California, 1927—Continued

CATCH: BY GEAR

Species	Haul seines		Paranzella nets		Lines [1]		Gill nets	
	Pounds	*Value*	*Pounds*	*Value*	*Pounds*	*Value*	*Pounds*	*Value*
FISH								
Carp	2,896	$65						
Catfish					79,152	$11,873		
Flounders:								
"Sole"			200,625	$8,003	4,374	98		
Other			74,958	4,170	21,755	1,113		
Halibut			4,030	403	553,110	63,695		
Herring							50,294	$797
"Lingcod"			4,030	111	60,421	1,666		
Perch					30,153	1,350	12,912	535
Pilchard or sardine							168	5
Rockfishes			17,630	353	106,716	2,824		
Sablefish					392,674	13,865		
Salmon					2,769,283	278,036	616,066	42,117
Skates			390	4				
Smelt					7,605	565	27,700	2,028
Other fish					1,925	38		
Total	2,896	65	301,063	13,044	4,027,168	375,123	707,140	45,482
SHELLFISH, ETC.								
Crabs			96	6				
Grand total	2,896	65	301,759	13,050	4,027,168	375,123	707,140	45,482

Species	Dip nets		Abalone outfits		Shovels		Traps	
	Pounds	*Value*	*Pounds*	*Value*	*Pounds*	*Value*	*Pounds*	*Value*
FISH								
Whitebait	101,272	$7,560						
SHELLFISH, ETC.								
Crabs							161,616	$10,190
Abalone			17,200	$3,440				
Clams:								
Cockle					173	$80		
Mixed					1,702	696		
Octopus							519	42
Total			17,200	3,440	1,875	776	162,135	10,232
Grand total	101,272	7,560	17,200	3,440	1,875	776	162,135	10,232

[1] The salmon were taken by troll lines and the remainder of the catch by hand and set lines.

NOTE.—The catch by abalone outfits was made by fishermen from the Monterey district.

SAN FRANCISCO DISTRICT

The catch in this district amounted to 52,551,605 pounds, valued at $2,013,430. Considered according to quantity, the more important species comprising this catch were pilchard or sardine, 18,741,812 pounds, valued at $116,580; flounders, 10,146,382 pounds, valued at $465,274; cod, which were taken by California fishermen in Alaska waters, 2,746,880 pounds, valued at $186,644; crabs, 2,539,320 pounds, valued at $190,449; salmon, 2,409,532 pounds, valued at $237,058; and shrimp, 1,697,365 pounds, valued at $28,007.

Operating units.—The catch of fishery products in the San Francisco district during 1927 was taken by 1,308 fishermen, 584 motor and other small boats, 4 steam vessels, 19 motor vessels, 5 sailing vessels, and 12 major type of gears. The combined capacity of the vessels amounted to 2,295 net tons.

Catch by gear.—Five types of gear accounted for 91 per cent of the fishery products taken in this district during 1927. In the order of their importance they were lampara nets, which accounted for 38 per cent of the catch; paranzella nets, 21 per cent; gill nets, 12 per cent; lines, 10 per cent; and whaling apparatus, 10 per cent. The catch by lampara nets was chiefly pilchard or sardines; that by paranzella nets principally flounders; that by gill nets chiefly shad, salmon, and striped bass; that by lines largely cod taken in Alaska waters and salmon; and that by whale apparatus exclusively whales. Statistics for whale oil only are shown, it being the only whale product marketed.

Fisheries of the San Francisco district of California, 1927

OPERATING UNITS: BY GEAR

Items	Haul seines	Lampara nets (sardine)	Paranzella nets	Troll lines	Trawl and hand lines	Gill nets: Drift (salmon)	Gill nets: Sea bass	Gill nets: Shad	Gill nets: Striped bass	Gill nets: Other
Fishermen:										
On vessels			66	4	192					
On boats and shore	6	115		316	195	574	8	415	276	38
Total	6	115	66	320	387	574	8	415	276	38
Vessels:										
Motor			16	2	1					
Net tonnage			250	16	10					
Sail					5					
Net tonnage					1,782					
Total vessels			16	2	6					
Total net tonnage			250	16	1,792					
Boats:										
Motor	2	24		288	178	303	5	257	172	31
Other						4		4	4	
Apparatus:										
Number	2	24	9	1,160	877	307	5	261	176	31
Length, yards	360	2,880								
Square yards						753,685	12,400	620,136	373,824	32,395
Yards at mouth			150							
Hooks				5,798	117,194					

Items	Fyke nets	Beam trawls	Crab traps	Shovels and rakes	Tongs	Whaling apparatus	Total, exclusive of duplication
Fishermen:							
On vessels		2				44	305
On boats and shore	55	29	246	17	6		1,003
Total	55	31	246	17	6	44	1,038
Vessels:							
Steam						4	4
Net tonnage						241	241
Motor		1					19
Net tonnage		6					272
Sail							5
Net tonnage							1,782
Total vessels		1				4	28
Total net tonnage		6				241	2,295
Boats:							
Motor	39	20	246		2		566
Other	9				6		18
Apparatus:							
Number	816	21	4,920	17	6	4	
Yards at mouth		126					

Fisheries of the San Francisco district of California, 1927—Continued

CATCH: BY GEAR

Species	Haul seines		Lampara nets		Paranzella nets		Lines [1]	
	Pounds	*Value*	*Pounds*	*Value*	*Pounds*	*Value*	*Pounds*	*Value*
FISH								
Anchovies			278,125	$2,781				
Carp	1,306	$39						
Cod, dry salted							[2] 2,746,880	$186,644
Eels							5	1
Flounders:								
"Sole"					8,975,232	$403,885	12,448	622
Other			837	42	1,149,127	60,529	45	3
Grayfish					184,687	3,694	2,757	55
Hake					69,774	1,744	6,177	185
Halibut					9,734	1,071	3,063	459
Hardhead	16,009	1,441						
Herring			938,202	18,764				
Kingfish			4,809	289	42,712	2,136		
"Lingcod"					131,711	5,268	197,645	8,894
Mackerel			138	6				
Perch			34,468	1,206	3,120	94		
Pilchard or sardine			18,741,812	116,580				
Rockfishes					379,199	15,168	522,612	20,904
Sablefish					62,067	2,793	341,730	17,087
Salmon							1,492,162	153,898
Skates					221,928	4,438		
Smelt			31,729	2,538				
Splittail	2,712	163						
Squawfish	55	5						
Tomcod					690	21		
Whitebait			28,365	3,120				
Other fish					21,370	748	1,768	71
Total	20,082	1,648	20,058,485	145,326	11,251,351	501,589	5,327,292	388,823
SHELLFISH, ETC.								
Crabs					16,600	1,245		
Octopus					75	8	3,314	354
Total					16,675	1,253	3,314	354
Grand total	20,082	1,648	20,058,485	145,326	11,268,026	502,842	5,330,606	389,177

Species	Gill nets		Fyke nets		Beam trawls		Traps	
	Pounds	*Value*	*Pounds*	*Value*	*Pounds*	*Value*	*Pounds*	*Value*
FISH								
Carp	33,359	$834	22,852	$549				
Catfish	7,634	1,298	284,517	42,678				
Flounders	8,693	193						
Hardhead			16,889	1,397				
Herring	160,358	3,207						
Perch	59,134	2,366						
Salmon	917,370	83,160						
Sea bass, white, or squeteague	23,956	2,995						
Shad	4,103,423	148,201						
Smelt	91,901	8,271						
Splittail			7,889	473				
Squawfish	6,044	483	1,766	141				
Striped bass	647,594	92,036						
Suckers			1,020	20				
Whitebait	2,610	365						
Other fish	2,523	177						
Total	6,064,599	343,586	334,933	45,258				
SHELLFISH, ETC.								
Crabs							2,522,720	$189,204
Shrimp					1,697,365	$28,007		
Total					1,697,365	28,007	2,522,720	189,204
Grand total	6,064,599	343,586	334,933	45,258	1,697,365	28,007	2,522,720	189,204

[1] The salmon were taken by troll lines and the remainder by set or hand lines.
[2] The catch of cod was made in Alaska waters.

Fisheries of the San Francisco district of California, 1927—Continued

CATCH: BY GEAR—Continued

Species	Tongs		Shovels and rakes		Whaling apparatus	
SHELLFISH, ETC.	*Pounds*	*Value*	*Pounds*	*Value*	*Pounds*	*Value*
Clams:						
Cockle			615	$528		
Soft			25,231	12,975		
Mixed			7,102	4,058		
Mussels			419	64		
Oysters, Eastern market	55,492	$23,782				
Total	55,492	23,782	33,367	17,625		
WHALE PRODUCTS						
Whale oil					5,165,930	$326,975
Grand total	55,492	23,782	33,367	17,625	5,165,930	326,975

MONTEREY DISTRICT

The catch in the Monterey district amounted to 186,350,813 pounds, valued at $1,352,768. By far the most important species contributing to this catch were pilchard or sardine, the catch of which amounted to 173,956,587 pounds, valued at $877,021. Other important species were squid, 5,985,482 pounds, valued at $54,288; rockfishes, 1,798,298 pounds, valued at $71,219; flounders, 1,077,190 pounds, valued at $54,017; and mackerel, 1,040,245 pounds, valued at $31,776. The catch of other species individually amounted to less than 1,000,000 pounds.

Operating units.—The catch of fishery products in the Monterey districts during 1927 was taken by 1,170 fishermen, 341 motor and other small boats, 6 motor vessels, and 9 major types of gear. The combined capacity of the vessels amounted to 74 net tons.

Catch by gear.—Three types of gear accounted for 98 per cent of the fishery products taken in this district during 1927. In the order of their importance they were lampara nets, which accounted for 94 per cent of the catch, and purse seines and lines, each of which accounted for 2 per cent of the catch. The catch by lampara nets and purse seines consisted almost exclusively of pilchard or sardine, and that by lines was principally rockfishes, mackerel, and salmon.

Fisheries of the Monterey district of California, 1927

OPERATING UNITS: BY GEAR

Items	Purse seines (sardine)	Lampara nets		Troll lines	Trawl and hand lines
		Sardine	Squid		
Fishermen:					
On vessels	17	22	10		
On boats and shore		789	281	242	254
Total	17	811	291	242	254
Vessels, motor	2	2	2		
Net tonnage	45	17	17		
Boats:					
Motor		71	53	228	232
Other					6
Apparatus:					
Number	2	73	55	456	1,007
Length, yards	620	23,908	12,958		
Hooks				2,736	126,325

Fisheries of the Monterey district of California—Continued

OPERATING UNITS: BY GEAR—Continued

Items	Gill nets			Traps		Rakes	Abalone outfits	Total, exclusive of duplication
	Barracuda	Sea bass	Other	Crab	Octopus			
Fishermen:								
On vessels							10	49
On boats and shore	1	53	105	4	10	8	45	1,121
Total	1	53	105	4	10	8	55	1,170
Vessels, motor							2	6
Net tonnage							12	74
Boats:								
Motor	1	34	72	4	7	2	9	331
Other						6		10
Apparatus:								
Number	1	34	72	40	31	8	11	
Square yards	3,200	119,893	200,576					

NOTE.—Paranzella nets also were operated in this district by fishermen from the San Francisco district.

CATCH: BY GEAR

Species	Purse seines		Lampara nets		Paranzella nets		Lines [1]	
FISH	*Pounds*	*Value*	*Pounds*	*Value*	*Pounds*	*Value*	*Pounds*	*Value*
Albacore							1,051	$158
Anchovies			56,600	$529				
Barracuda			50	6				
Bonito			1,906	114				
Flounders:								
"California halibut"			442	66	5,710	$753	4,425	607
"Sole"					836,189	41,809	34,122	1,672
Other					190,157	8,842	6,145	268
Grayfish					10,400	52		
Hake					8,602	215		
Herring			2,530	80				
Horse mackerel			41,497	1,338			14,591	1,004
Kingfish			53,444	2,982	20,835	1,146	2,442	146
"Lingcod"					15,467	695	144,510	6,601
Mackerel	700	$5	83,939	2,959			955,606	28,812
Perch			5,614	195	7,800	234	26,767	1,011
Pilchard or sardine	4,477,545	24,626	169,479,042	852,395				
Pompano			177	108				
Rockfishes			1,190	58	13,940	558	1,783,168	70,603
Sablefish					3,575	179	190,314	9,592
Salmon							717,027	86,961
Sculpin							752	22
Sea bass, white, or squeteague			4,494	567			296	39
Skates					16,915	254	4,137	76
Smelt			25,849	2,042			1,668	130
Whitebait			1,757	140				
Other fish			3,130	158	250	8	13,809	443
Total	4,478,245	24,631	169,761,661	863,737	1,129,840	54,745	3,900,830	208,145
SHELLFISH, ETC.								
Octopus							2,435	250
Squid			5,985,482	54,288				
Total			5,985,482	54,288			2,435	250
Grand total	4,478,245	24,631	175,747,143	918,025	1,129,840	54,745	3,903,265	208,395

[1] Of the line catch, albacore and salmon were taken by troll lines and the remainder by set and hand lines.

NOTE.—The catch by paranzella nets was made by fishermen from the San Francisco district.

Fisheries of the Monterey district of California—Continued

CATCH: BY GEAR—Continued

Species	Gill nets		Traps		Rakes		Abalone outfits	
FISH	*Pounds*	*Value*	*Pounds*	*Value*	*Pounds*	*Value*	*Pounds*	*Value*
Barracuda	2,594	$260						
Bonito	1,771	54						
Herring	450	9						
Kingfish	56,900	2,772						
Sea bass:								
Black	100	4						
White, or squeteague	42,721	4,724						
Skipjack or striped tuna	1,051	52						
Smelt	152,247	9,835						
White bait	145	13						
Total	257,979	17,723						
SHELLFISH, ETC.								
Crabs	257,736	17,182	1,584	$106				
Abalone							542,489	$108,498
Mussels					2,533	$329		
Octopus			29,999	3,134				
Total	257,736	17,182	31,583	3,240	2,533	329	542,489	108,498
Grand total	515,715	34,905	31,583	3,240	2,533	329	542,489	108,498

SOUTHERN DISTRICT

The combined catch in the San Pedro and San Diego sections, which comprise the southern district, amounted to 247,123,307 pounds, valued at $6,236,377. This includes the catch off the coast of California and that off the coast of Mexico. Considered according to quantity, the more important species contributing to this catch were pilchard or sardine, 149,576,722 pounds, valued at $833,179; skipjack or striped tuna, 33,805,960 pounds, valued at $1,260,795; and yellowfin tuna, 25,933,966 pounds, valued at $1,304,002.

The operating units and catch of the principal species are discussed for each section individually in the following paragraphs.

SAN PEDRO SECTION

Operating units.—The catch of fishery products in the San Pedro section was taken by 3,053 fishermen, 755 motor and other small boats, 249 motor vessels, and 11 major types of gear. The combined capacity of the vessels amounted to 3,980 net tons.

Off California.—That part of the catch in this section taken off the California coast amounted to 171,632,995 pounds, valued at $2,677,150. Considered according to quantity, the more important species were pilchard or sardine, 143,548,925 pounds, valued at $789,520; skipjack or striped tuna 4,791,589 pounds, valued at $204,239; bluefin tuna, 4,362,235 pounds, valued at $281,696; albacore, 3,719,880 pounds, valued at $425,108; barracuda, 3,518,483 pounds, valued at $283,721; mackerel, 3,131,462 pounds, valued at $77,778; and rockfishes, 2,395,717 pounds, valued at $126,801.

Catch by gear.—Four types of gear accounted for 98 per cent of the fishery products taken in this division during 1927. In the order of their importance they were purse seines, which accounted for 49 per cent of the catch; lampara nets, 40 per cent; troll lines, 6 per cent; and set and hand lines, 3 per cent. The catch by purse seines and lampara nets was principally pilchard or sardine, although bluefin tuna and barracuda were important in the catch made by purse seines. The catch by troll lines was principally skipjack or striped tuna and albacore, and that by set and hand lines chiefly rockfishes and mackerel.

Off Mexico.—That part of the catch in the San Pedro section taken off the coast of Mexico amounted to 30,447,551 pounds, valued at $1,410,746. Considered according to quantity, the more important species were skipjack or striped tuna, 13,321,014 pounds, valued at $445,961; yellowfin tuna, 12,783,271 pounds, valued at $604,185; barracuda, 1,569,186 pounds, valued at $211,326; and yellowtail, 1,239,508 pounds, valued at $45,809.

Catch by gear.—Two types of gear accounted for 97 per cent of the fishery products taken in this division during 1927. By far the more important of these gears were troll lines, which accounted for 85 per cent of the catch. Purse seines accounted for 12 per cent. The catch by purse seines was principally skipjack or striped tuna and yellowfin tuna, and that by purse seines was chiefly barracuda and yellowfin tuna.

Fisheries of the San Pedro section of the southern district of California, 1927

OPERATING UNITS: BY GEAR

Items	Purse seines			Haul seines	Lampara nets (sardine)	Paranzella nets	Troll lines	Set and hand lines
	Barracuda	Sardine	Tuna					
Fishermen:								
On vessels	225	640	320		575	6	708	133
On boats and shore				3	99	15	1,091	491
Total	225	640	320	3	674	21	1,799	624
Vessels, motor	25	71	35		70	2	157	37
Net tonnage	676	1,974	929		774	16	1,736	407
Boats:								
Motor				1	22	6	641	257
Other								27
Apparatus:								
Number	25	71	35	1	92	4	5,301	1,345
Length, yards	11,075	27,382	18,424	100	36,860			
Yards at mouth						60		
Hooks							5,301	300,436

Items	Gill nets			Trammel nets	Lobster traps	Harpoons, (swordfish)	Shovels	Abalone outfits	Total, exclusive of duplication
	Barracuda	Sea bass	Other						
Fishermen:									
On vessels	44	13		40	36	6			1,699
On boats and shore	119	73	9	81	237	10	78	5	1,354
Total	163	86	9	121	273	16	78	5	3,053
Vessels, motor	14	4		13	12	2			249
Net tonnage	94	21		89	86	40			3,980
Boats:									
Motor	42	25	6	29	113	5			716
Other			1		10			3	39
Apparatus:									
Number	54	29	7	42	3,370	7	78	5	
Square yards	466,312	150,280	8,000	238,700					

Fisheries of the San Pedro section of the southern district of California, 1927—Con.

CATCH OFF CALIFORNIA: BY GEAR

Species	Purse seines		Haul seines		Lampara nets		Paranzella nets	
	Pounds	*Value*	*Pounds*	*Value*	*Pounds*	*Value*	*Pounds*	*Value*
FISH								
Anchovies	2,095	$42			30,031	$533		
Barracuda	1,087,452	111,138			188,245	13,748		
Bonito	475,018	14,507			32,808	889		
Carp			2,601	$130				
Flounders:								
"California halibut"	374	55			1,104	142	259,024	$30,267
"Sole"					110	6	206,954	9,088
Grayfish	105	1			2,130	39		
Horse mackerel	116,897	3,538			253,021	10,948		
Kingfish					327,738	6,437		
Mackerel	435,259	3,726			701,641	12,944		
Mullet					710	43		
Perch	3,689	220			46,057	3,357	546	33
Pilchard or sardine	77,582,818	426,706			65,966,107	362,814		
Pompano	79	37			3,578	1,712		
Rock bass	50,639	3,941			412	30		
Rockfishes					2,663	147		
Sculpin					420	34		
Sea bass:								
Black	6,026	214			270	12	621	19
White or squeteague	110,417	11,851			46,345	4,800		
Sheepshead	390	16			88	4		
Skates					125	3		
Skipjack or striped tuna	260,072	11,197						
Smelt	2,294	165			415,321	15,089		
Tuna:								
Bluefin	3,740,615	235,378			8,288	539		
Yellowfin	28,538	1,696						
Whitefish	180	13						
Yellowtail	291,730	18,437						
Other fish	7,440	454			17,578	1,072	334	20
Total	84,202,127	843,332	2,601	130	68,044,790	435,342	467,479	39,427
SHELLFISH, ETC.								
Sea crawfish or spiny lobster							863	146
Squid					28,329	1,416		
Total					28,329	1,416	863	146
Grand total	84,202,127	843,332	2,601	130	68,073,119	436,758	468,342	39,573

Species	Troll lines		Set and hand lines		Gill nets		Trammel nets	
	Pounds	*Value*	*Pounds*	*Value*	*Pounds*	*Value*	*Pounds*	*Value*
FISH								
Albacore	3,719,880	$425,108						
Barracuda	431,661	29,629			1,811,125	$129,206		
Bonito	110,641	3,576	27,824	$871	77,471	1,882	6,961	$204
Flounders.								
"California halibut"			27,507	4,480	2,419	392	454,088	77,62
"Sole"			1,940	108	8	1	22,507	1,490
Other			16,113	1,149			152	8
Grayfish	1,399	28	36,223	744	26,802	503	24,213	530
Herring					542	16		
Horse mackerel	1,689	61	10,744	393	24,100	872		
Kingfish			9,673	211	5,493	122		
"Lingcod"			1,294	49				
Mackerel			1,523,685	46,274	460,920	14,657	9,957	177
Mullet					5,705	513		
Perch			11,598	887	11,137	881	341	23
Pompano					101	47		
Rock bass	892	68	267,274	18,953	13,775	1,125	289	20
Rockfishes			2,392,433	126,622	263	14	358	18
Sablefish			1,994	100				
Salmon	21	3						
Sculpin			74,239	6,732	419	39	326	25
Sea bass:								
Black			51,587	2,853	3,956	166	2,601	121
White, or squeteague			135,705	14,970	259,392	31,801	8,661	773
Sheepshead			88,965	3,558	2,540	80	3,478	119
Skates			1,361	32	2,756	55	15,128	322
Skipjack or striped tuna	4,531,517	193,042						
Smelt			9,836	604	177,099	13,006		
Swordfish	554	19						

Fisheries of the San Pedro section of the southern district of California, 1927—Con.

CATCH OFF CALIFORNIA: BY GEAR—Continued

Species	Troll lines		Set and hand lines		Gill nets		Trammel nets	
FISH—continued	*Pounds*	*Value*	*Pounds*	*Value*	*Pounds*	*Value*	*Pounds*	*Value*
Tuna:								
Bluefin	613,332	$45,779						
Yellowfin	521,461	32,655						
Whitefish			202,056	$21,309	107	$7	55	$4
Yellowtail	87,091	3,462			24,963	1,566	12	1
Other fish	24,989	1,121	72,312	3,423	2,935	225	1,224	47
Total	10,045,127	734,551	4,964,363	254,322	2,914,028	197,176	550,351	81,508
SHELLFISH, ETC.								
Octopus			351	49				
Grand total	10,045,127	734,551	4,964,714	254,371	2,914,028	197,176	550,351	81,508

Species	Traps		Harpoons		Rakes and shovels		Abalone outfits	
FISH	*Pounds*	*Value*	*Pounds*	*Value*	*Pounds*	*Value*	*Pounds*	*Value*
Rock bass	3,148	$274						
Sheepshead	17,292	692						
Swordfish			9,652	$685				
Total	20,440	966	9,652	685				
SHELLFISH, ETC.								
Sea crawfish or spiny lobster	345,558	71,752						
Abalone							3,617	$884
Clams:								
Pismo					33,250	$15,441		
Mixed					58	22		
Mussels					11	1		
Total	345,558	71,752			33,319	15,464	3,617	884
Grand total	365,998	72,718	9,652	685	33,319	15,464	3,617	884

CATCH OFF MEXICO: BY GEAR

Species	Purse seines		Lampara nets		Troll lines		Set and hand lines		Shovels	
FISH	*Pounds*	*Value*	*Pounds*	*Value*	*Pounds*	*Value*	*Pounds*	*Value*	*Pounds*	*Value*
Albacore					23,073	$2,423				
Barracuda	1,567,291	$211,091	434	$59	1,461	176				
Bonito	178,528	5,941			382,710	10,888				
Flounders, "California halibut"	384	61	263	41			822	$132		
Horse mackerel	2,166	104	1,945	195			726	36		
Mackerel			308	3						
Mullet			9,074	925						
Perch	205	14	6,784	505						
Pompano							33,247	2,519		
Rock bass	163	13					4,509	410		
Rockfishes			472	25			587	41		
Sea bass:										
Black	13,333	667			100	5	1,012	46		
White, or squeteague	45,836	7,396	9,634	1,377			791,632	67,392		
Skipjack or striped tuna	153,980	4,234			13,167,034	441,727				
Tuna, yellowfin	1,492,802	58,856			11,290,469	545,330				
Whitefish	2,231	203					7,647	533		
Yellowtail	197,647	16,049			1,041,861	29,760				
Other fish	2,095	168	12,005	982	2,243	179				
Total	3,656,661	304,801	40,919	4,112	25,908,951	1,030,488	840,182	71,109		
SHELLFISH, ETC.										
Clams, mixed									838	$236
Grand total	3,656,061	304,801	40,919	4,112	25,908,951	1,030,488	840,182	71,109	838	236

SAN DIEGO SECTION

Operating units.—The catch of fishery products in the San Diego section was taken by 784 fishermen, 183 motor boats, 108 motor vessels, and 6 major types of gear. The combined capacity of the vessels amounted to 1,459 net tons.

Off California.—That part of the catch in the San Diego section taken off the California coast amounted to 13,362,571 pounds, valued at $478,989. Considered according to quantity, the more important species were pilchard or sardine, the catch of which amounted to 6,027,797 pounds, valued at $43,659; rockfishes, 1,149,151 pounds, valued at $54,923; yellowtail, 1,031,660 pounds, valued at $49,162; and skipjack or striped tuna, 1,011,009 pounds, valued at $42,963.

Catch by gear.—Four types of gear accounted for 93 per cent of the fishery products taken in this division during 1927. In the order of their importance they were lampara nets, which accounted for 45 per cent of the catch; troll lines, 28 per cent; set and hand lines, 15 per cent; and purse seines, 5 per cent. The catch by lampara nets was made up chiefly of pilchard or sardine; that by troll lines principally of skipjack or striped tuna, yellowtail, and albacore; that by set and hand lines principally of rockfishes and mackerel; and that by purse seines was almost exclusively bluefin tuna.

Off Mexico.—That part of the catch in the San Diego section taken off the coast of Mexico amounted to 31,680,190 pounds, valued at $1,669,492. Considered according to quantity, the more important species were skipjack or striped tuna, 14,682,348 pounds, valued at $507,632; yellowfin tuna, 12,555,448 pounds, valued at $662,751; and yellowtail, 1,549,889 pounds, valued at $77,026.

Catch by gear.—Three types of gear accounted for 95 per cent of the catch in this division. By far the most important of these gears were troll lines, which accounted for 84 per cent of the catch. Purse seines accounted for 8 per cent and traps for 3 per cent of the catch. The catch by troll lines was principally skipjack or striped tuna and yellowfin tuna, that by purse seines largely yellowfin tuna, and that by traps almost exclusively sea crawfish or spiny lobsters.

Fisheries of the San Diego section of the southern district of California, 1927

OPERATING UNITS: BY GEAR

Items	Lampara nets (sardines)	Troll lines	Set and hand lines	Gill nets			Trammel nets	Lobster traps	Harpoons (swordfish)	Total, exclusive of duplication
				Barracuda	Sea bass	Other				
Fishermen:										
On vessels	145	480	171	31	28	4	30	55	9	491
On boats and shore	71	272	142	46	37	13	29	135	15	293
Total	216	752	313	77	65	17	59	190	24	784
Vessels, motor	30	105	38	10	8	1	9	15	2	108
Net tonnage	309	1,435	611	75	62	15	70	153	20	1,459
Boats, motor	20	159	71	18	14	10	10	70	6	183
Apparatus:										
Number	50	1,700	718	28	22	11	19	2,540	8	
Length, yards	9,610									
Square yards				190,210	116,830	14,246	327,350			
Hooks		1,700	109,422							

NOTE.—Purse seines fished for tuna also were operated in this district by fishermen from the San Pedro section

Fisheries of the San Diego section of the southern district of California, 1927—Con.

CATCH OFF CALIFORNIA: BY GEAR

Species	Purse seines		Lampara nets		Troll lines		Set and hand lines	
FISH	*Pounds*	*Value*	*Pounds*	*Value*	*Pounds*	*Value*	*Pounds*	*Value*
Albacore					734,441	$78,923		
Anchovies			1,350	$24				
Barracuda	324	$22			598,351	45,335	861	$89
Bonito					371,527	9,740		
Flounders:								
"California halibut"							2,115	280
"Sole"							3,734	441
Grayfish							11,627	53
Kingfish			4,522	100			662	23
Mackerel	5,350	134	16,910	134	1,533	25	482,215	10,264
Perch			250	9				
Pilchard or sardine			6,027,797	43,659				
Pompano			790	225				
Rock bass					4,469	241	133,543	8,985
Rockfishes							1,147,720	54,861
Sculpin							38,053	3,104
Sea bass:								
Black					4,813	246	105,134	4,228
White, or squeteague			4,216	276			30,887	3,674
Sheepshead			163	5			9,100	286
Skipjack or striped tuna					1,011,069	42,963		
Smelt			13,549	838			2,116	162
Tuna:								
Bluefin	535,669	29,789			482	27		
Yellowfin					45,248	2,715		
Whitefish							85,046	4,633
Yellowtail	60,317	3,638			957,815	44,952		
Total	601,660	33,583	6,069,547	45,270	3,729,688	225,167	2,052,813	91,083
SHELLFISH, ETC.								
Squid			302	30				
Grand total	601,660	33,583	6,069,849	45,300	3,729,688	225,167	2,052,813	91,083

Species	Gill nets		Trammel nets		Traps		Harpoons	
FISH	*Pounds*	*Value*	*Pounds*	*Value*	*Pounds*	*Value*	*Pounds*	*Value*
Barracuda	234,920	$17,388						
Bonito	14,498	358						
Flounders:								
"California halibut"			60,033	$8,303				
"Sole"			25	2				
Grayfish			24,560	123				
Herring	15,945	380						
Kingfish	37	1						
Mackerel	51,050	812						
Mullet	7,171	772						
Perch	1,543	68						
Rock bass	4,063	254			7,278	$437		
Rockfishes			1,431	62				
Sea bass:								
Black	344	17	7,274	437				
White, or squeteague	139,469	13,045						
Sheepshead	692	24			36,079	1,479		
Smelt	6,687	498						
Swordfish							120,082	$11,583
Whitefish	150	10						
Yellowtail	13,528	572						
Total	490,097	34,199	93,323	8,927	43,357	1,916	120,082	11,583
SHELLFISH, ETC.								
Sea crawfish or spiny lobster					161,702	27,231		
Grand total	490,097	34,199	93,323	8,927	205,059	29,147	120,082	11,583

NOTE.—The catch by purse seines was made by fishermen from the San Pedro section.

Fisheries of the San Diego section of the southern district of California, 1927—Con.

CATCH OFF MEXICO: BY GEAR

Species	Purse seines		Lampara nets		Troll lines		Set and hand lines	
FISH	*Pounds*	*Value*	*Pounds*	*Value*	*Pounds*	*Value*	*Pounds*	*Value*
Albacore					100, 922	$10, 742		
Barracuda	76, 501	$11, 222	130	$17	105, 008	14, 843		
Bonito	5, 688	171	330	13	23, 903	628		
Flounders:								
"California halibut"							100	$3
"Sole"							22	2
Mackerel			2, 343	247			1, 770	44
Mullet			15, 464	1, 382				
Perch			775	37				
Pompano			17, 155	1, 760				
Rock bass			4, 160	337	373	19	25, 578	1, 577
Rockfishes							5, 977	343
Sea bass:								
Black	197	11	8, 934	317	26, 838	1, 065	206, 087	9, 068
White, or squeteague	75	12	7, 752	1, 318			333, 801	19, 820
Skipjack, or striped tuna	139, 582	3, 839			14, 542, 766	563, 793		
Smelt			40	3				
Tuna:								
Bluefin					79	5		
Yellowfin	2, 212, 312	78, 803			10, 343, 136	583, 948		
Whitefish	140	3	610	18			13, 945	746
Yellowtail	39, 200	3, 942	7, 063	798	1, 484, 255	70, 986		
Other fish			1, 482	90	1, 290	65	16, 144	1, 028
Total	2, 473, 695	98, 003	66, 238	6, 337	26, 628, 570	1, 246, 094	603, 424	32, 631

Species	Gill nets		Trammel nets		Traps	
FISH	*Pounds*	*Value*	*Pounds*	*Value*	*Pounds*	*Value*
Barracuda	93, 331	$11, 768				
Bonito	5, 373	161				
Flounders, "California halibut"			483, 473	$64, 060		
Mackerel	7, 225	162	90	4		
Mullet	1, 852	152				
Rock bass	119	12	5, 076	253	80	$6
Rockfishes			820	30		
Sea bass:						
Black	883	52	27, 485	1, 239		
White, or squeteague	277, 830	30, 869	288	45		
Sheepshead					610	19
Smelt	280	20				
Whitefish			935	37		
Yellowtail	19, 371	1, 300				
Other fish	307	16				
Total	406, 571	44, 512	518, 167	65, 068	690	25
SHELLFISH, ETC.						
Sea crawfish, or spiny lobster					982, 835	176, 222
Grand total	406, 571	44, 512	518, 167	65, 668	983, 525	176, 247

PACIFIC HALIBUT [8]

AMERICAN AND CANADIAN FISHERIES

The halibut fishery of the Pacific coast, which is prosecuted by American and Canadian vessels, ranks as one of the foremost fisheries of that section. In 1928 the total weight of the catch landed

[8] To preclude the possibility of unwarranted comparison of figures given in this section with others for years previous to 1927, it should be explained that the figures as herein compiled differ from those published in separate reports for the Alaska fisheries and the Pacific Coast States. The difference lies principally in the fleet classifications as between Washington and Alaska, though there is reason to believe that the figures on landings also are not comparable with those previously published, due to variable practice in the inclusion of American-caught halibut landed at foreign ports as well as the possible duplication of figures.

The present compilation is a complete résumé of the landings of the American fleet for the year 1928 at all Pacific ports except those in Oregon and California, without omission or duplication. The fleet classification has been applied arbitrarily by including in the "Washington fleet" all vessels that land more than half of their catch in that State. All others were included in the "Alaska fleet." It has been necessary, in some cases, to use "hailing fares"; the error therefrom is estimated to be less than 2 per cent.

by vessels of both nationalities amounted to 54,915,000 pounds, valued at $5,673,000. This is virtually the same as the amount of the catch in 1927 and but little more than that for 1925 and 1926. Of this amount, 79 per cent was taken by American craft and 21 per cent by Canadian craft. Of the total catch, 57 per cent was landed in British Columbia. Due to Prince Rupert, British Columbia, having excellent rail facilities with western points of Canada and the United States, and being in close proximity to the fishing grounds, the majority of the British Columbia landings were made there. The rest of them were made at Vancouver and Victoria, British Columbia. Twenty-five per cent of the total catch was landed at ports in the State of Washington and 18 per cent at ports in Alaska.

AMERICAN FISHERY

Operating units.—The American halibut fleet numbered 226 vessels that fished regularly for halibut; their total tonnage was 5,657, they were manned by 1,696 fishermen, and operated 9,560 skates of lines. In addition to the regular vessels, 56 other vessels and 181 boats landed halibut at times. These used 2,960 skates of lines.

Catch.—The total weight of the catch as landed by all American craft fishing for halibut amounted to 47,507,419 pounds, valued at $4,645,617. Of this amount, 92 per cent consisted of halibut, 5 per cent of sablefish, 2 per cent of "lingcod," and 1 per cent of rockfishes. The regular halibut vessels made 93 per cent of the total catch, while the casual vessels and boats in this fishery caught the rest, or 7 per cent.

Halibut fishery of the Pacific coast, 1928

AMERICAN OPERATING UNITS: BY FLEET CLASSIFICATION

Items	Washington fleet	Alaska fleet	Total
Regular halibut vessels:			
Number	81	145	226
Net tonnage	1,922	3,735	5,657
Crew	580	1,116	1,696
Dories	81	145	226
Skates of lines	3,550	6,010	9,560
Vessels in other fisheries but landing one or more fares of halibut:			
Number	26	30	56
Net tonnage	401	446	847
Crew	137	114	251
Dories	19	22	41
Skates of lines	960	610	1,570
Regular halibut boats:			
Number		30	30
Crew		60	60
Skates of lines		450	450
Boats in other fisheries but landing one or more fares of halibut:			
Number	2	149	151
Crew	4	212	216
Skates of lines	40	900	940

Halibut fisheries of the Pacific coast, 1928—Continued

CATCH OF ALL SPECIES: BY AMERICAN VESSELS AND BOATS

Fleet classification	Landed in—						Total	
	Washington		British Columbia		Alaska			
	Pounds	*Value*	*Pounds*	*Value*	*Pounds*	*Value*	*Pounds*	*Value*
WASHINGTON FLEET								
Regular vessels:								
Halibut	9,316,825	$1,113,068	1,265,200	$142,580	370,665	$26,771	10,952,690	$1,282,419
Sablefish	2,209,400	104,506	5,000	200	8,363	369	2,222,763	105,075
"Lingcod"	719,750	26,941			17	1	719,767	26,942
Rockfishes	522,725	18,144			151	4	522,876	18,148
Total	12,768,700	1,262,659	1,270,200	142,780	379,196	27,145	14,418,096	1,432,584
Other vessels and boats:								
Halibut	889,550	92,394	31,500	2,828	8,754	884	929,804	96,106
Sablefish	112,400	5,450					112,400	5,450
"Lingcod"	191,200	6,640					191,200	6,640
Rockfishes	53,600	1,906					53,600	1,906
Total	1,246,750	106,390	31,500	2,828	8,754	884	1,287,004	110,102
ALASKA FLEET								
Regular vessels:								
Halibut	3,527,400	392,720	18,181,800	1,923,443	8,081,516	627,552	29,790,716	2,943,715
Sablefish	32,400	1,500	49,500	2,110	79,414	2,877	161,314	6,487
"Lingcod"	17,900	716					17,900	716
Rockfishes	14,100	570			371	6	14,471	576
Total	3,591,800	395,506	18,231,300	1,925,553	8,161,301	630,435	29,984,401	2,951,494
Other vessels and boats:								
Halibut	19,000	2,661	484,400	49,971	1,272,547	97,237	1,775,947	149,869
Sablefish	1,000	30	4,000	160	27,650	1,125	32,650	1,315
"Lingcod"					1,214	20	1,214	20
Rockfishes	800	24			7,307	209	8,107	233
Total	20,800	2,715	488,400	50,131	1,308,718	98,591	1,817,918	151,437
BOTH FLEETS								
Regular vessels:								
Halibut	12,844,225	1,505,788	19,447,000	2,066,023	8,452,181	654,323	40,743,406	4,226,134
Sablefish	2,241,800	106,006	54,500	2,310	87,777	3,246	2,384,077	111,562
"Lingcod"	737,650	27,657			17	1	737,667	27,658
Rockfishes	536,825	18,714			522	10	537,347	18,724
Total	16,360,500	1,658,165	19,501,500	2,068,333	8,540,497	657,580	44,402,497	4,384,078
Other vessels and boats:								
Halibut	908,550	95,055	515,900	52,799	1,281,301	98,121	2,705,751	245,975
Sablefish	113,400	5,480	4,000	160	27,650	1,125	145,050	6,765
"Lingcod"	191,200	6,640			1,214	20	192,414	6,660
Rockfishes	54,400	1,930			7,307	209	61,707	2,139
Total	1,267,550	109,105	519,900	52,959	1,317,472	99,475	3,104,922	261,539
All vessels and boats:								
Halibut	13,752,775	1,600,843	19,962,900	2,118,822	9,733,482	752,444	43,449,157	4,472,109
Sablefish	2,355,200	111,486	58,500	2,470	115,427	4,371	2,529,127	118,327
"Lingcod"	928,850	34,297			1,231	21	930,081	34,318
Rockfishes	591,225	20,644			7,829	219	599,054	20,863
Grand total	17,628,050	1,767,270	20,021,400	2,121,292	9,857,960	757,055	47,507,419	4,645,617

NOTE.—Weight of the catch is shown as landed.

Halibut fisheries of the Pacific coast, 1928—Continued

CATCH OF HALIBUT: BY AMERICAN AND CANADIAN VESSELS AND BOATS

[Expressed in thousands of pounds and thousands of dollars; that is 000 omitted]

Fleet classification	Landed in—						Total	
	Washington		British Columbia		Alaska			
	Quantity	*Value*	*Quantity*	*Value*	*Quantity*	*Value*	*Quantity*	*Value*
WASHINGTON FLEET								
Regular halibut vessels	9,317	1,113	1,265	143	370	26	10,952	1,282
Other vessels and boats	890	92	32	3	8	1	930	96
Total	10,207	1,205	1,297	146	378	27	11,882	1,378
ALASKA FLEET								
Regular halibut vessels	3,527	393	18,182	1,923	8,082	628	29,791	2,944
Other vessels and boats	19	3	484	50	1,273	97	1,776	150
Total	3,546	396	18,666	1,973	9,355	725	31,567	3,094
COMBINED FLEET								
Regular halibut vessels	12,844	1,506	19,447	2,066	8,452	654	40,743	4,226
Other vessels and boats	909	95	516	53	1,281	98	2,706	246
Total	13,753	1,601	19,963	2,119	9,733	752	43,449	4,472
British Columbia fleet			11,396	[1] 1,197	70	4	11,466	1,201
Grand total	13,753	1,601	31,359	3,316	9,803	756	54,915	5,673

[1] Estimated.

NOTE.—Weight of the catch is shown as landed.

Halibut fishery of the Pacific coast, 1925–1928

CATCH OF HALIBUT: BY AMERICAN AND CANADIAN VESSELS AND BOATS

[Expressed in thousands of pounds; that is, 000 omitted]

Year	Landed in—							Total		Grand total
	Washington	British Columbia [1]			Alaska					
	By American vessels	By American vessels	By Canadian vessels	Total	By American vessels	By Canadian vessels	Total	By American vessels	By Canadian vessels	
1925	9,685	22,390	7,731	30,121	10,038		10,038	42,113	7,731	49,844
1926	10,050	20,231	9,277	29,608	14,122		14,122	44,503	9,277	53,780
1927	11,789	18,258	10,076	28,334	15,052		15,052	45,099	10,076	55,175
1928	13,753	19,963	11,396	31,359	9,733	70	9,803	43,449	11,466	54,915

[1] Statistics furnished by American Consular Service and the Seattle and Prince Rupert Halibut Exchanges.

VESSEL FISHERIES AT SEATTLE, WASH.

During 1928 fishing vessels of 5 net tons and over and collecting vessels landed 33,773,388 pounds of fishery products at Seattle, valued at $3,147,362. This is an increase over the previous year of 7 per cent in the amount and a decrease of 3 per cent in value. The decrease in value was due mainly to the lesser value of the halibut landed.

The fishing vessels in 1928 made 1,165 trips and landed 17,547,015 pounds of fish, valued at $1,755,959. This is an increase of 94 trips and 12 per cent in amount, compared with the previous year, but a decrease of 13 per cent in the value. Halibut was the most important species taken by the fishing vessels, accounting for 78 per cent of the catch, while sablefish accounted for 13 per cent and "lingcod," rockfishes, and sturgeon the remaining 9 per cent.

The catch by fishing vessels was taken from fishing grounds along the Pacific coast from Oregon to Portlock Bank, Alaska. Hecate Straits ranked as the most important bank, 45 per cent of the catch being made there. Second in importance was Portlock Bank, which provided 28 per cent of the catch while the Flattery Banks ranked third, furnishing 20 per cent. The remainder of the catch was taken on the Oregon coast, Yakutat grounds, and along the west coast of Vancouver Island.

Most of the catch by fishing vessels was made during the eight months from March to October, inclusive, which is due mainly to the closed season on the taking of halibut from November 15 to February 15.

Collecting vessels landed 16,226,373 pounds of fishery products at Seattle in 1928, valued at $1,391,403, all of which were taken on Puget Sound. This was 3 per cent more than the landings made here the previous year by collecting vessels, and the value was 11 per cent greater. The increase in amount was due principally to the large landings of herring, while the greater value was accountable mainly to the higher value of salmon landed.

Of the total fishery products landed by collecting vessels, salmon accounted for 83 per cent, while herring, sole, crabs, smelt, steelhead trout, perch, rockfishes, flounders, "lingcod," and sturgeon, in the order of their importance, made up the remainder. Collecting vessels landed their largest fares during the months of May to November, inclusive, which is the time when salmon are in season. Landings by collecting vessels were largest during October.

Fishery products landed by American fishing vessels at Seattle, Wash., 1928

BY BANKS

Fishing grounds	Trips	Halibut		Sablefish		"Lingcod"	
	Number	*Pounds*	*Value*	*Pounds*	*Value*	*Pounds*	*Value*
Oregon coast	46	214, 200	$29, 982	672, 500	$32, 372	63, 400	$2, 478
Flattery Banks	396	1, 428, 475	192, 578	1, 247, 650	58, 658	488, 400	19, 771
Hecate Strait	573	6, 996, 720	812, 439	303, 900	13, 226	394, 120	10, 530
West coast Vancouver Island	3	3, 700	747	2, 000	120	2, 500	120
Yakutat Grounds	17	258, 000	37, 955	26, 000	1, 110	5, 300	128
Portlock Bank	130	4, 833, 300	520, 872			3, 400	146
Total	1, 165	13, 734, 395	1, 594, 573	2, 252, 050	105, 486	957, 120	33, 173

Fishing grounds	Rockfishes		Sturgeon		Total	
	Pounds	*Value*	*Pounds*	*Value*	*Pounds*	*Value*
Oregon coast	25, 100	$816	28, 000	$1, 400	1, 003, 200	$67, 048
Flattery Banks	326, 500	14, 140	500	10	3, 491, 525	285, 157
Hecate Strait	218, 350	6, 206	500	25	7, 913, 590	842, 426
West coast Vancouver Island	1, 500	70			9, 700	1, 057
Yakutat Grounds	3, 000	60			292, 300	39, 253
Portlock Bank					4, 836, 700	521, 018
Total	574, 450	21, 292	29, 000	1, 435	17, 547, 015	1, 755, 959

BY MONTHS

Months	Trips	Halibut		Sablefish		"Lingcod"	
	Number	*Pounds*	*Value*	*Pounds*	*Value*	*Pounds*	*Value*
January	11					93, 500	$5, 347
February	39	173, 525	$23, 651	63, 650	$2, 560	69, 250	3, 890
March	133	1, 889, 350	195, 302	53, 200	1, 724	79, 500	2, 646
April	144	1, 389, 000	156, 816	66, 850	2, 308	119, 100	3, 967
May	180	2, 214, 320	227, 897	50, 650	2, 327	166, 600	3, 465
June	145	1, 995, 050	212, 609	158, 400	8, 167	80, 320	1, 960
July	101	1, 578, 300	198, 257	196, 300	9, 688	38, 950	1, 407
August	131	2, 012, 200	210, 833	355, 100	17, 610	92, 900	1, 971
September	100	970, 650	145, 776	384, 100	18, 540	69, 800	2, 367
October	98	833, 500	118, 809	723, 600	33, 877	67, 300	2, 680
November	76	678, 500	104, 623	187, 200	8, 405	57, 900	2, 147
December	7			13, 000	780	22, 100	1, 326
Total	1, 165	13, 734, 395	1, 594, 573	2, 252, 050	105, 486	957, 120	33, 173

Months	Rockfishes		Sturgeon		Total	
	Pounds	*Value*	*Pounds*	*Value*	*Pounds*	*Value*
January	51, 500	$2, 810			145, 000	$8, 157
February	48, 500	2, 656			354, 925	32, 757
March	42, 400	1, 382			2, 064, 450	201, 054
April	63, 450	2, 100	500	$10	1, 688, 900	165, 201
May	86, 800	2, 153			2, 518, 270	235, 842
June	44, 100	1, 085			2, 277, 870	223, 821
July	19, 750	652			1, 833, 300	210, 004
August	54, 600	1, 154			2, 514, 800	231, 568
September	38, 500	1, 353	28, 000	1, 400	1, 491, 050	169, 436
October	56, 550	2, 461	500	25	1, 681, 450	157, 352
November	22, 600	744			946, 200	115, 919
December	45, 700	2, 742			80, 800	4, 848
Total	574, 450	21, 292	29, 000	1, 435	17, 547, 015	1, 755, 959

Fishery products landed by collecting vessels at Seattle, Wash., 1928 (taken in Puget Sound)

BY MONTHS

Species	January		February		March		April		May	
	Pounds	*Value*	*Pounds*	*Value*	*Pounds*	*Value*	*Pounds*	*Value*	*Pounds*	*Value*
Herring	168,000	$840	1,200,000	$6,000	160,000	$800	18,000	$900		
Salmon:										
King or spring							240,000	24,000	1,200,000	$120,000
Coho or silver									8,000	480
Trout, steelhead			8,000	1,280			16,000	1,600	22,000	2,200
Smelt	11,500	935			3,500	460				
Perch	8,000	560	6,000	300	22,000	1,100	6,000	150	8,600	576
Rockfishes	7,500	525			8,000	480	8,000	560	6,000	420
"Lingcod"					4,000	160				
Flounders	9,000	180			4,000	160	4,000	80		
"Sole"	33,000	1,280			18,000	720	72,000	880	16,000	640
Crabs	22,000	1,500	25,080	1,710	26,400	1,800	18,400	1,260	18,040	1,230
Total	259,000	5,820	1,239,080	9,290	245,900	5,680	382,400	29,430	1,278,640	125,546

Species	June		July		August		September	
	Pounds	*Value*	*Pounds*	*Value*	*Pounds*	*Value*	*Pounds*	*Value*
Sturgeon			640	$64	800	$160	4,800	$620
Salmon:								
Humpback or pink					12,600	756	210,000	6,300
Chum or keta	4,000	$480	8,000	800	39,200	1,586	48,000	2,100
King or spring	805,500	96,660	2,224,000	311,360	1,517,600	182,112	900,000	108,000
Coho or silver	252,300	25,230	356,850	32,120	650,400	52,032	590,000	47,200
Sockeye or red	8,500	850	12,000	1,440	39,200	4,700	42,000	4,200
Trout, steelhead	27,000	2,700	32,000	3,200	12,000	1,200	18,000	1,800
Smelt			15,000	1,730	42,000	5,880	32,000	3,200
Perch			14,000	560			6,000	420
Rockfishes	4,300	300					9,000	720
"Lingcod"	5,500	110	16,000	320	12,000	480		
Flounders	6,000	120	6,000	120	6,500	130	8,000	160
"Sole"	12,400	496	24,000	960	20,000	800	18,000	720
Total	1,125,500	126,946	2,708,490	352,674	2,352,300	249,836	1,885,800	175,440

Species	October		November		December		Total	
	Pounds	*Value*	*Pounds*	*Value*	*Pounds*	*Value*	*Pounds*	*Value*
Sturgeon	2,300	$230					8,540	$1,074
Herring			78,000	$780			1,624,000	9,320
Salmon:								
Humpback or pink							222,600	7,056
Chum or keta	1,406,000	56,240	640,000	32,000	293,994	$29,399	2,439,194	122,605
King or spring	122,000	12,200	30,000	3,000	27,169	2,717	7,066,269	860,049
Coho or silver	1,520,000	121,600	200,000	20,000			3,577,550	298,662
Sockeye or red							101,700	11,190
Trout, steelhead							135,000	13,980
Smelt	54,000	5,490	30,000	4,500	31,000	4,030	219,000	26,225
Perch			6,000	240	4,500	315	81,100	4,221
Rockfishes	11,000	660	10,000	600	11,000	660	74,800	4,925
"Lingcod"							37,500	1,070
Flounders	7,500	150	5,000	100			56,000	1,200
"Sole"	17,000	680	35,000	1,400	45,000	1,800	310,400	10,376
Crabs	59,400	4,050	66,000	4,500	37,400	3,400	[1] 272,720	19,450
Total	3,199,200	201,300	1,100,000	67,120	450,063	42,321	16,226,373	1,391,403

[1] 12,400 dozen.

LAKE FISHERIES

The latest complete statistical canvass made by the bureau of the American catch in the lake fisheries (Lakes Ontario, Erie, Huron, Michigan, Superior, St. Clair, Kabetogama, Namakan, and Sand Point, Lake of the Woods, and Rainy Lake) was for the year 1922. The statistics collected in this canvass are published in condensed form in Bureau of Fisheries Statistical Bulletin No. 618 and in full in the report of the division of fishery industries for 1923.

The statistics of the catch presented herewith for 1927 were obtained from the various State fisheries agencies and the Dominion of Canada report, while statistics of the operating units (fishermen, vessels, boats, and gear) actually fished in 1927 were obtained by the bureau in a personal canvass. In this latter canvass the catch, segregated as to method of taking, was not ascertained.

Statistics in the tables for the years 1913 to 1927 are for Lakes Ontario, Erie, Huron, Michigan, Superior, and Namakan, Lake of the Woods, and Rainy Lake. Those for the years 1913 to 1924 were obtained in a survey of the lake fisheries made by the United States Tariff Commission, while those for the years 1925 to 1927, inclusive, were compiled and supplemented by the bureau from State statistics. To complete the data for the various lakes there have been included statistics of the Canadian lake fisheries for the years 1913 to 1927, which were obtained from official reports of the Dominion of Canada. The statistics shown for the years 1913 to 1925 are exclusive of the production of Illinois. The disparity resulting from the noninclusion of the production of Illinois is negligible. The production of Indiana from 1913 to 1925 has been estimated. The 1926 and 1927 statistics of the fisheries of these two States were collected by the bureau, which permits of their inclusion with the statistics collected by New York, Pennsylvania, Ohio, Michigan, Wisconsin, and Minnesota.

In all cases the statistics collected are for the calendar year, except for Lake of the Woods and Rainy Lake, and Lake Namakan in Minnesota, which are for two seasons. For Lake of the Woods the seasons are from June 1 to November 1 and December 1 to April 1, and for Rainy and Namakan Lakes from May 15 to November 1 and December 1 to April 1. The catch for these two seasons, in the order named, have been combined to constitute a year. The quantity of fish taken in these lakes between January 1 and April 1 amounted to less than 3 per cent of the total catch in 1927.

UNITED STATES AND CANADA

GENERAL STATISTICS

In 1927 the total catch of the lake fisheries of the United States and Canada amounted to 111,952,531 pounds. This represents an increase of 9 per cent compared with the previous year and a decrease of 6 per cent compared with the 10-year average, 1917–1926. Of the total catch, that taken in the United States amounted to 81,326,550 pounds, valued at $6,794,891. This represents 73 per cent of the total catch of the lake fisheries. It is an increase of 8 per cent in amount compared with the previous year's catch and a decrease of 3 per cent compared with the 10-year average. The Canadian catch, which amounted to 30,625,981 pounds, shows an increase of 11 per cent as compared with the previous year and a decrease of 14 per cent as compared with the 10-year average of the Canadian catch.

CATCH

By species.—The statistics of the catch in the United States and Canada in 1927 shows that lake herring ranked first in quantity of production among species of fish taken in the lake fisheries. The catch in 1927 amounted to 25,650,527 pounds, which is 23 per cent of the total production for all the lake fisheries. It is an increase in production of 33 per cent as compared with the previous year and 38 per cent compared with the 10-year average for this species. About 86 per cent of the herring caught in the lake fisheries are caught in the waters of the United States. Lake trout ranks second in importance, with a catch of 17,569,041 pounds. This is a decrease of 2 per cent in amount compared with the previous year but an increase of 5 per cent over the 10-year average. About 60 per cent of the trout taken are caught in the waters of the United States. Blue pike rank third in importance, with a catch of 10,410,092 pounds in 1927. This is a decrease of 16 per cent compared with the production in 1926 and an increase of 5 per cent as compared with the 10-year average. The catch of whitefish nearly equaled the catch of blue pike and ranked fourth in importance, with a catch amounting to 10,254,736 pounds in 1927. This is an increase of 3 per cent over the previous year and less than 1 per cent as compared with the 10-year average. The catch of chubs, 88 per cent of which were caught in the waters of the United States, amounted to 7,991,167 pounds. This is an increase of 13 per cent over the previous year and 63 per cent over the 10-year average. The catch of yellow perch amounted to 7,722,562 pounds. This is an increase of 5 per cent over the catch in 1926 and 19 per cent when compared with the 10-year average. The catch of the cisco in Lake Erie (the only lake in which this species is taken) amounted to 4,658,939 pounds. This is an increase of 54 per cent compared with last year but is a decrease of 81 per cent compared with the 10-year average for this species. The catch of yellow pike, considered by some ichthyologists to be the same species as the blue pike, amounted to 4,578,654 pounds, showing a small increase compared with the catch of 1926 but a decrease of 3 per cent compared with the 10-year average for this species.

By lakes.—Statistics of the production in the United States and Canada in 1927, by lakes, shows that Lake Erie ranks as the most important, with a catch of 33,865,274 pounds. This is an increase of less than 1 per cent compared with the previous year and a decrease of 38 per cent compared with the 10-year average for this lake. Lake Huron ranks second in importance, the catch amounting to 24,575,270 pounds. This is an increase of 19 per cent over 1926 and 33 per cent as compared with the 10-year average. Lake Michigan ranks third, with a catch nearly equal to that for Lake Huron, or 23,680,884 pounds. This is an increase of 16 per cent in amount compared with the previous year and 9 per cent compared with the 10-year average for this lake. Lake Superior produced 20,453,162 pounds and was fourth in importance. This is an increase of 15 per cent compared with the catch in 1926 and 41 per cent compared with the

10-year average. Lake Ontario was next, with a production of 4,539,931 pounds. This is a decrease of 9 per cent compared with the catch for the previous year and 20 per cent compared with the 10-year average. The catch of Lake of the Woods, Rainy Lake, and Namakan Lake, which amounted to 4,838,010 pounds, shows a decrease of 6 per cent compared with 1926 and an increase of 11 per cent compared with the 10-year average for these lakes.

Lake fisheries of the United States and Canada, 1927

CATCH: BY LAKES

Species	Lake Ontario			Lake Erie		
	United States	Canada	Total	United States	Canada	Total
	Pounds	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*
Lake trout	41,796	713,500	755,296	8,866	200	9,066
Whitefish	165,660	1,503,300	1,668,960	624,445	748,000	699,245
Lake herring	102,347	730,800	833,147			
Chubs				1,187		1,187
Cisco				2,350,239	2,308,700	4,658,939
Sturgeon	19,221	6,310	25,531	6,434	42,512	48,946
Yellow pike	19,170	40,900	60,070	1,364,493	167,000	1,531,493
Blue pike	22,221	8,100	30,321	7,301,371	8,078,100	10,379,471
Sauger				1,167,815		1,167,815
Sucker, "mullet"	61,947		61,947	1,141,961		1,141,961
Sheepshead				4,318,443		4,318,443
Yellow perch	39,186	100,800	139,986	2,747,454	2,490,600	5,238,054
Pike (jacks)		124,400	124,400	15,420	8,400	23,820
Carp	17,639	68,500	86,139	1,698,278	197,000	1,895,278
White bass				121,124		121,124
Catfish and bullheads	41,562	107,000	148,562	557,343	42,400	599,743
Burbot	88,709		88,709	358,064		358,064
Miscellaneous	78,363	438,500	516,863	13,525	985,900	999,425
Total	697,821	3,842,110	4,539,931	23,796,462	10,068,812	33,865,274

Species	Lake Huron			Lake Michigan	Lake Superior		
	United States	Canada	Total	United States	United States	Canada	Total
	Pounds	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*
Lake trout	1,691,697	4,152,100	5,843,797	5,698,624	3,051,289	2,196,700	5,247,989
Whitefish	1,676,616	1,965,500	3,642,116	2,591,291	328,157	336,700	664,857
Lake herring	5,604,373	283,200	5,887,573	5,842,231	10,628,176	2,459,400	12,087,576
Chubs	825,486	980,600	1,806,086	4,764,769	877,933	1,200	879,133
Sturgeon	8,033	26,039	34,072	5,418	210	200	410
Yellow pike	901,401	397,000	1,298,401	59,199	24,350	78,800	103,150
Blue pike		300	300				
Sauger	26,634		26,634		12		12
Sucker, "mullet"	2,460,575		2,460,575	814,616	148,575		148,575
Sheepshead	40,342		40,342	1,960			
Yellow perch	203,542	112,700	316,242	1,969,855	14,576		14,576
Pike (jacks)	35,737	203,300	239,037	28,757	6,703	7,000	13,703
Carp	1,938,760	55,800	1,994,560	6,487		1,500	1,500
White bass					5,200		5,200
Catfish and bullheads	179,762	2,000	181,762	287			
Burbot	3,017		3,017	35,008	370		
Miscellaneous	114,756	686,000	800,756	1,862,382	216,011	70,100	286,370
Total	15,710,731	8,864,539	24,575,270	23,680,884	15,301,562	5,151,600	20,453,162

Lake fisheries of the United States and Canada, 1927—Continued

CATCH: BY LAKES—Continued

Species	Namakan Lake			Rainy Lake		
	United States	Canada	Total	United States	Canada	Total
	Pounds	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*
Lake trout					46	46
Whitefish	7,572	8,370	15,942	53,303	40,696	93,999
Chubs	51,306	9,485	60,791	69,172	383,596	452,768
Sturgeon	20	875	895	357	461	818
Yellow pike	18,331	18,975	37,306	50,676	258,189	308,865
Sucker "mullet"	235		235	10,986		10,986
Yellow perch	5,977		5,977	4,977	21,454	26,431
Pike (jacks)	33,468	4,970	38,438	57,607	234,371	291,978
Tullibees	4,000		4,000			
Miscellaneous					7,040	7,040
Total	120,909	42,675	163,584	247,078	945,853	1,192,931

Species	Lake of the Woods			Total all lakes		
	United States	Canada	Total	United States	Canada	Total
	Pounds	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*
Lake trout	87	14,136	14,223	10,492,359	7,076,682	17,569,041
Whitefish	15,884	189,242	205,126	5,462,928	4,791,808	10,254,736
Lake herring				22,177,127	3,473,400	25,650,527
Chubs	26,433		26,433	6,616,286	1,374,881	7,991,167
Cisco				2,350,239	2,308,700	4,658,939
Sturgeon	904	304	1,208	40,597	76,701	117,298
Yellow pike	587,716	592,454	1,180,170	3,025,336	1,553,318	4,578,654
Blue pike				7,323,592	3,086,500	10,410,092
Sauger	51,273		51,273	1,245,734		1,245,734
Sucker, "mullet"	126,450		126,450	4,765,345		4,765,345
Sheepshead				4,360,745		4,360,745
Yellow perch	9,699	1,742	11,441	4,995,266	2,727,296	7,722,562
Pike (jacks)	220,400	516,563	736,963	398,092	1,099,004	1,497,096
Carp	7,426	4,753	12,179	3,668,590	327,553	3,996,143
White bass				126,324		126,324
Catfish and bullheads	36,111		36,111	815,065	151,400	966,465
Tullibees	658,169	106,241	764,410	662,169	106,241	768,410
Burbot	25,804		25,804	510,972		510,972
Miscellaneous	4,747	284,957	289,704	2,289,784	2,472,497	4,762,281
Total	1,771,103	1,710,392	3,481,495	81,326,550	30,625,981	111,952,531

UNITED STATES

OPERATING UNITS

In conducting the survey of the operating units employed in the lake fisheries for 1927 an effort was made to determine the actual number of men, boats, and amount of gear employed in the fisheries. In making this determination only the average number of units of gear actually fishing simultaneously were counted, and those units being dried on shore, carried on the boats, or held in reserve were disregarded.

Fishermen.—There were 5,825 fishermen employed in the lake fisheries during 1927. Of this number, 72 per cent were engaged in the boat and shore fisheries and 28 per cent in the vessel fisheries. Thirty-three per cent fished on Lake Michigan, 28 per cent on Lake Erie, 17 per cent on Lake Superior, 15 per cent on Lake Huron, 4 per cent on Lake Ontario, and 3 per cent on Lake of the Woods, Rainy Lake, and Namakan Lake.

Vessels.—During 1927 there were 145 steam vessels and 256 motor vessels engaged in the lake fisheries of the United States. Of this number, 39 per cent of the steam vessels and 64 per cent of the motor vessels were engaged in fishing on Lake Michigan, 37 per cent of the steam vessels and 16 per cent of the motor vessels on Lake Erie, 14 per cent of the steam vessels and 11 per cent of the motor vessels were engaged on Lake Huron, 10 per cent of the steam vessels and 7 per cent of the motor vessels on Lake Superior, only 2 motor vessels were engaged on Lake Ontario, and only 1 on Lake of the Woods.

Boats.—There were 1,283 motor boats and 1,078 row boats employed in the lake fisheries during 1927. Of this number, 25 per cent of the motor boats and 16 per cent of the row boats were engaged on Lake Michigan, 25 per cent of the motor boats and 21 per cent of row boats on Lake Erie, 20 per cent of the motor boats and 44 per cent of row boats on Lake Superior, 18 per cent of the motor boats and 7 per cent of the row boats on Lake Huron, 5 per cent of the motor boats and 9 per cent of the row boats on Lake Ontario, and 7 per cent of the motor boats and 3 per cent of the row boats were engaged on Lake of the Woods, Rainy Lake, and Namakan Lake.

Gill nets.—During 1927 an average number of 105,732 gill nets was used in the lake fisheries. These nets had a total area, as fished, of 25,758,647 square yards, or more than 8 square miles. Of this amount, about 51 per cent were used on Lake Michigan, 26 per cent on Lake Erie, 14 per cent on Lake Superior, 8 per cent on Lake Huron, less than 1 per cent on Lake Ontario, and less than 1 per cent on Lake of the Woods, Rainy Lake, and Namakan Lake.

Pound nets.—There were 1,766 pound nets used. Of this total, 48 per cent were used on Lake Huron, 32 per cent on Lake Michigan, 11 per cent on Lake Superior, 5 per cent on Lake Erie, and 4 per cent on Lake of the Woods, Rainy Lake, and Namakan Lake. Fishing with pound nets is not permitted on Lake Ontario by New York State.

Trap nets.—There were 6,316 trap nets fished during 1927. Of this number, 67 per cent were fished on Lake Erie, 24 per cent on Lake Huron, 5 per cent on Lake Ontario, 3 per cent on Lake Michigan, and 1 per cent on Lake Superior. Fishing with trap nets is not permitted by the State of Minnesota in the waters of Lake of the Woods, Rainy Lake, and Namakan Lake.

Fyke nets.—There were 2,373 fyke nets fished on the Great Lakes during 1927. Of this amount, 48 per cent were fished on Lake Erie, 32 per cent on Lake Michigan, 10 per cent on Lake Huron, 5 per cent on Lake Ontario, 4 per cent on Lake of the Woods, Rainy Lake, and Namakan Lake, and 1 per cent on Lake Superior.

Hooks.—There were 689,704 hooks fished during 1927. Forty-six per cent of these were fished on Lake Michigan, 40 per cent on Lake Superior, 10 per cent on Lake Huron, 2 per cent on Lake Erie, and 2 per cent on Lake Ontario. Fishing with trawl lines is not permitted by the State of Minnesota in the waters of Lake of the Woods, Rainy Lake, and Namakan Lake.

Seines.—During 1927 there were 247 seines used in the lake fisheries. Of this number, 64 per cent were fished on Lake Erie, 21 per cent on Lake Huron, 8 per cent on Lake Michigan, 4 per cent on Lake Ontario, and 3 per cent on Lake Superior.

Other apparatus.—Local and minor apparatus consisted of 49 trolling hooks fished on Lake Superior and 4 machine traps operated on the Niagara River.

Lake fisheries of the United States, 1927

OPERATING UNITS: BY STATES

Items	New York	Pennsylvania	Ohio	Michigan	Indiana	Illinois	Wisconsin	Minnesota	Total
Fishermen:									
On boats and shore	308	45	827	1,612	19	24	738	605	4,178
On vessels	116	264	181	707	26	27	324	2	1,647
Total	424	309	1,008	2,319	45	51	1,062	607	5,825
Vessels:									
Steam	8	26	10	64	3	1	24		145
Net tonnage	195	643	464	1,206	69	14	609		3,200
Motor	17	13	14	133	3	6	69	1	256
Net tonnage	110	142	195	1,225	83	55	985	7	2,752
Boats:									
Motor	84	13	250	565	11	8	193	159	1,283
Row	126	7	149	276	1	4	97	418	1,078
Other				7					7
Apparatus:									
Gill nets	7,235	11,332	9,626	42,779	1,293	1,752	25,160	6,555	105,732
Square yards	1,593,511	2,248,700	1,155,614	11,204,098	341,597	362,910	6,677,258	2,174,959	25,758,647
Pound nets		50	36	1,363	10	1	229	77	1,766
Trap nets	348	25	4,034	1,904			5		6,316
Fyke nets	117		840	621		288	420	87	2,373
Hooks	28,950		2,400	464,080	7,200		187,074		689,704
Trolling hooks				49					49
Machine traps	4								4
Seines	9		124	95			19		247
Square yards	2,261		223,272	100,495			21,661		347,689

OPERATING UNITS: BY LAKES

Items	Lake Ontario	Lake Erie	Lake Huron	Lake Michigan	Lake Superior	Lake of the Woods, Rainy Lake, and Namakan Lake	Total
Fishermen:							
On boats and shore	242	1,079	668	1,170	870	149	4,178
On vessels	6	555	196	754	134	2	1,647
Total	248	1,634	864	1,924	1,004	151	5,825
Vessels:							
Steam		53	20	57	15		145
Net tonnage		1,302	398	1,107	393		3,200
Motor	2	42	27	165	19	1	256
Net tonnage	10	437	267	1,879	152	7	2,752
Boats:							
Motor	66	313	234	319	259	92	1,283
Row	94	222	78	177	477	30	1,078
Other			4	3			7
Apparatus:							
Gill nets	1,100	27,096	8,593	53,461	15,135	347	105,732
Square yards	267,530	4,730,717	2,931,155	12,977,656	4,768,452	83,137	25,758,647
Pound nets		86	856	560	187	77	1,766
Trap nets	333	4,210	1,511	207	55		6,316
Fyke nets	117	1,144	251	753	21	87	2,373
Hooks	15,650	15,900	70,050	311,870	276,234		689,704
Trolling hooks					49		49
Machine traps	3	1					4
Seines	9	159	51	20	8		247
Square yards	2,261	265,139	51,433	21,737	7,119		347,689

Fisheries of Lake Ontario, in the United States, 1927

OPERATING UNITS: BY GEAR

Items	Gill nets	Trap nets	Fyke nets	Sturgeon hooks	Seines	Machine traps	Total, exclusive of duplication
Fishermen:							
On boats and shore	97	103	20	46	19	3	242
On vessels	6	1					6
Total	103	104	20	46	19	3	248
Boats:							
Motor	42	27	5	9	2		66
Row	24	26	12	35	9		94
Vessels, motor, 5 to 10 tons	2	1					2
Net tonnage	10	5					10
Apparatus:							
Number	1,100	333	117	15,650	9	3	
Square yards	267,530				2,261		

Fisheries of Lake Erie, in the United States, 1927

OPERATING UNITS: BY GEAR

Items	Gill nets	Pound nets	Trap nets	Fyke nets	Hooks	Seines	Total, exclusive of duplication
Fishermen:							
On boats and shore	106	37	501	96	43	374	1,079
On vessels	555		20	20			555
Total	661	37	521	116	43	374	1,634
Boats:							
Motor	40	11	173	36	2	78	313
Row	26	2	16	8	40	142	222
Vessels:							
Steam—							
5 to 10 tons	1		1	1			2
11 to 20 tons	12						12
21 to 30 tons	29		1	1			30
31 to 40 tons	7						7
41 to 50 tons	1						1
51 to 60 tons	1						1
Total	51		2	2			53
Net tonnage	1,270		32	32			1,302
Motor—							
5 to 10 tons	30						30
11 to 20 tons	8						8
21 to 30 tons	2						2
31 to 40 tons	2						2
Total	42						42
Net tonnage	437						437
Grand total	93		2	2			95
Net tonnage	1,707		32	32			1,739
Apparatus: [1]							
Number	27,096	86	4,210	1,144	15,900	159	
Square yards	4,730,717					265,139	

[1] In addition to the above apparatus 1 machine trap was operated.

Fisheries of Lake Huron, in the United States, 1927

OPERATING UNITS: BY GEAR

Items	Gill nets	Pound nets	Trap nets	Fyke nets	Hooks	Seines	Total, exclusive of duplication
Fishermen:							
On boats and shore	180	342	188	31	16	129	668
On vessels	174	24	26	4	47		196
Total	354	366	214	35	63	129	864
Boats:							
Motor	63	115	73	15	9	38	234
Row	36	7	8	6	2	28	78
Other	4						4
Vessels:							
Steam—							
5 to 10 tons	4	1	1		2		5
11 to 20 tons	7	2	1		1		8
21 to 30 tons	3				2		3
31 to 40 tons	3				1		3
51 to 60 tons	1						1
Total	18	3	2		6		20
Net tonnage	378	32	20		113		398
Motor—							
5 to 10 tons	14	5	5	1	2		17
11 to 20 tons	6		4		1		10
Total	20	5	9	1	3		27
Net tonnage	192	35	95	9	32		267
Grand total	38	8	11	1	9		47
Net tonnage	570	67	115	9	145		665
Apparatus:							
Number	8,593	856	1,511	251	70,050	51	
Square yards	2,931,155					51,433	

Fisheries of Lake Michigan, 1927

OPERATING UNITS: BY GEAR

Items	Gill nets	Pound nets	Trap nets	Fyke nets	Hooks	Seines	Total, exclusive of duplication
Fishermen:							
On boats or shore	962	301	35	107	46	42	1,170
On vessels	705	22		89	161		754
Total	1,667	323	35	196	207	42	1,924
Boats:							
Motor	251	49	12	42	15	14	319
Row	138	21	9	30	11	11	177
Sail	2	1					3
Vessels:							
Steam—							
5 to 10 tons	9	1			2		10
11 to 20 tons	24	2			5		25
21 to 30 tons	10				5		12
31 to 40 tons	6				4		7
41 to 50 tons	2				1		2
51 to 60 tons	1						1
Total	52	3			17		57
Net tonnage	1,000	37			375		1,107
Motor—							
5 to 10 tons	96	19	6	8	20		105
11 to 20 tons	39	2	1		11		41
21 to 30 tons	10				2		11
31 to 40 tons	6				1		6
41 to 51 tons	2						2
Total	153	21	7	8	34		165
Net tonnage	783	165	51	60	390		1,879
Grand total	205	24	7	8	51		222
Net tonnage	1,783	202	51	60	765		2,986
Apparatus:							
Number	53,461	560	207	753	311,870	20	
Square yards	12,977,656					21,737	

Fisheries of Lake Superior, in the United States, 1927

OPERATING UNITS: BY GEAR

Items	Gill nets	Pound nets	Trap nets	Fyke nets	Hooks	Trolling hooks	Seines	Total, exclusive of duplication
Fishermen:								
On boats or shore	796	86	18	11	165	10	8	870
On vessels	121	2		2	57			134
Total	917	88	18	13	222	10	8	1,004
Boats:								
Motor	219	39	6	6	93	8	2	259
Row	465	12	8	4	11		6	477
Vessels:								
Steam—								
5 to 10 tons	3	1			2			3
11 to 20 tons	3				2			3
21 to 30 tons	3				1			3
31 to 40 tons	3				2			3
41 to 50 tons	1				1			2
51 to 60 tons	1							1
Total	14	1			8			15
Net tonnage	350	10			225			393
Motor:								
5 to 10 tons	10	1		1	9			13
11 to 20 tons	5	4			2			6
Total	15	5		1	11			19
Net tonnage	116	42		6	88			152
Grand total	29	6		1	19			34
Net tonnage	466	52		6	313			545
Apparatus:								
Number	15,135	187	55	21	276,234	49	8	
Square yards	4,768,452						7,119	

Fisheries of Lake of the Woods, Rainy Lake, and Namakan Lake, in the United States, 1927

OPERATING UNITS: BY GEAR

Items	Gill nets	Pound nets	Fyke nets	Total, exclusive of duplication
Fishermen:				
On boats and shore	121	33	22	149
On vessels	2			2
Total	123	33	22	151
Boats:				
Motor	75	20	20	92
Row	28		2	30
Vessels, motor, 5 to 10 tons	1			1
Net tonnage	7			7
Apparatus:				
Number	347	77	87	
Square yards	83,137			

Lake fisheries of the United States, 1927

OPERATING UNITS: BY LAKES

Items	New York			Pennsylvania, Lake Erie	Ohio, Lake Erie
	Lake Ontario	Lake Erie	Total		
Fishermen:					
On boats and shore	242	66	308	45	827
On vessels	6	110	116	264	181
Total	248	176	424	309	1,008
Boats:					
Motor	66	18	84	13	250
Row	94	32	126	7	149
Vessels:					
Steam		8	8	26	19
Net tons		195	195	643	464
Motor	2	15	17	13	14
Net tons	10	100	110	142	195
Total	2	23	25	39	33
Net tons	10	295	305	785	659
"Shoal" gill nets, 3-3$\frac{7}{16}$ inches: [1]					
Fished by boats	409	237	646	122	1,163
Square yards	77,460	31,395	108,855	17,694	52,524
Fished by vessels	20	2,086	2,106	7,784	7,370
Square yards	1,778	287,754	289,532	1,232,827	823,493
Total	429	2,323	2,752	7,906	8,533
Square yards	79,238	319,149	398,387	1,250,521	876,017
"Shoal" gill nets, 4½-6 inches: [2]					
Fished by boats	503	72	575		90
Square yards	109,147	11,520	120,667		12,000
Fished by vessels	110	2,360	2,470	840	
Square yards	20,889	522,416	543,305	117,520	
Total	613	2,432	3,045	840	90
Square yards	130,036	533,936	663,972	117,520	12,000
"Bull" gill nets, 3-3$\frac{7}{16}$ inches: [1]					
Fished by boats		48	48		
Square yards		18,432	18,432		
Fished by vessels		880	880	1,738	832
Square yards		345,205	345,205	707,699	254,720
Total		928	928	1,738	832
Square yards		363,637	363,637	707,699	254,720
"Bull" gill nets, 4½-5½ inches: [2]					
Fished by boats		72	72		
Square yards		15,360	15,360		
Fished by vessels		296	296	848	
Square yards		75,777	75,777	172,960	
Total		368	368	848	
Square yards		91,137	91,137	172,960	
Sturgeon gill nets, 10-12 inches: [3]					
Fished by boats	58	84	142		
Square yards	58,256	18,122	76,378		
Bar gill nets, 5 inches: [4]					
Fished by boats					147
Square yards					11,917
Perch gill nets, 2¾ inches: [5]					
Fished by boats					24
Square yards					960

[1] Used principally for taking ciscoes in Lake Erie and lake herring in Lake Ontario.
[2] Used principally for taking whitefish, trout, and suckers.
[3] Used principally for taking sturgeon.
[4] Used principally for taking carp.
[5] Used principally for taking perch.

Lake fisheries of the United States, 1927—Continued

OPERATING UNITS: BY LAKES—Continued

Items	New York			Pennsylvania, Lake Erie	Ohio, Lake Erie
	Lake Ontario	Lake Erie	Total		
Pound nets, fished by boats [6]				50	36
Trap nets: [6]					
Fished by boats	332	15	347	25	3,984
Fished by vessels	1		1		50
Total	333	15	348	25	4,034
Fyke nets: [6]					
Fished by boats	117		117		660
Fished by vessels					180
Total	117		117		840
Hooks: Fished by boats [7]					2,400
Sturgeon hooks, fished by boats [8]	15,650	13,300	28,950		
Machine traps [9]	3	1	4		
Seines: Fished by boats [10]	9		9		124
Square yards	2,261		2,261		223,272

Items	Michigan					Indiana, Lake Michigan
	Lake Erie	Lake Huron	Lake Michigan	Lake Superior	Total	
Fishermen:						
On boats and shore	141	668	518	285	1,612	19
On vessels		196	391	120	707	26
Total	141	864	909	405	2,319	45
Boats:						
Motor	32	234	164	135	565	11
Row	34	78	108	56	276	1
Other		4	3		7	
Vessels:						
Steam		20	30	14	64	3
Net tons		398	448	360	1,206	69
Motor		27	90	16	133	3
Net tons		267	828	130	1,225	33
Total		47	120	30	197	6
Net tons		665	1,276	490	2,431	102
Gill nets, 2¼–2¾ inches: [1]						
Fished by boats	3	518	2,492	610	3,623	112
Square yards	422	104,652	283,201	111,877	500,152	19,250
Fished by vessels		2,140	4,162	354	6,656	587
Square yards		703,950	946,409	79,312	1,729,671	149,980
Total	3	2,658	6,654	964	10,279	699
Square yards	422	808,602	1,229,610	191,189	2,229,823	169,230

[1] Used principally for taking chubs, herring, perch, and Menominees. In Michigan the minimum-sized mesh allowed by the State law is 2½ inches.
[6] Used for taking miscellaneous fish.
[7] Used principally for taking catfish.
[8] Used principally for taking sturgeon.
[9] Used principally for taking lake herring, blue pike, suckers, and shad.
[10] Used principally for taking carp, catfish, bullheads, and burbot

Lake fisheries of the United States, 1927—Continued

OPERATING UNITS: BY LAKES—Continued

Items	Michigan					Indiana, Lake Michigan
	Lake Erie	Lake Huron	Lake Michigan	Lake Superior	Total	
Gill nets, 4–6-inches: [2]						
Fished by boats		2,106	5,733	3,095	10,934	42
Square yards		705,252	1,192,982	788,148	2,686,382	10,500
Fished by vessels		3,829	14,959	2,778	21,566	552
Square yards		1,417,301	3,810,746	1,059,846	6,287,893	161,867
Total		5,935	20,692	5,873	32,500	594
Square yards		2,122,553	5,003,728	1,847,994	8,974,275	172,367
Pound nets: [3]						
Fished by boats		820	294	89	1,203	10
Fished by vessels		36	80	44	160	
Total		856	374	133	1,363	10
Trap nets: [3]						
Fished by boats	136	1,340	63	54	1,593	
Fished by vessels		171	140		311	
Total	136	1,511	203	54	1,904	
Fyke nets: [3]						
Fished by boats	304	241	66		611	
Fished by vessels		10			10	
Total	304	251	66		621	
Hooks: [4]						
Fished by boats	200	15,900	14,720	135,310	166,130	
Fished by vessels		54,150	121,400	122,400	297,950	7,200
Total	200	70,050	136,120	257,710	464,080	7,200
Trolling hooks, fished by boats [4]				49	49	
Seines, fished by boats [5]	35	51	1	8	95	
Square yards	41,867	51,433	76	7,119	100,495	

Items	Illinois, Lake Michigan	Wisconsin			Minnesota		
		Lake Michigan	Lake Superior	Total	Lake Superior	Lake of the Woods, Rainy Lake, and Namakan Lake	Total
Fishermen:							
On boats and shore	24	609	129	738	456	149	605
On vessels	27	310	14	324		2	2
Total	51	919	143	1,062	456	151	607
Boats:							
Motor	8	136	57	193	67	92	159
Row	4	64	33	97	388	30	418
Vessels:							
Steam	1	23	1	24			
Net tons	14	576	33	609			
Motor	6	66	3	69		1	1
Net tons	55	963	22	985		7	7
Total	7	89	4	93		1	1
Net tons	69	1,539	55	1,594		7	7

[2] Used principally for taking whitefish, trout, and suckers. In Michigan the minimum-sized mesh allowed by the State law is 4½ inches.
[3] Used for taking miscellaneous fish.
[4] Used principally for taking trout.
[5] Used principally for taking carp, pike, perch, and suckers.

Lake fisheries, of the United States, 1927—Continued

OPERATING UNITS: BY LAKES—Continued

Items	Illinois, Lake Michigan	Wisconsin			Minnesota		
		Lake Michigan	Lake Superior	Total	Lake Superior	Lake of the Woods, Rainy Lake, and Namakan Lake	Total
Gill nets, 2⅜–2¾ inches:[1]							
Fished by boats	441	6,321	450	6,771	4,671		4,671
Square yards	69,663	800,418	110,223	910,64[illegible]	1,537,464		1,537,464
Fished by vessels	528	6,315	132	6,447			
Square yards	100,725	1,903,970	40,614	1,944,584			
Total	969	12,636	582	13,218	4,671		4,671
Square yards	170,388	2,704,388	150,837	2,855,225	1,537,4[illegible]4		1,537,464
Gill nets, 4–6 inches:[2]							
Fished by boats	210	5,114	1,370	6,484	1,537	343	1,880
Square yards	40,906	837,2[illegible]9	428,410	1,265,699	554,358	81,803	636,161
Fished by vessels	573	5,320	138	5,458		4	4
Square yards	151,616	2,498,134	58,200	2,556,334		1,334	1,334
Total	783	10,434	1,508	11,942	1,537	347	1,884
Square yards	192,522	3,335,423	486,610	3,822,033	554,358	83,137	637,495
Pound nets:[3]							
Fished by boats	1	171	54	225		77	77
Fished by vessels		4		4			
Total	1	175	54	229		77	77
Trap nets:[3] Fished by boats		4	1	5			
Fyke nets:[3]							
Fished by boats	218	349	17	366		87	87
Fished by vessels	75	50	4	54			
Total	288	399	21	420		87	87
Hooks:[4]							
Fished by boats		21,150	18,524	39,674			
Fished by vessels		147,400		147,400			
Total		168,550	18,524	187,074			
Seines:[5] Fished by boats		19		19			
Square yards		21,661		21,661			

[1] Used principally for taking chubs, herring, perch, and bluefin. In Illinois the minimum sized mesh allowed by State law in 2½ inches.
[2] Used principally for taking whitefish, trout, pike, and suckers. In Illinois the minimum sized mesh allowed by State law is 4½ inches.
[3] Used for taking miscellaneous fish.
[4] Used principally for taking trout.
[5] Used principally for taking carp and suckers.

CATCH

Michigan, with frontage on Lakes Erie, Huron, Michigan, and Superior, ranked first in importance in the Lake fisheries of the United States in 1927. The catch in the waters of this State amounted to 32,503,014 pounds, valued at $3,078,151. This is 40 per cent of the total quantity of the Lakes production in the United States and 45 per cent of the total value. Ohio, with fisheries only on Lake Erie, ranked second with a catch of 16,653,943 pounds, valued at $1,064,883. This is 20 per cent of the total quantity and 16 per cent of the total value. Wisconsin, with fisheries in Lakes Michigan and Superior, ranked third with a catch of 12,410,466 pounds, valued at $1,127,015. This represents 15 per cent of the total quantity and

17 per cent of the total value. Minnesota was fourth with a catch of 12,167,316 pounds, valued at $583,607. Minnesota has fisheries on Lake Superior, Lake of the Woods, Rainy Lake, and Namakan Lake, and its catch in these waters amounted to 15 per cent of the total quantity and 9 per cent of the total value. The catch of Pennsylvania, which is taken entirely in Lake Erie, amounted to 4,408,194 pounds, valued at $512,184. This is 5 per cent of the total quantity and 8 per cent of the total value. The catch of New York, which was taken from Lakes Ontario and Erie, amounted to 2,019,542 pounds, valued at $257,807. This is 2 per cent of the total catch and 4 per cent of the total value. The catch in Indiana amounted to 775,716 pounds, valued at $113,507. This is about 1 per cent of the total production and 2 per cent of the total value. The catch of Illinois amounted to 388,359 pounds, valued at $57,737. This is less than 1 per cent of the total production and 1 per cent of the total value.

Lake fisheries of the United States, 1927

CATCH: BY STATES

Species	New York		Pennsylvania		Ohio		Michigan	
	Pounds	*Value*	*Pounds*	*Value*	*Pounds*	*Value*	*Pounds*	*Value*
Lake trout	50,610	$7,993	52	$7			6,785,335	$1,064,651
Whitefish	259,869	53,448	288,135	72,476	242,101	$48,420	4,180,492	751,549
Lake herring	102,347	8,990					9,923,532	316,994
Chubs							2,604,661	237,668
Cisco	612,050	77,435	1,624,737	198,048	113,452	13,614		
Sturgeon	24,546	11,919	1,109	444			12,861	4,033
Yellow pike	24,522	4,292	19,175	2,676	1,268,670	204,256	1,007,387	221,123
Blue pike	497,366	49,445	2,189,557	214,379	4,636,669	296,747		
Sauger					1,144,197	89,247	50,264	4,621
Sucker "mullet"	140,776	9,670	20,829	577	971,666	43,725	3,491,154	240,097
Sheepshead			33,808	1,345	4,065,713	89,446	261,224	4,000
Yellow perch	79,555	7,838	206,329	19,881	2,468,417	182,663	665,470	51,804
Pike (jacks)							63,661	5,794
Carp	18,879	1,660	3,465	125	733,911	36,696	2,904,909	123,811
White bass			4,343	847	116,781	11,678		
Catfish and bullheads	41,950	7,427	3,157	377	535,730	41,259	198,117	27,129
Burbot	88,709	9,256	7,443	118	849,921	6,998	15,534	581
Miscellaneous	78,363	8,434	6,555	1,384	6,715	134	338,413	24,296
Total	2,019,542	257,807	4,408,194	512,184	16,653,943	1,064,883	32,503,014	3,078,151

Species	Indiana		Illinois		Wisconsin		Minnesota		Total	
	Pounds	*Value*	*Pounds*	*Value*	*Pounds*	*Value*	*Pounds*	*Value*	*Pounds*	*Value*
Lake trout	252,546	$50,509	167,354	$31,797	2,912,763	$520,173	323,699	$45,412	10,492,359	$1,720,542
Whitefish	22,436	5,609			388,433	68,468	81,462	10,874	5,462,928	1,010,834
Lake herring	143,352	14,335	29,045	2,905	2,702,990	90,829	9,275,861	329,277	22,177,127	763,330
Chubs	234,184	28,104	175,270	21,032	3,042,758	276,258	559,413	83,746	6,616,286	596,808
Cisco									2,350,239	289,097
Sturgeon					800	190	1,281	542	40,597	17,128
Yellow pike					48,859	8,983	656,723	98,761	3,025,836	540,091
Blue pike									7,323,592	560,571
Sauger							51,273	4,151	1,245,734	98,019
Sucker "mullet"	1,949	195					139,471	3,693	4,765,345	297,957
Sheepshead									4,360,745	94,791
Yellow perch	92,488	11,099	16,690	2,003	1,445,664	71,290	20,653	2,053	4,995,266	348,631
Pike (jacks)					22,956	2,366	311,475	17,333	398,092	25,493
Carp							7,426	497	3,668,590	162,789
White bass					5,200	520			126,324	12,545
Catfish and bullheads							36,111	3,971	815,065	80,163
Tullibees							662,169	31,435	662,169	31,435
Burbot	23,561	2,356					25,804	444	510,972	19,758
Miscellaneous	5,200	1,300			1,840,043	87,948	14,495	1,418	2,289,784	124,914
Total	775,716	113,507	388,359	57,737	12,410,466	1,127,015	12,167,316	583,607	81,326,550	6,794,891

Lake fisheries of the United States, 1927—Continued

CATCH: BY LAKES

Species	Lake Erie									
	New York		Pennsylvania		Ohio		Michigan		Total	
	Pounds	*Value*	*Pounds*	*Value*	*Pounds*	*Value*	*Pounds*	*Value*	*Pounds*	*Value*
Lake trout	8, 814	$1, 084	52	$7					8, 866	$1, 091
Whitefish	94, 209	24, 068	288, 135	72, 476	242, 101	$48, 420			624, 445	144, 964
Chubs							1, 187	$119	1, 187	119
Cisco	612, 050	77, 435	1, 624, 737	198, 048	113, 452	13, 614			2, 350, 239	289, 097
Sturgeon	5, 325	2, 588	1, 109	444					6, 434	3, 032
Yellow pike	5, 352	672	19, 175	2, 676	1, 268, 670	204, 256	71, 296	11, 202	1, 364, 493	218, 806
Blue pike	475, 145	46, 678	2, 189, 557	214, 379	4, 636, 669	296, 747			7, 301, 371	557, 804
Sauger					1, 144, 197	89, 247	23, 618	1, 862	1, 167, 815	91, 109
Sucker, "mullet"	78, 829	4, 781	20, 329	577	971, 666	43, 725	71, 137	3, 790	1, 141, 961	52, 873
Sheepshead			33, 808	1, 345	4, 065, 713	89, 446	218, 922	2, 031	4, 318, 443	92, 822
Yellow perch	40, 369	4, 309	206, 329	19, 881	2, 468, 417	182, 663	32, 339	3, 156	2, 747, 454	210, 009
Pike (jacks)							15, 420	576	15, 420	576
Carp	1, 240	63	3, 465	125	733, 911	36, 696	959, 662	67, 583	1, 698, 278	104, 467
White bass			4, 343	347	116, 781	11, 678			121, 124	12, 025
Catfish and bullheads	388	48	3, 157	377	535, 730	41, 259	18, 068	2, 121	557, 343	43, 805
Burbot			7, 448	118	349, 921	6, 998	700	48	358, 064	7, 164
Miscellaneous			6, 555	1, 384	6, 715	134	255	3	13, 525	1, 521
Total	1, 321, 721	161, 726	4, 408, 194	512, 184	16, 653, 943	1, 064, 883	1, 412, 604	92, 491	23, 796, 462	1, 831, 284

Species	Lake Michigan									
	Michigan		Indiana		Illinois		Wisconsin		Total	
	Pounds	*Value*	*Pounds*	*Value*	*Pounds*	*Value*	*Pounds*	*Value*	*Pounds*	*Value*
Lake trout	2, 900, 036	$494, 852	252, 546	$50, 509	167, 354	$31, 797	2, 378, 688	$459, 225	5, 698, 624	$1,036,383
Whitefish	2, 254, 623	384, 124	22, 436	5, 609			314, 232	58, 089	2, 591, 291	447, 822
Lake herring	3, 932, 068	82, 165	143, 352	14, 335	29, 045	2, 905	1, 737, 766	67, 961	5, 842, 231	167, 366
Chubs	1, 381, 715	112, 893	234, 184	28, 104	175, 270	21, 032	2, 973, 600	272, 627	4, 764, 769	434, 656
Sturgeon	4, 618	1, 894					800	190	5, 418	2, 084
Yellow pike	24, 055	4, 194					35, 144	6, 131	59, 199	10, 325
Sucker, "mullet"	812, 667	46, 249	1, 949	195					814, 616	46, 444
Sheepshead	1, 960	192							1, 960	192
Yellow perch	417, 712	22, 551	92, 488	11, 099	16, 690	2, 003	1, 442, 965	70, 950	1, 969, 855	106, 603
Pike (jacks)	9, 887	1, 140					18, 870	1, 807	28, 757	2, 947
Carp	6, 487	395							6, 487	395
Catfish and bullheads	287	21							287	21
Burbot	11, 447	436	23, 561	2, 356					35, 008	2, 792
Miscellaneous	201, 388	13, 743	5, 200	1, 300			1, 655, 794	81, 764	1, 862, 382	96, 807
Total	11, 958, 950	1, 164, 849	775, 716	113, 507	388, 359	57, 737	10, 557, 859	1, 018, 744	23, 680, 884	2, 354, 837

Species	Lake Superior							
	Michigan		Wisconsin		Minnesota		Total	
	Pounds	*Value*	*Pounds*	*Value*	*Pounds*	*Value*	*Pounds*	*Value*
Lake trout	2, 193, 602	$304, 844	534, 075	$60, 948	323, 612	$45, 403	3, 051, 289	$411, 195
Whitefish	249, 253	39, 175	74, 201	10, 369	4, 703	739	328, 157	50, 283
Lake herring	387, 091	19, 439	965, 224	22, 868	9, 275, 861	329, 277	10, 628, 176	371, 584
Chubs	396, 273	31, 008	69, 158	3, 631	412, 502	27, 201	877, 933	61, 840
Sturgeon	210	102					210	102
Yellow pike	10, 635	1, 952	13, 715	2, 852			24, 350	4, 804
Sauger	12	1					12	1
Sucker, "mullet"	146, 775	7, 118			1, 800	19	148, 575	7, 137
Yellow perch	11, 877	1, 451	2, 699	340			14, 576	1, 791
Pike (jacks)	2, 617	297	4, 086	559			6, 703	856
White bass			5, 200	520			5, 200	520
Burbot	370	19					370	19
Miscellaneous	22, 014	1, 040	184, 249	6, 184	9, 748	784	216, 011	8, 008
Total	3, 420, 729	406, 446	1, 852, 607	108, 271	10, 028, 226	403, 423	15, 301, 562	918, 140

Lake fisheries of the United States, 1927—Continued

CATCH: BY LAKES—continued

Species	Lake Ontario		Lake Huron		Lake of the Woods, Rainy Lake, and Namakan Lake		Total all lakes	
	New York		Michigan		Minnesota			
	Pounds	*Value*	*Pounds*	*Value*	*Pounds*	*Value*	*Pounds*	*Value*
Lake trout	41,796	$6,909	1,691,697	$264,955	87	$9	10,492,359	$1,720,542
Whitefish	165,660	29,380	1,676,616	328,250	76,759	10,135	5,462,928	1,010,834
Lake herring	102,347	8,990	5,604,373	215,390			22,177,127	763,330
Chubs			825,486	93,648	146,911	6,545	6,616,286	596,808
Cisco							2,350,239	289,097
Sturgeon	19,221	9,331	8,033	2,037	1,281	542	40,597	17,128
Yellow pike	19,170	3,620	901,401	203,775	656,723	98,761	3,025,336	540,091
Blue pike	22,221	2,767					7,323,592	560,571
Sauger			26,634	2,758	51,273	4,151	1,245,734	98,019
Sucker, "mullet"	61,947	4,889	2,460,575	182,940	137,671	3,674	4,765,345	297,957
Sheepshead			40,342	1,777			4,360,745	94,791
Yellow perch	39,186	3,529	203,542	24,646	20,653	2,053	4,995,266	348,631
Pike (jacks)			35,737	3,781	311,475	17,333	398,092	25,493
Carp	17,639	1,597			7,426	497	3,668,590	162,789
White bass			1,938,760	55,833			126,324	12,545
Catfish and bullheads	41,562	7,379	179,762	24,987	36,111	3,971	815,065	80,163
Tullibees					662,169	31,435	662,169	31,435
Burbot	88,709	9,256	3,017	78	25,804	444	510,972	19,753
Miscellaneous	78,363	8,434	114,756	9,510	4,747	634	2,289,784	124,914
Total	697,821	96,081	15,710,731	1,414,365	2,139,090	180,184	81,326,550	6,794,891

Lake fisheries of the United States and Canada, 1913 to 1927

CATCH: BY LAKES

[Expressed in thousands of pounds; that is, 000 omitted]

Years	Lake Ontario			Lake Erie			Lake Huron			Lake Michigan
	United States[1]	Canada[2]	Total	United States	Canada	Total	United States	Canada	Total	United States
Average, 1913-1914	243	3,241	3,484	37,845	19,768	57,613	9,716	6,449	16,165	27,594
Average, 1915-1919	473	5,127	5,600	45,756	16,313	62,069	14,022	6,977	20,999	28,103
Average, 1920-1924	964	4,903	5,867	40,895	17,527	58,422	10,611	6,768	17,379	17,946
1925	446	4,351	4,797	26,639	11,080	37,719	6,567	7,748	14,315	21,710
1926	788	4,227	5,015	25,057	8,752	33,809	13,132	7,483	20,615	20,495
1927	698	3,842	4,540	23,796	10,069	33,865	15,711	8,864	24,575	23,681

Years	Lake Superior			Lake of the Woods, Rainy Lake, and Namakan Lake			Total		
	United States	Canada	Total	United States[3]	Canada[4]	Total	United States	Canada	Total
Average, 1913-1914	6,752	2,633	9,385	1,315	3,406	4,721	83,467	35,497	118,964
Average, 1915-1919	8,613	6,173	14,786	1,516	3,240	4,756	98,483	37,829	136,312
Average, 1920-1924	7,968	4,041	12,009	1,148	2,536	3,684	79,531	35,776	115,307
1925	12,307	3,567	15,874	1,463	4,411	5,874	69,132	31,157	100,289
1926	13,436	4,311	17,747	2,392	2,725	5,117	75,300	27,498	102,798
1927	15,302	5,152	20,454	2,139	2,699	4,838	81,327	30,626	111,953

[1] Includes the catch of Lake Ontario proper and Chaumont Bay in the years from 1913 to 1924 inclusive, Lake Ontario proper in 1925, and Lake Ontario proper, Niagara River below the falls, St. Lawrence River, and Chaumont, Black River, Port, Great Sodus, and Little Sodus Bays in 1926 and 1927.
[2] Includes the catch in the Niagara River below the falls.
[3] Does not include the catch in Namakan and Rainy Lakes prior to 1926.
[4] Includes the catch in Lac Suel, Eagle Lake, etc., in the interior of Canada, prior to 1926.

NOTE.—The catch in the Detroit River, St. Clair River, and Lake St. Clair are not included in these statistics.

Lake fisheries of the United States and Canada, 1913 to 1927—Continued

CATCH: BY SPECIES

[Expressed in thousands of pounds; that is, 000 omitted]

Years	Lake trout			Whitefish			Lake herring		
	United States	Canada	Total	United States	Canada	Total	United States	Canada	Total
Average, 1913–1914	10,385	5,289	15,674	4,627	5,015	9,642	14,255	1,593	15,848
Average, 1915–1919	10,724	6,025	16,749	5,049	5,463	10,512	19,052	4,802	23,854
Average, 1920–1924	10,298	5,848	16,146	3,793	6,181	9,974	12,679	1,753	14,432
1925	11,125	6,860	17,985	3,668	5,660	9,328	14,549	1,683	16,232
1926	11,559	6,433	17,992	5,148	4,800	9,948	16,522	2,807	19,329
1927	10,493	7,077	17,570	5,463	4,792	10,255	22,177	3,474	25,651

Years	Chubs			Cisco			Sturgeon		
	United States	Canada	Total	United States	Canada	Total	United States	Canada	Total
Average, 1913–1914	4,550	408	4,958	13,310	8,795	22,105	72	202	274
Average, 1915–1919	5,254	496	5,750	19,381	9,180	28,561	76	130	206
Average, 1920–1924	2,729	242	2,971	16,821	8,266	25,087	30	89	119
1925	6,016	429	6,445	2,817	2,840	5,657	24	90	114
1926	6,069	973	7,042	1,449	1,573	3,022	38	84	122
1927	6,616	1,375	7,991	2,350	2,309	4,659	41	77	118

Years	Yellow pike			Blue pike			Sauger	Sucker or mullet	Sheepshead
	United States	Canada	Total	United States	Canada	Total	United States	United States	United States
Average, 1913–1914	2,212	3,224	5,436	6,658	1,728	8,386	2,908	4,590	1,439
Average, 1915–1919	3,301	1,904	5,205	6,582	2,235	8,817	3,962	4,715	2,548
Average, 1920–1924	2,556	2,171	4,727	8,389	4,476	12,865	3,547	3,563	2,032
1925	2,320	2,343	4,663	10,513	3,445	13,958	2,119	2,762	2,395
1926	2,828	1,623	4,451	9,362	3,031	12,393	1,634	4,122	1,325
1927	3,025	1,553	4,578	7,324	3,087	10,411	1,246	4,765	4,361

Years	Yellow perch			Pike (jacks)			Carp			White bass
	United States	Canada	Total	United States	Canada	Total	United States	Canada	Total	United States
Average, 1913–1914	5,898	1,396	7,294	460	3,852	4,312	7,056	1,019	8,075	502
Average, 1915–1919	5,302	1,486	6,788	456	1,659	2,115	5,901	990	6,891	341
Average, 1920–1924	4,057	2,220	6,277	444	1,086	1,530	4,781	484	5,265	540
1925	4,110	2,233	6,343	269	1,160	1,429	2,409	327	2,736	232
1926	5,407	1,956	7,363	302	952	1,254	4,649	292	4,941	158
1927	4,995	2,727	7,722	398	1,099	1,497	3,669	327	3,996	126

Years	Catfish			Tullibees			Burbot	Miscellaneous fish		
	United States	Canada	Total	United States	Canada	Total	United States	United States	Canada	Total
Average, 1913–1914	498	362	860	....	152	152	75	3,969	2,461	6,430
Average, 1915–1919	1,170	381	1,551	....	211	211	257	4,410	2,868	7,278
Average, 1920–1924	833	257	1,090	....	149	149	366	2,076	2,559	4,635
1925	835	233	1,068	301	461	762	269	2,399	3,393	5,792
1926	910	173	1,083	990	164	1,154	373	2,455	2,637	5,092
1927	815	151	966	662	106	768	511	2,290	2,472	4,762

FISHERIES OF THE MISSISSIPPI RIVER AND TRIBUTARIES

The latest statistical canvass made of the fisheries and fishery industries of the Mississippi River and tributaries was for the calendar year 1922. The complete statistics for the canvass were published in the report of the division of fishery industries for 1923 and in Statistical Bulletin No. 607. During 1922 the fisheries and fishery industries of this region employed 19,122 persons, and the yield of the fisheries amounted to 105,733,734 pounds, valued at $4,503,521.

LAKE PEPIN

The fisheries of Lake Pepin, exclusive of those prosecuted for mussel shells, in 1928 employed 124 fishermen, compared with 139 in 1927. The catch amounted to 720,658 pounds, valued at $44,661, a decrease from 1927 of 17 per cent in quantity and 20 per cent in value. Compared with 1922 there has been a decline of 80 per cent in quantity. In 1928 German carp was by far the most important species taken in this lake, constituting 68 per cent of the total catch and 53 per cent of the value of the catch. Drum, catfish, suckers, and buffalofish made up the majority of the remainder of the catch.

Operating units.—In 1928, 124 fishermen employed 43 motor boats and 98 other small boats. The gear used consisted of 27 haul seines, 67 fish traps, 127 gill nets, 100 fyke nets, 2 spears, and 5 lines, named in the order of the value of their catches.

Catch by gear.—Two types of gear accounted for 92 per cent of the fishery products taken in this lake during 1928. By far the most important of these were haul seines, which accounted for 73 per cent of the catch and 63 per cent of the value of the catch, and fish traps, which accounted for 19 per cent of the catch and 30 per cent of the value of the catch.

Fisheries of Lake Pepin, 1928

OPERATING UNITS AND CATCH: BY GEAR

Items	Haul seines		Gill nets		Lines	
Fishermen	89		15		1	
Boats:						
Motor	27		4		1	
Other	68		7		1	
Fishing apparatus	27		127		5	
Length in yards	15,695		6,316		833	
	Pounds	*Value*	*Pounds*	*Value*	*Pounds*	*Value*
Bowfin	3,062	$86				
Buffalofish	12,297	1,006	755	$85		
Carp, German	428,487	20,193	26,080	1,906	214	$11
Carp, American, or quillback	673	34				
Catfish	10,012	1,336			118	14
Drum, fresh-water, or sheepshead	40,531	3,388				
Mooneye	1,200	12				
Paddlefish	7,827	939				
Suckers	22,337	1,072				
Total	526,426	28,066	26,835	1,991	332	25

Fisheries of Lake Pepin, 1928—Continued

OPERATING UNITS AND CATCH: BY GEAR—Continued

Items	Fish traps		Fyke nets		Spears		Total[1]	
Fishermen	27		18		2		124	
Boats:								
Motor	12		9		----		43	
Other	26		6		2		98	
Fishing apparatus	67		100		2		----	
	Pounds	*Value*	*Pounds*	*Value*	*Pounds*	*Value*	*Pounds*	*Value*
Bowfin	646	$16	4,769	$119	----	----	8,477	$221
Buffalofish	10,871	1,249	69	6	----	----	23,992	2,346
Carp, German	12,839	811	19,413	867	990	$59	488,023	23,847
Carp, American, or quillback	2,166	74	----	----	----	----	2,839	108
Catfish	41,838	6,063	380	45	8	1	52,356	7,459
Drum, fresh-water, or sheepshead	56,862	4,597	4,189	210	----	----	101,582	8,195
Eels	222	22	13	2	----	----	235	24
Mooneye	400	8	----	----	----	----	1,600	20
Paddlefish	82	7	----	----	----	----	7,909	946
Suckers	8,649	337	2,659	86	----	----	33,645	1,495
Total	134,575	13,184	31,492	1,335	998	60	720,658	44,661

[1] Exclusive of duplication.

Fisheries of Lake Pepin, 1914 to 1928

OPERATING UNITS AND CATCH

Items	1914	1917	1922	1927	1928
Fishermen	135	126	219	139	124
Boats:					
Motor	28	35	109	39	43
Other	54	55	136	105	98
Fishing apparatus:					
Haul seines	14	17	33	23	27
Gill nets	664	371	351	152	127
Lines	----	----	----	----	5
Fish traps	8	14	----	----	67
Fyke nets	295	262	95	280	100
Spears	----	----	7	4	2
	Pounds	*Pounds*	*Pounds*	*Pounds*	*Pounds*
Bowfin	1,534	24,021	16,136	3,334	8,477
Buffalofish	261,250	300,808	340,309	33,449	23,992
Carp, German	237,517	467,588	2,578,916	615,242	488,023
Carp, American, or quillback	60,605	14,238	47,377	4,835	2,839
Catfish and bullheads	26,830	254,249	127,384	53,076	52,356
Drum, fresh-water, or sheepshead	131,785	118,304	395,592	113,793	101,582
Eels	----	----	541	318	235
Mooneye, fresh	9,300	7,656	----	8,976	1,600
Mooneye, smoked	1,465	7,250	----	----	----
Paddlefish or spoonbill cat	8,877	2,923	15,971	1,191	7,909
Pike (grass)	50	----	----	----	----
Sturgeon, lake	1,067	512	5,253	----	----
Sturgeon, shovelnose	----	----	1,080	----	----
Suckers	18,340	15,260	43,466	31,911	33,645
Sunfish	50	----	----	----	----
Turtles	----	----	442	----	----
Total	758,670	1,212,809	3,572,467	866,125	720,658

LAKE KEOKUK

The fisheries of Lake Keokuk, exclusive of those for mussel shells, in 1928 employed 85 fishermen, compared with 102 in 1927. The catch amounted to 537,794 pounds, valued at $44,277, or a decrease from 1927 of 5 per cent in quantity and an increase of 1 per cent in value. Since 1917 there has been a decline in quantity of 70 per cent.

The most important species taken, according to value, was catfish, with a total catch of 163,576 pounds, valued at $20,748. The catch of German carp amounted to 281,419 pounds, valued at $16,905. The combined totals of these two species made up over 83 per cent of the total output and 85 per cent of its value. Of the other species, buffalofish and drum alone are deserving of mention, 36,498 pounds of buffalofish, valued at $3,790, and 16,809 pounds of drum, valued at $1,070, being taken.

Operating units.—In 1928, 85 fishermen employed 56 motor boats and 70 other small boats. The gear consisted of 4 haul seines, 30 gill nets, 13 lines, 7 fish traps, 1,547 fyke nets, and 692 baskets.

Catch by gear.—Fyke nets and fish baskets together took nearly 94 per cent of the entire catch, which consisted mainly of catfish and German carp. The combined value of the fish taken by these two types of gear accounted for about 94 per cent of the total value of all fish taken in the lake.

Fisheries of Lake Keokuk, 1928

OPERATING UNITS AND CATCH: BY GEAR

Items	Haul seines		Gill nets		Lines		Fish traps	
Fishermen		10		2		16		4
Boats:								
Motor		2				3		2
Other		4		1		12		2
Fishing apparatus		4		30		13		7
Length in yards		450		1,500		6,500		
	Pounds	*Value*	*Pounds*	*Value*	*Pounds*	*Value*	*Pounds*	*Value*
Bowfin					1,339	$41		
Buffalofish			960	$96				
Carp, German	6,830	$359	1,000	50	8,230	494	2,900	$149
Carp, American, or quillback							400	16
Catfish	861	88			9,090	1,121	950	106
Drum, fresh-water, or sheepshead	282	15			1,009	66	375	21
Sunfish	150	12						
Total	8,123	474	1,960	146	19,668	1,722	4,625	292

Items	Fyke nets		Baskets		Total[1]	
Fishermen		66		35		85
Boats:						
Motor		51		28		56
Other		52		29		70
Fishing apparatus		1,547		692		
	Pounds	*Value*	*Pounds*	*Value*	*Pounds*	*Value*
Bowfin	12,368	$371			13,707	$412
Buffalofish	35,538	3,694			36,498	3,790
Carp, German	262,459	15,853			281,419	16,905
Carp, American, or quillback	11,067	452			11,467	468
Catfish	34,864	4,729	117,821	$14,704	163,576	20,748
Drum, fresh-water, or sheepshead	15,143	968			16,809	1,070
Paddlefish or spoonbill cat	157	16			157	16
Sunfish	14,011	856			14,161	868
Total	385,597	26,939	117,821	14,704	537,794	44,277

[1] Exclusive of duplication.

Fisheries of Lake Keokuk, 1914 to 1928

OPERATING UNITS AND CATCH

Items	1914	1917	1922	1927	1928
Fishermen	105	118	122	102	85
Boats:					
Motor	36	52	58	70	56
Other	94	80	111	82	70
Fishing apparatus:					
Haul seines		1	2	3	4
Gill nets		12	235	26	30
Trammel nets	14	17	17		
Lines [1]					13
Fish traps		81		815	7
Fyke nets	1,378	1,368	1,301	1,594	1,547
Dip nets			1		
Baskets					692
	Pounds	*Pounds*	*Pounds*	*Pounds*	*Pounds*
Black bass	15	4,163	6,200		
Bowfin		26,000		14,055	13,707
Buffalofish	249,900	696,543	113,946	67,872	36,498
Carp, German	302,365	762,259	276,431	291,199	281,419
Carp, American, or quillback		5,936		9,880	11,467
Catfish and bullheads	71,535	109,904	183,919	140,343	163,576
Crappie	70	17,560	13,770		
Drum, fresh-water, or sheepshead	26,860	160,554	65,040	27,538	16,809
Eels	3,800	2,087			
Paddlefish or spoonbill cat		927	27,405	1,249	157
Pike (grass)		20			
Pike, sauger			2,280		
Sturgeon, lake	1,900	454			
Sturgeon, shovelnose			600		
Suckers	4,640	700			
Sunfish	50	13,879	11,590	13,563	14,161
Turtles				385	
Total	661,135	1,800,986	701,181	566,084	537,794

[1] Lines are omitted in 1914, 1917, 1922, and 1927 because data on the number were not available.

FISHERIES OF ALASKA

The latest statistical canvass, prior to that for 1928, made of the fisheries and fishery industries of Alaska was for the calendar year 1927. The complete statistics for the canvass were published in the report "Alaska fishery and fur-seal industries, 1927," and in Statistical Bulletin No. 790.

In 1928 the fisheries of Alaska employed 31,086 persons, of whom 11,519 were fishermen, 17,812 were employed in the wholesale and manufacturing industries, and 1,755 in transporting fishery products. The catch in the round weight, exclusive of whales, amounted to 690,170,888 pounds, valued at $17,343,034. The round weight of whales could not be determined, but their products amounted to 8,835,000 pounds, valued at $454,274. Of the total catch, exclusive of whales, 517,069,403 pounds, valued at $12,790,138, consisted of salmon; 171,506,365 pounds, valued at $4,465,315, were other fish; and 1,595,120 pounds, valued at $87,581, consisted of shellfish.

In 1928 there were 288 establishments (exclusive of duplication) in Alaska engaged in the fisheries trade. Of this number, 154 canned fish, 119 cured fish, 36 handled fresh and frozen fishery products, and 27 manufactured by-products. The output of these establishments amounted to 414,183,105 pounds, valued at $54,553,376. The salmon industry was by far the most important and produced 308,691,203 pounds of products, valued at $47,487,763. In value the halibut industry was next in importance and produced 31,567,000 pounds of products valued at $3,094,000. The herring industry ranked third and produced 63,047,653 pounds of products, valued at at $3,098,457. Of the remainder, whales, shrimp, and clam products were most important in value.

In considering the various industries separately, the canning industry ranked foremost and produced 292,224,451 pounds of fishery products, valued at $45,498,498. In value the fresh-fish industry ranked second, with a production of 29,178,585 pounds, valued at $2,934,533; the cured-fish industry ranked third with a production of 24,528,006 pounds, valued at $2,717,294; the by-products industry ranked fourth with an output of 49,655,733 pounds, valued at $2,187,838; and the frozen-fish industry ranked fifth, accounting for the remaining products, amounting to 18,596,330 pounds, valued at $1,215,213. The complete statistics for 1928 are published in the report "Alaska fishery and fur-seal industries, 1928," and in Statistical Bulletin No. 831.

COMMON AND SCIENTIFIC NAMES OF FISHERY PRODUCTS

In order to prevent misunderstanding from the use of common names employed in the tables and discussions, the following list of common and scientific names is given.

Common and scientific names of the commercial fishery products caught in the United States and Alaska

Common name as shown in bureau reports	Other common names	Scientific names
Albacore	Longfin tuna	*Germo alalunga.*
Alewives	Branch herring, wall-eyed or big-eyed herring.	*Pomolobus pseudoharengus.*
	Blueback, glut herring	*Pomolobus æstivalis.*
Amberjack		Seriola sp.
Anchovies		*Engraulis mordax.* *Anchoviella delicatissima.* *Anchoviella compressa.*
Angelfish		*Pomacanthus arcuatus.* *Angelichthys isabelita.*
Barracuda		*Sphyræna argentea* (Pacific coast). *Sphyræna barracuda* (Atlantic coast).
Black bass	Small-mouthed bass	*Micropterus dolomieu.*
	Large-mouthed bass	*Micropterus salmoides.*
Bluefish	Tailor	*Pomatomus saltatrix.*
Blue pike	Pike-perch, blue pickerel (Canada)	*Stizostedion glaucum.*
Blue runner or hardtail	Runner	*Caranx crysos.*
Bonito		*Sarda sarda.* *Euthynnus pelamis.*
Bowfin		*Amia calva.*
Buffalofish		Ictiobus sp.
Bullhead		Ameiurus sp.
Butterfish	Dollarfish	*Poronotus triacanthus.*
Burbot	Lawyer, ling	*Lota maculosa.*
Cabio	Coal-fish, crab eater, sergeantfish, cobia.	*Rachycentron canadum.*
Carp (German)		*Cyprinus carpio.*
Catfish		Siluridæ sp.
Cero		*Scomberomorus regalis.*
Chubs	Tullibee in Canada; longjaws, bluefin, blackfin in United States.	All Leucichthys except *artedi* (in Great Lakes).
Cisco	Herring in Canada	*Leucichthys artedi* (Lake Erie only).
Cod	Codfish	*Gadus macrocephalus* (Pacific coast). *Gadus callarias* (Atlantic coast).
Cowfish	Trunkfish, chapin	Ostracion sp.
Crappie	White crappie	*Pomoxis annularis.*
	Black crappie, strawberry bass, calico bass.	*Pomoxis sparoides.*
Crevalle		*Caranx hippos.*
Croaker	Crocus, hardhead	*Micropogon undulatus.*
Cunner	Chogset, blue perch, bergall	*Tautogolabrus adspersus.*
Cusk		*Brosmius brosme.*
Dolly Varden trout	Salmon trout, bull trout	*Salvelinus parkei.*
Drum, fresh-water, or sheepshead.	White perch, gaspergou	*Aplodinotus grunniens.*
Drum, black		*Pogonias cromis.*
Drum, red	Channel bass, redfish, spotted bass	*Sciænops ocellatus.*

Common and scientific names of the commercial fishery products caught in the United States and Alaska—Continued

Common name as shown in bureau reports	Other common names	Scientific names
Eels		*Anguilla rostrata.* *Leptocephalus conger.* *Gymnothorax mordax.* *Gymnothorax moringua.*
Eulachon	Candlefish	*Thaleichthys pacificus.*
Flounders	Dabs, blackbacks, lemon sole, winter flounder; summer flounder.	Pleuronectidae sp.
Flying fish		*Cypsilurus californicus.*
Gizzard shad	Nanny shad, mud shad	*Dorosoma cepedianum.*
Goldfish	Sand perch	*Carassius auratus.*
Grayfish	Dogfish Spiny dog Smooth dog	*Squalus sucklii* (Pacific coast). *Squalus acanthias.* *Galeohinus lævis.*
Greenfish	Rudderfish	*Girella nigricans.*
Groupers		Epinephelus sp. Mycteroperca sp.
Grunts	Margatefish, sailor's choice (Key West).	Hæmulon sp.
Haddock		*Melanogrammus aeglifinus.*
Hake	Squirrel hake, Boston hake, ling, black hake, mud hake. Merluccio	Urophycis sp. (Atlantic coast). *Merlucius productus* (Pacific coast).
Halfmoon		*Medialuna californiensis.*
Halibut		*Hippoglossus hippoglossus.*
Halibut, "California"		*Paralichthys californicus.*
Hardhead		*Orthodon microlepidotus.*
Harvestfish	Starfish, pappyfish	*Peprilus alepidotus.*
Herring		*Clupea harengus* (Atlantic coast). *Clupea pallasii* (Pacific coast).
Hickory shad	Tailor shad	*Pomolobus mediocris.*
Hog-choker		*Achirus fasciatus*
Hogfish	Capitaine, perro perro	*Lachnolaimus maximus* (Florida)
Jewfish		*Promicrops itaiara.*
Kingfish		*Scomberomorus cavalla.*
Kingfish (California)	Little roncador, croaker	*Genyonemus lineatus.*
King whiting	Northern whiting, kingfish, sea mink	Menticirrhus sp.
Ladyfish	Bonefish, banana fish	*Albula vulpes.*
Lake herring	Herring	*Leucichthys artedi* (Great Lakes, except Erie).
Lake trout		*Cristivomer namaycush.*
Launce	Sand eel, lant, sand launce	*Ammodytes americanus.*
"Lingcod"	Cultus cod, blue cod, buffalo cod, ling.	*Ophiodon elongatus.*
Mackerel		*Scomber scombrus* (Atlantic coast). *Scomber diego* (Pacific coast).
Menhaden	Mossbunker, pogy	*Brevoortia tyrannus.*
Moon-eye	Toothed herring	Hiodon sp.
Moonfish		*Vomer setipinnis.* *Selene vomer.*
Mullet	Jumping mullet	Mugil sp
Mummichog	Mayfish, killifish	Fundulus sp.
Muttonfish		*Lutianus analis.*
Paddlefish	Spoonbill cat	*Polyodon spathula.*
Parrotfish		Scaridæ sp.
Perch, white	White perch Blue perch, surf-fishes	*Morone americana.* Embiotocidæ sp. (Pacific coast).
Perch, yellow	Winged perch	*Perca flavescens.*
Permit	Great pompano	*Trachinotus goodei.*
Pickerel		*Esox reticulatus.* *Esox americanus.*
Pigfish		*Orthopristis chrysopterus.*
Pike (jacks)	Great Lakes pike, pickerel	*Esox lucius.*
Pilchard	Sardine	*Sardinia cærulea.*
Pilotfish		*Naucrates ductor.*
Pinfish	Bream, salt-water bream	*Lagodon rhomboides.*
Pollock		*Pollachius virens.*
Pompano		Trachinotus sp. (Atlantic coast). *Palometa simillimus* (Pacific coast).
Porgies	Porgee	Calamus sp.
Porkfish	Sisi	*Anisotremus virginicus.*
Quillback	Spearfish or skimfish	Carpiodes sp.
Roach	Shiner	*Notemigonus crysoleucas.*
Rock bass	Sand bass Red-eye, goggle-eye	Paralabrax sp. (Pacific coast). *Ambloplites rupestris* (Mississippi River and tributaries).
Rockfishes	Rock cod	Sebastodes sp. (Pacific coast).
Rosefish		*Sebastes marinus.*
Sablefish	Black cod	*Anaplopoma fimbria.*

Common and scientific names of the commercial fishery products caught in the United States and Alaska—Continued

Common name as shown in bureau reports	Other common names	Scientific names
Salmon:		
Atlantic		*Salmo salar* (Atlantic coast).
Pacific—		
King, chinook, or spring	Tyee, Columbia, Sacramento	*Oncorhynchus tschawytscha.*
Red or sockeye	Blueback	*Oncorhynchus nerka.*
Coho or silver		*Oncorhynchus kisutch.*
Humpback or pink.		*Oncorhynchus gorbuscha.*
Chum or keta	Dog salmon	*Oncorhynchus keta.*
Steelhead		(See steelhead trout.)
Sauger pike	Sand pike	*Stizostedion canadense.*
Scamp		*Mycteroperca phenax.*
Sculpin		Cottidæ sp.
Scup	Paugy or porgy, fair maid	*Stenotomus chrysops.*
Sea bass	Black jewfish or black sea bass Black sea bass	*Stereolepis gigas* (Pacific coast). *Centropristes striatus* (Atlantic coast).
Sea bass, white (California)		*Cynoscion nobilis* (Pacific coast).
Sea gar	Needlefish, billfish, houndfish	Tylosurus sp.
Sea robin		Prionotus sp.
Shad	American shad	*Alosa sapidissima.*
Sheepshead (salt-water)		*Archosargus probatocephalus.*
Sheepshead (fresh-water)	Drum, fresh-water	*Aplodinotus grunniens.*
Sheepshead (Pacific coast)	Redfish, flat head	*Pimelometopon pulcher.*
Silversides	Spearing	Menidia sp.
Silver perch	Sand perch	*Bairdiella chrysura.*
Skipjack	Striped tuna	*Sarda chilensis.*
Smelt		*Osmerus mordax* (Atlantic coast). Argentinidæ sp. (Pacific coast).
Snapper, Mangrove	Gray snapper	*Lutianus griseus.*
Snapper, red		*Lutianus blackfordii.*
Snook	Robalo	*Centropomus undecimalis.*
Sole		*Psettichthys melanostictus* (Pacific coast).
Spadefish		*Chædipterus faber.*
Spanish mackerel		*Scomberomorus maculatus.*
Splittail		*Pogonichthys macrolepidotus.*
Spot	Lafayete, goody	*Leiostomus xanthurus.*
Squawfish	Sacramento pike	*Ptychocheilus oregonensis.*
Squeteague (gray)	Gray trout, weakfish, trout	*Cynoscion regalis.*
Squeteague (spotted)	Spotted weakfish, spotted trout	*Cynoscion nebulosus.*
Steelhead trout	Salmon trout	*Salmo gairdneri.*
Striped bass	Rockfish, rock	*Roccus lineatus.*
Sturgeon		Acipenser sp.
Sturgeon, shovel-nosed		*Scaphirhynchus platorynchus.*
Sucker	Fresh-water mullet	Catostomidæ sp.
Sunfish		Lepomis sp. Centrarchidæ sp.
Swellfish	Puffer, swell toad, balloonfish, globe-fish.	*Spheroides maculatus.*
Swordfish		*Xiphias gladius.*
Tang		Hepatus sp.
Tarpon	Silver king	*Tarpon atlanticus.*
Tautog	Blackfish, oysterfish	*Tautoga onitis.*
Ten-pounder	Elops	*Elops saurus.*
Thimble-eyed mackeral	Bull's-eye	*Scomber colias.*
Tilefish		*Lopholatilus chamæleonticeps.*
Tomcod		*Microgadus tomcod* (Atlantic coast). *Microgadus proximus* (Pacific coast).
Tripletail		*Lobotes surinamensis.*
Tuna	Blufin tuna, tunny, horse mackerel, leaping tuna.	*Thunnus thynnus.*
Turbot	Greenland halibut, American turbot	*Reinhardtius hippoglossoides.* *Balistes carolinensis.*
White bass	White lake bass	*Roccus chrysops.*
White bait		Small fry of any fish.
Whitefish		*Coregonus clupeiformis* (Great Lakes) *Caulolatilus princeps* (Pacific coast)
Whiting	Silver hake	*Merluccius bilinearis.*
Wolffish		*Anarrhichas lupus.*
Yellow bass		*Morone interrupta.*
Yellow perch		*Perca flavescens.*
Yellow pike	Wall-eyed pike, pike perch, dore	*Stizostedion vitreum.*
Yellowfin tuna		*Neothunnus macropterus.*
Yellowtail		*Ocyurus chrysurus* (Atlantic coast). *Seriola dorsalis* (Pacific coast).
Abalone		Haliotis sp.

Common and scientific names of the commercial fishery products caught in the United States and Alaska—Continued

Common name as shown in bureau reports	Other common names	Scientific names
Clams:		
Hard	Round clam, quahog, little neck	*Tivela stultorum* (Pacific coast). *Venus mercenaria* (Atlantic coast). *Venus mortoni* (Florida coast).
Cockle		*Cardium corbis*.
Soft	Sand clam, soft-shelled clam, nanny-nose.	*Mya arenaria*.
Razor		*Siliqua patula* (Pacific coast).
Pismo		*Tivela stultorum* (Pacific coast).
Conchs		Strombus sp. Busycon sp.
Crabs:		
Stone		*Menippi mercenaria*.
Soft	Soft-shelled crab, blue crab	*Callinectes sapidus*.
Hard	Hardshell crab, blue crab	Do.
	Dungeness crab	*Cancer magister* (Pacific coast).
	Rock crab, hard crab	*Cancer irroratus* (Atlantic coast).
King	Horseshoe crab	Limulus.
Spider	Toad crab	*Hyas coarctatus*.
Crawfish	Crayfish	Cambarus sp. (Atlantic coast). Astacus sp. (Pacific coast).
Lobsters:		
Common		*Homarus americanus* (Atlantic coast).
Spiny	Rock lobster, crayfish	*Panulirus interruptus* (Pacific coast). *Panulirus argus* (Atlantic coast).
Mussels		*Mytilus californianus* (Pacific coast). *Mytilus edulis*.
Octopus		*Octopus punctatus* (Pacific coast).
Oysters:		
Eastern		*Ostrea elongata*.
Western	Olympia	*Ostrea lurida* (Pacific coast).
Japanese (introduced)		*Ostrea gigas*.
Periwinkles		Littorina sp.
Scallops:		
Sea		*Pecten magellanicus*.
Bay		*Pecten irradians* (Atlantic coast). *Pecten æquisulcatus* (Pacific coast).
Shrimp		*Peneus setiferus*. *Peneus brasiliensis* (Atlantic and Gulf coasts). Pandalus sp. (Pacific coast). Pandalopsis sp. (Pacific coast). Orangon sp. (Pacific coast).
Snails		Gastropoda sp.
Squid		*Loligo opalescens* (Pacific coast). *Loligo pealei* (Atlantic coast).
Turtles:		
Green		*Chelonia mydas*.
Loggerhead		*Thalassochelys caretta*.
Hawksbill		*Chelonia inbricata*.
Snapping	Mud turtle, mossback	*Chelydra serpentina*.
Terrapin	Diamond-back terrapin	*Malacoclemmys palustris*.
Frogs		Rana sp.

METHODS USED IN COLLECTING STATISTICS

In order that persons using the statistics in this report may judge as to their completeness and authenticity, there follows an outline of the methods employed by the bureau in collecting fishery statistics. It will be noted that several methods are used. Each, in so far as possible, is the most efficient that can be developed to accomplish the desired result with the available personnel.

General fishery statistics.—The purpose of collecting general fishery statistics is to obtain statistics on the catch of fishery products and its value as landed by the fishermen, the quantity or number of each kind of gear used, the number of fishing boats, the number and net tonnage of fishing and transporting vessels, the number of wholesale establishments, the amount of wages and salaries paid in these establishments, the quantity and value of products prepared, and the number of persons engaged in each phase of the industry.

The scope of the coastal surveys includes the commercial fisheries of the oceans, bays, and coastal rivers as far inland as commercial fishing is important. This usually coincides with the range of commercial fishing for anadromous species. Statistics of the fisheries of the Mississippi River include the fisheries of the Mississippi River proper as well as all tributaries wherein commercial fishing for either fish, crustaceans, or mollusks is prosecuted. Statistics of the lake fisheries include those prosecuted in the Great Lakes, adjacent bays, and the International lakes of northern Minnesota, as well as certain rivers having outlets into these waters.

General statistics of the fisheries of the United States are not collected each year, but each year statistics are collected for one or more geographical sections. The aggregate of these statistics for the various years is taken to represent an average year.

In conducting these surveys it is the custom of the bureau to dispatch agents to the district or districts to be surveyed early in the calendar year. They obtain statistics on operations during the previous calendar year, except that statistics of the oyster fishery are obtained for the season ending in the spring of the previous year. The agents conducting these surveys are trained men or recruits working under the close supervision of trained men. Recruits are permitted to work individually only after proving a satisfactory aptitude for the work during their training period. While it is impossible for the few agents available to interview each fisherman in a given locality, the more important ones are visited and a sufficient number of those of lesser importance are interviewed to obtain reliable information on their production. In practice, virtually all wholesale firms are visited, as well as captains of fishing vessels (over 5 net tons) and also all the more important shore fishermen and representative small producers.

As an aid in locating fishermen, lists of vessel and motor-boat owners are obtained from local customs houses. It is also often possible to obtain the names of licensed commercial fishermen and occasionally some statistics of the catch from the various State fishery agencies. In the Great Lakes and Pacific Coast States such exceptional cooperation has been obtained from the State agencies in recent years that only fragmentary surveys are made by the bureau to supplement missing data.

For the Great Lakes and international lakes of northern Minnesota the bureau obtains catch statistics and usually the value of the catch direct from the State records. To obtain data on the fishermen, boats, vessels, and gear the bureau conducts such personal surveys among the fishermen as may be necessary to supplement the State records. Statistics of the wholesale industry have not been obtained since 1922. Annual catch statistics are available since 1913.

An agent is stationed at Seattle, Wash., who surveys each of the Pacific Coast States annually to supplement data that is missing from the State records. In most cases the value of the catch is derived from dealers' records and from estimates of prices. In Washington and Oregon the offshore fisheries are surveyed separately for units of operation, catch, and value of the catch. In almost all other respects the statistics are as collected by the States. Statistics of the wholesale industry for this district have not been obtained since 1922.

A variation from the above method is found in Connecticut, where in recent years a State employee has obtained statistics on the catch, value of the catch, and operating units. This bureau has furnished blanks for the purpose, and completed schedules are forwarded to the bureau for compilation.

The fisheries of Alaska are conducted primarily by large operators. Sworn statements are required from these operators concerning their operations. These are collected and compiled by the Alaska division of this bureau. Bulletins containing statistics for each district are released following the survey.

Atlantic mackerel fishery.—Complete statistics on the catch by the Atlantic mackerel fleet are obtained by combining the figures of those landed at Boston and Gloucester, Mass., and Portland, Me., with those obtained by agents who in recent years have been stationed at other Atlantic ports where mackerel are landed. These agents obtain data on each fare of mackerel landed, similar to the data obtained on the landings by fishing vessels at the three New England ports. Complete statistics of this fishery appear only in the annual reports of this division, although the landings at the principal New England ports appear in the monthly and annual bulletins published for those ports.

Pacific halibut fishery.—Statistics of the Pacific halibut fishery are obtained by the bureau's agent in Seattle, aided by bureau representatives in Alaska and American consuls in British Columbia. The fleet classification has been arbitrarily applied by including in the "Washington fleet" all vessels that land more than half of their catch in that State. All other American vessels of the halibut fleet are included in the Alaska fleet. Monthly and annual statistical bulletins are available on this fishery, being published along with the statistics of the landings of fishery products at Seattle, Wash.

Shad and alewife fisheries.—Due to the importance of the Hudson and Potomac Rivers in the production of shad, surveys for statistics of the catch, value of the catch, and operating units are made annually. On the Potomac River similar statistics also are obtained for the alewife fishery. The surveys are conducted by agents in a manner similar to that employed in the collection of general statistics, except that probably more fishermen are interviewed as great care is exercised to make these canvasses as accurate as possible.

The State of New York obtains statistics for the fisheries of the Hudson River that closely parallel those desired by the bureau for this fishery, which alleviates the work on this river. Both Maryland and Virginia license the shad and alewife fishermen of the Potomac River, which gives a very satisfactory list of fishermen for the agents surveying this district.

Statistics of the shad and alewife fisheries are not published separately in bulletin form, but a summary of the year's activities is published in the annual report of this division.

Fisheries of Lakes Pepin and Keokuk.—As a means of ascertaining the effect of the Keokuk dam upon the fisheries of the upper Mississippi River, annual statistics of the fisheries of Lakes Pepin and Keokuk are obtained by personal surveys conducted by employees of the bureau at the Fairport (Iowa) biological station. Their methods are like those employed in the general surveys. The statistics are not published in bulletin form, but summaries of production appear in the annual reports of this division.

Fisheries of Lake Okeechobee.—Statistics of the fisheries for Lake Okeechobee were obtained for the first time in 1927 as a part of the general statistical canvass of the Gulf States.

Landings at certain important United States ports.—Statistics of the landings at the principal New England ports—Boston and Gloucester, Mass., and Portland, Me.—are similarly obtained. An agent is permanently stationed at each of these ports. His duties include the obtaining of statistics on the quantity of fish landed each day by each fishing vessel, the value of such fish landed, information concerning the date of departure and arrival of the vessel, and also a list of the grounds from which the fish were taken and the gear used in their capture. These statistics are forwarded to the bureau, where compilations are made. Monthly statistical bulletins are issued for these landings as well as annual bulletins summarizing the year's activities.

Landings of fish at Seattle, Wash., are collected by the bureau's agent at that place. Landings are classified as those made by fishing vessels and those made by collecting vessels. Those credited to fishing vessels are made by vessels operating distinctly as primary fishing units, usually in the offshore fisheries, while those credited to collecting vessels are made by transporting vessels that collect fishery products (usually taken in the shore fisheries) from points on Puget Sound. Monthly statistical bulletins are issued for these landings as well as annual bulletins summarizing the year's activities.

Statistics of the combined landings of fish at New York City and Groton, Conn., are obtained by J. H. Matthews, chairman of the statistical committee for the United States Fisheries Association. Statements of these landings are forwarded to the bureau, where they are compiled. These statistics have not included the value of the catch. Monthly bulletins including these data are not issued; however, a summary is published herewith. Current data will be forwarded to interested persons on request.

Statistics of the fishery products handled at the municipal wharf, Washington, D. C., are reported to the bureau daily by agents of the city health department. These are compiled on an annual basis. They are not published in bulletin form, but a summary of the year's activities is published in the annual report of this division.

Canned fishery products and by-products.—Beginning in 1921, the bureau has made annual surveys for statistics of the canned fishery products and by-products industries. These are begun the first week in January of each year for statistics of the production in the preceding year. The surveys occupy usually 6 to 9 weeks' time. During this period agents visit each plant in the United States where there is a production of canned fishery products or by-products. They obtain statistics of the production and value of the production for each commodity. In rare instances, where plants are not easily reached by regular transportation facilities, returns are obtained by mail.

The value shown for canned products constitutes the gross amount received by the packer at the production point, no deductions being made for commissions or expenses.

Statistics of the canned fishery products and by-products produced in Alaska are received on the same sworn statements that include statistics of the general fisheries. An annual statistical bulletin is issued on this trade.

Packaged-fish trade.—The first complete statistics of the annual production and value of fish packaged in the United States were obtained as a part of the survey for statistics of the canned fishery products and by-products industries. These statistics are not published in bulletin form, but a summary of the production is published in the annual reports of this division.

Cold-storage holdings of fish.—An arrangement has been made with the Bureau of Agricultural Economics, Department of Agriculture, whereby statistics of the cold-storage holdings of the various species of fish, by sections of the United States, are furnished to this bureau monthly. Included with statistics of the holdings is a statement of the quantity of the various species of fish frozen and also the holdings of cured fish. Bulletins showing these statistics are issued monthly.

Sponge market, Tarpon Springs.—A large proportion of the total output of sponges in Florida is handled through the sponge exchange at Tarpon Springs. In view of this, the bureau has arranged with a representative of the exchange to furnish statistics of the quantity and value of the sponges, by variety classification, handled through it annually. In 1927 about 69 per cent of the total quantity of sponges produced in Florida were handled through the exchange. Statistics of the quantity of sponges handled through the exchange are not published in bulletin form, but a summary of the year's activities is published in the annual reports of this division.

Foreign fishery trade.—Statistics on the foreign fishery trade are obtained from compilations made by the Bureau of Foreign and Domestic Commerce. Statistics of all known fishery products imported or exported are assembled in one table and published annually in the report of this division.

Statistical practices.—Practices followed in the collection and tabulation of statistics are explained below.

Days absent.—In computing "days absent" for vessels landing fares at the various ports, the day of departure and the day of arrival are included; thus, a vessel leaving port on the 8th of the month and returning on the 15th of the month will be shown as being absent eight days.

Operating units.—Operating units as referred to in this document include persons engaged and fishing craft and gear employed.

Vessels.—The term "vessels" refers to craft having a capacity of 5 net tons or greater.

Percentages.—Percentages are usually shown as whole numbers. Fractions of per cents are dropped if less than five-tenths, and the percentage is raised to the next higher integer if the fraction is greater than five-tenths. If the fraction is exactly five-tenths, the integer is raised or lowered to make it an even number.

Converting.—Many of the figures shown in the statistical tables published herewith have been reduced to thousands of pounds or dollars. In making these conversions the largest number from which a group of items is computed is raised or lowered to the nearest thousands place. If the number ends in an even 500, the thousands integer is raised or lowered to make it an even number. The individual items are changed to conform to the total thus obtained.

Conversion factors.—The principal conversion factors that have been used in this report follow.

Alewives	1 weighs about 3/8 of 1 pound.
Clams, hard	1 bushel equals about 8 pounds of meat.
Clams, soft	1 bushel equals about 10 pounds of meat.
Cod, large, salted	To convert to fresh-gutted weight multiply by 1.90.
Cod, market, salted	To convert to fresh-gutted weight multiply by 1.94.
Cod, scrod, salted	To convert to fresh-gutted weight multiply by 1.98.
Crabs, blue (hard and soft)	1 weighs about 1/3 of 1 pound.
Cusk, salted	To convert to fresh-gutted weight multiply by 1.90.
Haddock, large, salted	To convert to fresh-gutted weight multiply by 2.06.
Haddock, scrod, salted	To convert to fresh-gutted weight multiply by 2.10.
Hake, large, salted	To convert to fresh-gutted weight multiply by 1.90.
Hake, small, salted	To convert to fresh-gutted weight multiply by 1.98.
Halibut, salted	To convert to fresh-gutted weight multiply by 2.
Herring, salted	To convert to fresh-gutted weight multiply by 1.50.
Mackerel, salted	To convert to fresh-gutted weight multiply by 1.35.
Menhaden	1 weighs about 5/8 of 1 pound.
Oysters, market and seed	1 bushel equals about 7 pounds of meat.
Oil (east coast)	1 gallon weighs about 7.5 pounds.
Oil (west coast)	1 gallon weighs about 7.74 pounds.
Pollock, salted	To convert to fresh gutted weight multiply by 1.90.
Scallops	1 bushel equals about 6 pounds of meat.

Persons wishing to obtain copies of all statistical bulletins issued by the bureau should request to be put on the bureau's mailing list No. 132 for general statistical bulletins and No. 135 for the monthly cold-storage reports.

○

PROGRESS IN BIOLOGICAL INQUIRIES, 1928[1]

INCLUDING EXTRACTS FROM THE PROCEEDINGS OF THE DIVISIONAL CONFERENCE, JANUARY 2 TO 5, 1929

By Elmer Higgins

Assistant in Charge of Scientific Inquiry

(With the collaboration of investigators)

CONTENTS

Part I.—INVESTIGATIONS CONDUCTED DURING 1928

---

[1] Appendix X to the Report of the United States Commissioner of Fisheries for 1929. B. F. Doc. 1068.

Part II.—DIVISIONAL CONFERENCE, JANUARY 2 TO 5, 1929

Part I.—INVESTIGATIONS CONDUCTED DURING 1928

INTRODUCTION

The division of scientific inquiry of the United States Bureau of Fisheries is still responsible for the discharge of duties that formerly comprised the entire activities of the original Fish Commission. At the time of its founding the commission was required to prosecute the inquiries necessary to ascertain whether and what diminution in the number of food fishes of the United States had occurred, the causes of any decline observed, and what measures should be adopted for the protection of the declining fisheries. The scope of the bureau's activities has since been increased by the addition of divisions responsible for the propagation and distribution of food and game fishes, for investigations in technology and the collection of economic statistics of the fisheries, and for the administration of the fisheries and seal industry of Alaska. The division of inquiry, however, prosecutes scientific investigations for the purpose of supplying information necessary for wise conservation. Fishery administrators, State legislatures, commissions, and the fishery industries at large are furnished, in so far as our knowledge permits, with necessary information for the regulation of the fisheries and for the guidance of private industry in wise and safe exploitation of the Nation's aquatic food resources.

The division is, therefore, an investigative and advisory body having no administrative authority over any of the fisheries of America. Its investigations are designed with two definite aims—(1) to provide information for immediate use and (2) to contribute to the upbuilding of a coherent body of knowledge which is rapidly assuming rank among the various fields of biology as fishery science. The bureau is continually confronted with a host of practical and urgent questions regarding the fisheries: What becomes of the butterfish when it leaves the inshore waters in the wintertime? How long can the haddock fishery continue to increase on South Channel grounds? What are the probabilities of continued heavy catches in the mackerel fisheries? What can be done to prevent the greening of oysters in Connecticut? Should the inshore waters of the Texas coast be closed to commercial fishing to protect the fish supply? How great must be the spawning escapement of salmon in various rivers of Alaska to produce abundant runs in the future? All of these are intensely practical and many of them are urgent questions requiring early solution. In addition to these inquiries the division endeavors to satisfy private citizens who propound questions of amazing variety, ranging from requests for assistance in private frog culture to furthering plans for the international regulation of whaling. The bureau's scientific work, however, is so organized that in providing answers to these questions sound contributions having a general significance to fishery science are made.

The demands for investigations in all sections of the country continue to exceed the facilities of the bureau, and it is therefore necessary that the coherent program that has been developing for many years be followed with scrupulous care. The three main phases of this program, comprising investigations pertaining to conservation of the commercial fisheries, studies of aquiculture or the propagation and cultivation of fresh-water fishes, and the development of shellfish culture, by no means cover the entire field of fishery research. Well-conceived plans have been made, however, and presented to Congress to extend investigations in these respective fields during the next 5 years to all of the major fisheries of the country and to the important areas in the interior.

Outstanding results during 1928 have been obtained in the investigation of the fisheries of the Pacific coast, where the salmon fisheries, of Alaska in particular, are being brought under more perfect scientific regulation and control than perhaps any other great fishery in the world. Equally gratifying results are being obtained in understanding the causes of variations of yield in such apparently erratic sea fishes as the mackerel, and a substantial groundwork is being laid to solve the problems of supply in the shore fisheries of the middle-Atlantic section.

In the field of aquiculture refinements have been made in the methods of increasing production in ponds and inland water areas of the Mississippi River Valley. Pond-culture studies have been unusually successful. Production of such important food and game fishes as the basses has been increased by proper methods of handling to twice former normal production, and many of the factors that determine production in ponds have been ascertained by painstaking study.

A forward step of great importance has been taken in Great Lakes fishery conservation in the adoption of adequate fishery statistics by a number of States bordering the Great Lakes. The bureau's investigators have been active in urging the adoption of a statistical system that is uniform throughout the Great Lakes region in order that yields may be compared by districts and in various years with sufficient exactness to afford an index of abundance that will give evidence of depletion at the earliest moment and serve in determining the effectiveness of regulations on the fishery that have been and may be imposed. Such a system, which approaches the one in use in California in detail and accuracy but differs from it in method, is being adopted by various States and will soon cover the entire region.

One important new project was undertaken during 1928. This was the study of means of preventing the loss of migrating fish in the streams of the Pacific northwest, where annually millions of young salmon are destroyed on their seaward migration by entering irrigation ditches and power diversion canals. Power dams also cause considerable loss to adult fish, which are unable to surmount such obstacles to their spawning migrations. An appropriation of $25,000 was provided for the purpose of devising suitable screens or diverters to prevent young fish from entering such irrigation canals and also to improve the design of fish ladders for use of adult migrants. A suitable type of fish screen has been selected, experimental installations have been made, and it is proposed to install such devices on all the Government reclamation projects.

The division has always been fortunate in securing the wholehearted and generous cooperation of various State and private agencies, thus materially increasing its investigations in both extent and effectiveness. During 1928 the States of Maryland, North Carolina, Georgia, Texas, Michigan, Ohio, Wisconsin, New York, Washington, Oregon, and California officially entered into such cooperation. In addition, formal or informal cooperation of the Museum of Comparative Zoology of Harvard University, the Bingham Oceanographical Collections of Yale University, the Pepper Laboratory of Clinical Medicine and the Zoology Department of the University of Pennsylvania, the Buffalo Museum of Science, the university museums of the University of Michigan, the University of Wisconsin, University of Missouri, Duke University, Leland Stanford Junior University, and the College of Fisheries, University of Washington, is gratefully acknowledged. In the Great Lakes fishery investigation a cooperating investigator from the fisheries department of the Province of Ontario also took part.

A single meeting of the North American Committee on Fishery Investigations, an international body including representatives of Canada, Newfoundland, and the United States, was held during 1928 at the University of Toronto, Toronto, Canada. Various matters pertaining to the collection of statistics of the cod and haddock fisheries in North Atlantic waters and to the proposed haddock investigations in both Canada and the United States were considered. A matter of perhaps the most pressing importance to Canada and to the United States, namely, the possible effect on the fisheries of the proposed damming of Passamaquoddy Bay, was given some extended consideration by the committee. For the guidance of the Canadian Government the committee was requested to appoint a technical commission from its membership to visit Passamaquoddy Bay, examine the conditions and consider the plans of the power company, study available information bearing upon the predictable effects of the project on the fisheries of the region, and report its findings to the Governments of the United States and Canada.

During the year 1928, 10 scientific or administrative reports were published under the supervision of the division. These papers originate in two ways. Some are the results of investigations supported entirely by funds of the division and are prepared by members of the scientific staff, while others are the results of researches on subjects of direct interest to the bureau, but which are conducted by private investigators who receive little or no financial support from the division. The list of papers follows:

Progress in biological inquiries. By Elmer Higgins. 8°, 167 pp., 18 figs. Document No. 1029.

Annotated list of fishes collected in the vicinity of Greenwood, Miss., with descriptions of three new species. By S. F. Hildebrand and I. L. Towers. Royal 8°, 32 pp., 9 figs. Document No. 1027.

Biological survey of the upper Mississippi River, with special reference to pollution. By A. H. Wiebe. Royal 8°, 31 pp., 1 fig. Document No. 1028.

Production and distribution of cod eggs in Massachusetts Bay in 1924 and 1925. By Charles J. Fish. Royal 8°, 44 pp., 16 figs. Document No. 1032.

Fishes of Chesapeake Bay. By S. F. Hildebrand and William C. Schroeder. Royal 8°, 366 pp., 211 figs. Document No. 1024.

Quantitative study of the changes produced by acclimatization in the tolerance of high temperatures by fishes and amphibians. By Edward S. Hathaway. Royal 8°, 24 pp., 9 figs. Document No. 1030.

Nature and extent of fouling of ships bottoms. By J. Paul Visscher. Royal 8°, 60 pp., 40 figs. Document No. 1031.

Experimental study of the function of the oyster gills and its bearing on the problems of oyster culture and sanitary control of the oyster industry. By Paul S. Galtsoff. Royal 8°, 39 pp., 13 figs. Document No. 1035.

Food of bullheads. By Louella E. Cable. 8°, 15 pp., 2 figs. Document No. 1037.

Electric fish screen. By F. O. McMillan. Royal 8°, 32 pp., 21 figs. Document No. 1042.

The following progress reports covering the more important investigations conducted by the division during the calendar year 1928 were prepared in the main by the investigators in charge of various projects.

ATLANTIC AND GULF COAST FISHERY INVESTIGATIONS

LIFE HISTORIES AND MIGRATIONS OF COD, POLLOCK, AND HADDOCK

The study of the life histories of the cod, pollock, and haddock, by William C. Schroeder, which began in 1923, was in progress up to the end of 1928. Most of our efforts and results have been concerned with the cod, so that the study of migrations and the relationship between various stocks of fish living on different banks refers chiefly to this species. The haddock, however, is being sought after more and more each year by commercial fishermen, and in the future it must be given a full share of attention. A statistical summary of tagging operations conducted is given in the tables that follow.

Number of fish tagged

Item	1923	1924	1925	1926	1927	1928	Total
New York and New Jersey	0	0	0	0	167	550	717
Massachusetts, south of Cape Cod	10,231	4,384	6,143	1,730	6,123	1,247	29,858
Massachusetts, north of Cape Cod	13	163	314	0	68	87	645
New Hampshire and Maine	0	5,801	8,803	1,412	2,385	1,180	19,581
Georges Bank	0	0	0	1,103	726	173	2,002
Browns Bank and vicinity	0	0	0	0	1,559	554	2,113

Item	1923	1924	1925	1926	1927	1928	Total
Number of cruises	7	9	16	4	11	[1] 9	56
Days of actual fishing	43	51	76	23	64	[1] 68	325
Hours of actual fishing	333	320.5	461	167	428.7	(1)	------
Cod tagged	7,618	6,209	10,420	3,565	8,851	2,834	39,497
Pollock tagged	2,215	916	949	39	413	267	4,799
Haddock tagged	411	3,223	3,891	641	1,764	690	10,620
Total number of fish tagged	10,244	10,348	15,260	4,245	11,028	3,791	54,916
Number of fish recaptured to Dec. 31, 1928	332	550	1,131	196	414	30	2,653

[1] During 1928 fish were tagged both by the *Albatross II* and by using the equipment of fishermen. The *Albatross II* made 7 tagging cruises, fished 202 hours on 51 days, and tagged 2,422 cod, 267 pollock, and 690 haddock.

In addition to the 2,653 fish with tags that were recaptured, there were 125 with "tag marks" taken by the vessels *Halcyon* and *Albatross II*. These latter fish had lost their tags but showed unmistakable evidence of having been marked. A summary of all fish recaptured follows:

Date of tagging	1923	1924	1925	1926	1927	1928	Total
Cod:							
1923	159	90	34	4	2	0	289
1924	------	206	250	37	5	0	498
1925	------	------	615	387	64	2	1,068
1926	------	------	------	52	153	9	214
1927	------	------	------	------	223	191	414
1928	------	------	------	------	------	25	25
	159	296	899	480	447	227	2,508
Pollock:							
1923	11	25	7	2	0	0	45
1924	------	4	21	1	0	0	26
1925	------	------	7	8	4	0	19
1926	------	------	------	0	3	0	3
1927	------	------	------	------	0	1	1
1928	------	------	------	------	------	0	0
	11	29	35	11	7	1	94
Haddock:							
1923	0	5	1	0	0	0	6
1924	------	14	39	2	3	0	58
1925	------	------	34	31	6	0	71
1926	------	------	------	4	12	1	17
1927	------	------	------	------	3	13	16
1928	------	------	------	------	------	5	5
	0	19	74	37	24	19	173
Total	170	344	1,008	528	478	247	2,775

Not included in the preceding tables are 946 cod tagged at the Bureau of Fisheries biological station at Woods Hole, Mass., in January, 1926, of which 23 have been reported recaptured; 422 cod tagged in January, 1927, of which 10 have been recaptured; and 491 tagged in January, 1928, of which 14 have been recaptured. These fish had been caught near by during November and were held until they had spawned.

In a report prepared one year ago it was estimated that about 70 per cent of the tagged fish lost their tags within the first year. On the basis of the past year's operations no change is made in this estimate. All fish had been tagged on the tail up to and including the summer of 1927, but in the fall of that year the tags were fastened to the jaw. The recaptures during 1928 of these latter fish showed no improvement in numbers, so fish were again tagged on the tail.

During the early part of the investigation, experiments were made with various metals for tags, but monel has been in constant use since 1924. Tags of duralumin have been obtained and will probably be used in 1929 as soon as the present supply of monel tags is exhausted. The duralumin tags appear to have all the good qualities of monel but are much lighter in weight and may, therefore, prove superior.

The outstanding results of the fish-tagging experiments up to December, 1928, are as follows:

Cod grounds between southern Massachusetts and North Carolina.—Each fall, starting in October and continuing until the end of December, cod migrate from Nantucket Shoals and vicinity into the Rhode Island-Delaware region. Some go as far as Virginia and a few even to Cape Hatteras, N. C. The cod spend the winter in this region and return east in the spring (March and April), although a few of them may straggle back during the winter. During the summer cod are rarely caught west of Rhode Island.

Cod are found on Nantucket Shoals throughout the year, for not all of them join in this fall migration to the westward. In some summers, when the water on Nantucket Shoals is unusually warm (57° to 60° F.), part of the cod move 10 to 20 miles farther east into the Chatham Ground-South Channel region, where much cooler bottom temperatures prevail; but even in the warmest summers cod may be caught on Nantucket Shoals in commercial numbers.

During the summer, and sometimes from year to year, few immigrant cod reach Nantucket Shoals; but present records indicate that at times schools of cod migrate from Georges Bank to Nantucket Shoals. This migration appears to take place between late fall and early spring. A few of the Nantucket cod come from as far as Nova Scotia by way of the offshore banks, but only a straggler migrates south from the eastern coast of Maine.

Any one school of cod may be identified with the Nantucket Shoals region for from one to three years before it is caught up by the fishery or straggles away. Sometimes in the summer a large part of the stock of cod migrates toward South Channel and does not return. Few, however, migrate to the northward of Cape Cod, and only a straggler appears to pass Cape Ann.

New England coast from Massachusetts Bay to eastern Maine.—More cod migrate southward from the Massachusetts Bay region than migrate north. This region, however, supports relatively few cod. Farther east, along the coast of Maine, most of the cod are small, in the immediate shore waters being three years or less old. Most of them are caught up before migrating, but the greater part of those that do migrate go eastward to Nova Scotia.

In the middle of the Gulf of Maine, where there are a few isolated cod banks, such as Platts Bank and Cashes Ledge, cod may remain stationary from one year to the next or they may migrate away, depending on stimuli that we do not as yet understand. Individuals of the same body of fish may emigrate toward Nova Scotia, to the shores of Maine, or to South Channel and Nantucket Shoals, favoring no particular locality.

Georges Bank and Browns Bank.—A channel over 100 fathoms deep separates these two banks, and there has been some speculation as to whether this acted as a barrier to cod migrating from Nova Scotia and Browns to Georges Bank. Our tagged fish and those tagged by the Canadian Government have proven, however, that some cod from Nova Scotia and Browns Bank do migrate to Georges and even to as far as Rhode Island. Most of the Browns Bank tagged cod migrated to Nova Scotia, particularly along the east coast, while one fish went east as far as Western Bank in longitude 61°.

So few pollock have been tagged and so few recaptured that nothing definite can be said concerning migrations. Pollock are not as stable in their habits as cod, for while we found them plentiful on Nantucket Shoals in 1923 they have not reappeared there since that time except as stragglers. They migrated away from the southern Massachusetts region over the winter of 1923–24. Some pollock remain on the same ground from one year to the next, while some make long migrations. Fish of about the same size school together, and even large fish 30, 35, or 40 inches long remain together in small schools. A few pollock migrate westward as far as New Jersey over the winter, but they are not of commercial importance west of Rhode Island.

Haddock.—With less than 200 recaptures from over 10,000 tagged haddock, nothing definite can be as yet said about the migrations of this fish. It is obvious that haddock must migrate to the South Channel region, else the very intensive fishery that exists there at all times could not continue.

According to our results so far some haddock on Nantucket Shoals remain there from one year to the next, but most of them migrate to the Chatham–South Channel region sometime between summers. A few haddock migrate westward in the fall, along with the cod, to as far as northern New Jersey, while an occasional fish goes as far south as Cape May; but there is no commercial fishing for haddock farther west than the eastern part of the Long Island coast.

A large part of the marked haddock living in the immediate shore waters of the Gulf of Maine did not migrate within a year after tagging, but of those that did migrate more went southward to the South Channel region than went eastward to or toward Nova Scotia. It would seem that as haddock are caught up in South Channel new fish are drawn from all parts of the Gulf of Maine to take their place.

A complete report embodying the results of five years' investigations of the cod is virtually completed and will be presented for publication in the near future. These investigations have been conducted with the advice and under the general supervision of Dr. H. B. Bigelow of the Museum of Comparative Zoology, Harvard University.

SMELTS OF NEW ENGLAND

During the progress of the study by Dr. W. C. Kendall of the various problems pertaining to the smelts of New England, particularly as concerned relationships, it was found necessary to take into consideration the species of other countries, especially those of Europe and the Arctic regions. But few data of the kind to afford the desired information were available, and sufficient material for study at this time was lacking. However, comparisons of data pertaining to the smelt of eastern North America were made with scant similar data relating to the smelts of Europe, Siberia, and Alaska. Of the characters compared none was found that did not intergrade more or less, so that differences, if any, were indicated by averages only. Therefore, according to taxonomic usage each of the several divergent forms would be regarded as subspecies of the earliest described form, unless other characters should be found to distinguish them. Some European ichthyologists have disposed of them in that way. Apparently, however, the intergradations are not of such nature that they can be dismissed thus early, for the taxonomic definition of what constitutes a subspecies does not conform to what appears to be the rather complicated natural situation, for the complex of variations and intergradations is such that the same fish may be regarded as a subspecies of any one of two or more other forms, depending upon which characters are taken as the basis for the conclusion. The situation becomes still more involved because it does not conform to the taxonomic definition of species.

Therefore, since names are restricted to binomials and trinomials for species and their minor divisions, and since classification is for convenience, the simplest and most natural course to follow would be to regard the most widely divergent forms as entitled to binomial rank, regardless of intergradation. Thus, the species would be distinguished by an ensemble of characters varying in different directions or differences of degree of variation of characters. Even then there would be minor divisions of such ensemble species to consider as subspecies. The practical value of classification is not alone that of labeling specimens in a museum, or in the publication of faunal catalogues, but also in its economic and fish-cultural application. For example, there may be cited the one-time question concerning the relationship of the Atlantic and Pacific sardines (pilchards) or the still unsatisfactorily answered question concerning the western trouts.

As pertains to the smelts of this country, the economic problems can not be answered by any system of classification, but that of the relationship of the fresh-water smelts is of fish-cultural importance particularly as pertains to the popularly designated large and small smelts. Notwithstanding the overlapping of sizes and other puzzling differences, which we are not warranted in calling intergradation, there remain the distinctive facts separating the large and small forms: (1) Difference in spawning time. (2) Difference in character of food, so far as observed. (3) Differences in ages of breeding fish.

That this last fact is of some considerable significance is indicated by the establishment of large smelt from Green Lake in Crystal Lake, Michigan, in remarkable numbers, without any indication of the small category. Furthermore, both Creaser and Metzelaar found a few 2-year-old smelts much larger than the 4-year small class of Green Lake, but the majority of breeding fish were 3 years old. Thus, it appears to be established that the two categories of "small" and "large" smelt are at least physiological divergents, whether or not they can be regarded as distinct taxonomic species with respect to differences of structure.

In the spring of 1928 the observations upon the spawning runs of salt-water smelt, which had been carried on in two brooks in Freeport, Me., from 1924, were unavoidably interrupted, so that but few were made. This year the run was somewhat larger than in 1927, and there was a greater proportion of 2-year-old fish.

During the year the work on a report embodying the scientific results of this investigation has progressed. Recommendations for regulation of the smelt fishery and the abatement of abuses of wasteful and destructive fishing, which have led to serious reduction of the supply of smelt in Maine, were again offered to the State legislature.

MACKEREL INVESTIGATION

The outstanding peculiarity of the mackerel fishery is its wide fluctuations in productivity. At the beginning of the investigation in 1925 there was considerable doubt as to whether these reflected the abundance of mackerel or were due to other causes, such as local movements of this fish; but the past several years have proven that the catch does, in fact, depend largely on the abundance of mackerel. Moreover, it has been found that the changes in abundance are due to inequalities in the contribution of each spawning season to the stock in the sea, hence age domination has been evident in highly accentuated form during the three years that this fishery has been under observation, and it has been shown that the unusual abundance of mackerel during the period 1925–1928 was caused by the exceptionally successful 1923 brood, which accounted for about 90 per cent of the catch throughout most of this period.

Having discovered the nature of this phenomenon, our attention has been more recently directed toward refining our methods of observation of the fishery in order that a fairly accurate estimate of future abundance might be made as a service to the fishery. To do this we have used both statistical and biological approaches to the problem in a form of cooperation between the divisions of fishery industries and of scientific inquiry, which has proven effective. During 1928 the activities continued under the direction of Oscar E. Sette, assisted by Edward W. Bailey. Most of the observations on the mackerel at landing ports were made by Frank E. Firth, while special data on trap catches were collected by Robert A. Goffin. At the mackerel-landing ports at Cape May, N. J., New York City, and Boston and Gloucester, Mass., vessel captains were interviewed with respect to date, locality, quantity, and other items relating to their catches. The fish in a sample of 20 or more from most of the fares were measured, and scales were taken from lots of five fish from many of these samples. In this manner the observers secured data on 1,240 trips out of 2,517 landed by the fleet during the season. Samples totaling 32,294 mackerel were measured from 858 of these trips, and several thousand scale samples were collected.

These and similar data collected in previous years have demonstrated domination by the 1923 year class during the period 1925 to 1927 and made possible a forecast in advance of the 1928 season, the prediction being that a decline of at least 12½ per cent in abundance would occur between 1927 and 1928. In terms of catch, this meant a reduction from 42,000,000 pounds in 1927 to something less than 37,000,000 in 1928, provided the fishing effort remained the same in both years. This prediction proved to be approximately correct, for the catch in 1928 totaled slightly over 31,000,000.

The success of this prediction must be credited to the simplicity of conditions rather than to a profound knowledge of factors affecting the fishery. We had only to consider the 1923 brood in making the 1928 prediction, and since this had been subject to a decline in the previous year it was apparent that a further decline might be expected. The first tow-netting for mackerel eggs and larvæ was done in 1926, and in the past three years enough exploratory work has been done to define roughly the important spawning areas and to give a general idea of the abundance of mackerel eggs and larvæ to be expected in those areas.

Two cruises were made by the *Albatross II* in 1928. The first one, in May, covered the continental shelf from Cape Cod to Delaware Bay between the 10 and 100 fathom contours. Thirty-nine stations were occupied, and townet hauls were made at 37 of these. Analysis of the collections indicated mackerel eggs and larvæ in abundance nearly equal to that found on the comparable cruise of 1927. A second cruise in July included stations in the waters north, east, and south of Cape Cod within 50 miles of the shore line. The spawning season being past at this time, very few mackerel eggs were found in the tow-net hauls, but larvæ were taken in abundance in Massachusetts Bay and at stations just south of No Man's Land. While we can not yet express the abundance of mackerel eggs and larvæ in terms of expected yield of commercial mackerel two years hence, a longer series of data of the kind that indicates the abundance of commercial mackerel realized from a certain concentration of mackerel fry in previous years may eventually lead to a solution of the forecasting problem.

The results of the studies on abundance of the mackerel in its early stages may be even more significant in explaining the causes of age dominance. An estimate of the abundance of eggs and larvæ through a sufficient number of years should disclose whether brood failures are due to a dearth of mackerel eggs, unusual mortality of larvæ, or failure of later stages to survive. Many marine fishes are subject to fluctuations in abundance resulting from unequal year broods, and to find the cause in the case of any particular species would constitute a distinct advance in fisheries science. The mackerel, with its sharply contrasted "good" and "poor" broods, appears to be a particularly favorable subject for the study of the factors responsible for nonsurvival of certain broods, hence this phase is to receive considerable attention in future mackerel investigations.

SHORE FISHES OF THE MIDDLE ATLANTIC STATES

Studies of the fisheries of the Middle Atlantic States, begun in July, 1927, were continued and extended in 1928 by R. A. Nesbit, assisted by H. A. Hanson, H. M. Bearse, W. C. Neville, V. E. Heffelfinger, A. C. Redmond, Gerritt Bevelander, and Edward Bevelander.

Valuable assistance was rendered by C. M. Breder, jr., of the staff of the New York Aquarium. The Bingham Oceanographic Collection cooperated with the bureau in this investigation, A. E. Parr being engaged in biometric studies of races of squeteague.

The ultimate object of the investigation is to determine the causes of changes in the yield of these fisheries from year to year, with particular reference to separation of the results of natural changes in abundance from the results of possible overfishing. In order to accomplish this aim it has been necessary, as in 1927, to carry on two lines of investigation, the first to determine what changes have taken place in the past and are taking place at the present time, and the second to determine the causes of the changes observed.

In carrying on the work, statistical records and biological data have been collected for each of the more important food fishes taken in the region. Analysis and interpretation of the data collected has, for the present, been confined largely to squeteague, the most important species. Discussion of observations and results will therefore refer to this species.

The first line of investigation has been carried out by securing records of the catch of former years from log books and bookkeeping records, lent by fishermen from a number of localities, and by instituting a system of voluntary statistical returns for current catches. Leading pound-net operators have cooperated readily, so that about 80 per cent of the pound-net catch in New York and New Jersey was reported daily during the 1928 fishing season. Daily reports are particularly valuable, since it is important to note the magnitude of the several distinct runs that occur during the season, particularly as the runs show marked differences in age composition.

Comparison and analysis of the records of former years indicate that even though incomplete they provide a dependable index of change in abundance over the period covered. It was hoped that the range and character of the fluctuations, as shown by these records, would present unequivocal evidence of a definite trend in the yield. Unfortunately, most of the records cover only the period from 1920 to 1928. The general downward trend in New York and northern New Jersey contrasts with an upward trend in southern New Jersey for these years. A single record from eastern Long Island, N. Y., indicates that prior to 1900 the yield per trap was only moderate, but that between 1900 and 1908 a tremendous increase took place, followed by a decline to lower levels. Statistical canvasses indicate that the phenomenon was a general one for the whole of New York and southern New England. Since some species are known to fluctuate violently from natural causes, with lapses of as much as 40 to 60 years between periods of extreme abundance, it is possible that the present low level of abundance of squeteague in New York and southern New England waters is due to natural causes from which a natural recovery may be expected. Hence, it is not possible at this time to state definitely that the decline is due to overfishing.

Biological studies intended to discover the causes of fluctuations in the yield were designed to detect variations in the annual increment to the population. This seemed the most promising line of investigation, as dominant year classes have proved to be the most common cause of natural fluctuations in other fisheries.

Field bases were established at Montauk and West Sayville, N. Y., and Belford, Long Branch, and Wildwood, N. J. In addition, collections of field data were made by the laboratory staffs at Woods Hole, Mass., and Beaufort, N. C. Random samples of fish of the more important species were measured daily during the season, and scale samples were taken from those species that appear to have legible scales. In all, about 150,000 fish were measured and about 8,000 scale samples were collected.

Tabulation and comparison of the squeteague measurements from the several field bases have shown marked differences in the length-frequency composition of the runs in each locality sampled, as well as sharply defined seasonal differences in each locality. In general, the smaller sizes were taken in the more southerly part of the region and the larger sizes off northern New Jersey and New York. Comparison of the 1928 frequency distributions with the fragmentary records obtained during the 1927 survey shows that for corresponding dates and localities the distributions are nearly identical. Should future observations confirm the suggestion that there is a characteristic size group for each phase of the season in each locality, study of dominant year classes, if such exist, will be greatly complicated.

Scale studies are now being carried on to determine the percentage age composition of the size groups observed and to determine and compare the rate of growth of the fish composing them. At the same time a critical study of the validity of the scale theory, as applied to squeteague, is being made. Assuming, subject to verification, that the scale interpretations are correct, considerable differences in the rate of growth of fish making up the several distinct size groups have been noted. These differences exist, not only between different localities, but scale records from fish from the same localities at different times in the season show considerable differences.

In July and August a survey of Chesapeake Bay was made, preliminary to extension of the program of regular field-data collection to this region. Field bases for 1929 were selected. During the course of the survey several thousand fish were measured for comparison with measurements to be made in 1929.

Extension of the program for 1929 includes an investigation of spawning areas and studies of the growth of young fish in cooperation with the Bingham Oceanographic Collection.

SHORE FISHES OF NORTH CAROLINA

The program of the investigation of the eggs and larvæ of commercial fishes, announced in the last annual report as a preliminary step in the study of the biology of survival, has been continued by Dr. S. F. Hildebrand, assisted by J. S. Gutsell and Louella E. Cable at the Beaufort (N. C.) fisheries biological laboratory throughout the year. The immediate object of this work is to secure a complete developmental series of the important fishes of the region in order to facilitate their ready identification, to study their distribution and abundance throughout the year, and to collect such other biological information concerning their development as may be necessary for an understanding of the problems of their conservation.

One offshore trip, when weather conditions permitted, was made each week, and other collections were made in inshore waters. In offshore work meter townets were used almost exclusively, and an equal number of collections was made at the surface and bottom. Inshore work with meter townets was supplemented by collections made with an otter trawl, the "cod end" of which was covered with bobbinet. The last-mentioned apparatus brought in some greatly desired "intermediate sizes"; that is, specimens larger than those usually taken in meter townets and smaller than generally appear in collecting seines and trawls.

In addition to the collections made locally, many specimens of young fish collected in southern waters, principally by the late William W. Welsh, on cruises made by the *Bache* and the *Albatross* were transferred to this station for study.

The material at hand has not all been studied. To acquire a complete series, showing the development from the egg to the adult stage, generally is difficult. However, at least some of the stages in the development of 20 species, not studied previously with respect to the development of the young, have been secured and figured.

In 1928 scale studies relative to age determination and the rate of growth of the pigfish (*Orthopristis chrysopterus*) were undertaken by Louella E. Cable at Beaufort, N. C. Material for this work has been decidedly limited. However, it is hoped that more extensive observations may be possible soon. The food of the pigfish has been especially studied throughout the year, the alimentary tracts of more than 100 fish having been examined.

TEXAS FISHES

With the printing of Document 1046, Natural History and Conservation of the Redfish and Other Commercial Sciænids of the Texas Coast, by John C. Pearson, at the end of 1928, the bureau's intensive field work on the coastal fisheries of Texas was completed, and only laboratory studies on collections previously made were continued. In connection with the systematic study of the fish fauna of the Texas coast, undertaken last year by Isaac Ginsburg and arising from the identifications of species collected by field parties, several problems in systematic ichthyology have arisen. The problem of the specific identity of the sand trout of the Gulf coast was solved by a study of large series of specimens. In this study it was found desirable to make also an extensive study of the gray squeteague of the Atlantic coast in order to compare it with the Gulf coast fish. It has been definitely determined that the so-called sand trout consists of two entirely distinct species, which, although superficially alike in appearance, may be easily separated by well-marked structural differences. The two species vary in size and also in their market value. The smaller species is *Cynoscion nothus*, which also occurs on the Atlantic coast; the larger and more important market species is very close to *Cynoscion regalis* from the Atlantic coast but differs from it sufficiently to be regarded as a distinct species. This species is apparently as yet unnamed scientifically. The name *thalassinus*, which was provisionally used for it, is evidently untenable. A report on this investigation is in press.

GREAT LAKES FISHERY INVESTIGATIONS

The fishery investigation on the Great Lakes during 1928 was largely a continuation of the program inaugurated in 1927 on Lake Erie. Some fisheries work was carried on also on Lakes Huron and Michigan. In 1928 extensive limnological studies were begun on Lake Erie.

LAKE ERIE

1. *Fishery investigations.*—The work on Lake Erie may be considered conveniently in four categories: (1) General survey, (2) destructiveness of commercial gear, (3) selective effect of gear on the general population, and (4) biology of commercial species. In the general survey information was obtained on the history of the fisheries, the kind and amount of gear now employed, the size of meshes and twine and the depth and length of nets now in use, the location of fishing and spawning grounds, the spawning seasons, the abundance of fish (statistics), the migration and other habits of fish, probable causes of depletion and desirable legislation on size limits, closed areas, closed seasons, gear, etc.

In the study on the destructiveness of gear, data were obtained on the percentage of illegal or small fish taken and destroyed by the commercial gill net, bull net, trap net, pound net, and seine during various seasons of the year and in various areas of the lake. In order to determine whether it is possible to reduce the destructiveness to the gear now fished, two series of experimental nets were operated, one comprising shallow gill nets of various sized meshes and the other trap nets with various sized meshes in the back or head of the lifting crib. These experimental nets were fished throughout an entire fishing season to test all conditions in the fisheries, which vary greatly with the seasons. By these means many data were obtained on the selectivity exercised by the different-sized meshes on the various populations of fish.

Detailed studies have been begun on the biology of the nine most important commercial species of fish. Such studies are based on data on age, growth, sexual maturity, longevity, mortality, spawning, migration, relative abundance of males and females, fluctuations in abundance of size groups and year classes, in sex composition of schools, and in the relative abundance of the different species in the commercial lifts and on races.

The work was carried on in the field by members of the bureau's Great Lakes staff, who were assigned to various ports on the lake and under the direction of Dr. John Van Oosten. The following investigators were engaged on Lake Erie: Dr. Stillman Wright, Ben Hill, C. Willard Greene, and Hilary J. Deason.

Though the field work was carried on jointly by the various investigators, the laboratory work was apportioned among them, and each investigator was assigned a certain definite problem. Doctor Wright is carrying on a study of the correlation of growth and environment in several species of fish from a series of Wisconsin lakes. Mr. Greene is engaged in a study of the natural history and of the life history of the sheepshead as determined from the scales. With the depletion of the more valuable coregonids, the sheepshead is growing more important in the fishing industry. Mr. Deason is investigating the systematic status and the life history of the yellow pike, blue pike, and sauger, while Mr. Hill is analyzing biological data (scales, lengths, etc.) on the white or striped bass. Doctor Van Oosten is compiling the more general data collected in the field, such as those on the destructiveness and selectivity of gear and on legislation, and in addition is continuing his life-history studies on the cisco and whitefish of Lake Erie.

2. *Limnological investigations.*—In addition to the above fishery survey, the bureau cooperated with the game and fisheries department of Ontario, the New York department of conservation, the Buffalo Society of Natural Sciences, and the City of Buffalo in the most extensive limnological investigation ever undertaken on the Great Lakes. This survey was conducted on Lake Erie under the direction of Dr. Charles J. Fish of the Buffalo Society of Natural Sciences. The bureau's vessel *Shearwater* was equipped for the work. This work is discussed further elsewhere in this report.

LAKE HURON

It has been determined from biological studies that the lake herring of Saginaw Bay is subjected to intense fishing. This species is now wholly unprotected, and it is purposed to establish a size limit of 10 inches for its protection. As the herring is a very sensitive fish, it can not withstand the handling due to sorting, hence the only feasible method of protection seemed to be a regulation of the mesh of herring pound nets. To ascertain the mesh required to permit the escape of herring under 10 inches in length a series of pound nets of different sized meshes were fished on herring grounds in Saginaw Bay during November. This work, which will be resumed in the spring, was conducted by Doctor Van Oosten in cooperation with the department of conservation of the State of Michigan, which furnished the experimental nets and three assistants.

LAKE MICHIGAN

In cooperation with the department of conservation of the State of Michigan Doctor Van Oosten also began a preliminary study of the destructiveness to trout and the selectivity of chub nets of diferent sized meshes on Lake Michigan. The experiment was designed primarily to ascertain which of three meshes, 2½, 2⅝, or 2¾-inch, is most destructive to immature lake trout, a question of paramount importance on Lake Michigan at the present time. Due to severe storms, too few data to be conclusive were collected, but it is hoped that the experiment can be continued next year.

PACIFIC COAST AND ALASKA FISHERY INVESTIGATIONS

The investigation of the Pacific salmon has been seriously affected by the loss of Dr. Charles H. Gilbert, who died early in the year. Doctor Gilbert was responsible for the initiation of this work and took an active part up to the time of his death. In large measure the present program was planned by him, and much of the credit for future results will be due to his ability to plan such a program of research along broad scientific and practical lines.

ALASKA SALMON

Tagging experiments.—Only one small tagging experiment was made during the year, when 462 tags were attached to red salmon taken in a trap at Nicholaski Spit on the western shore of Pavlof Bay, Alaska Peninsula. The tagging was done on July 11, 12, and 17. There was some reason to suppose that fish caught in this trap were, in part at least, derived from the Bristol Bay runs, and the experiment was undertaken to test this theory. The new regulations for 1928, however, prohibited fishing in this locality prior to July 5, and it is known from previous experiments that most of the Bristol Bay fish have passed out of the region south of the peninsula by the middle of July. Only one tagged fish was recaptured in Bristol Bay, but others were taken at Ikatan and Morzhovoi Bay, possibly en route to Bristol Bay. It seems probable that the trap in question, if fished during the height of the run, would catch appreciable numbers of Bristol Bay red salmon; but under the present regulation it will not, apparently, intercept many of these fish. Four tagged fish were taken at Chignik and others in localities close to the point of tagging. This work was done by L. C. Wingard, assistant agent in the Alaska fisheries service, under the direction of Dr. W. H. Rich.

A report covering the experiments of 1927 and 1928 is in press.

Statistics of the Alaska salmon fisheries.—The compilation and analysis of the statistics of the Alaska salmon fisheries has been continued by Doctor Rich and E. M. Ball, assistant, Alaska service. A first part, dealing with the fisheries of Bristol Bay and the Alaska Peninsula, has been published, and material progress has been made in the preparation of a second part, which is to take up the data for as much of central Alaska as can be covered in the time available. The results of this work have proved to be of great practical value by showing more clearly than has been shown before the condition of the fisheries in each locality. The data clearly show serious depletion in certain restricted localities and to a lesser degree depletion, as indicated by reduced catches, appeared to be rather widespread. By means of correlation studies it has been possible to show a close association between the fisheries in the Ikatan-Shumagin Island district and Bristol Bay, thus corroborating the results obtained by tagging experiments in 1922 and 1923. Other studies based on the correlation between catches of red salmon in Bristol Bay at 4, 5, and 6 year intervals indicate that the Nushagak fish are predominantly 4 years old, while those taken in the Kvichak-Naknek-Egegik fishery are predominantly 5 years old.

Karluk River investigations.—Special and intensive study of the Karluk River red-salmon runs has been carried on for several years. The primary purpose is to determine the relationship between spawning population and the resultant production of adult fish and, further, to determine the factors that may modify the production from a given spawning population in different years. To this end the spawning population (the escapement) has been enumerated each year since 1921 by means of a counting weir located near the mouth of the river; the commercial catch has also been enumerated, a procedure made possible by the restricted character of the fishery; and the catch each year is carefully sampled, and age determinations are made so that the correct proportions of each run may be referred to the brood years from which they are derived. As the Karluk red-salmon runs contain appreciable numbers of 4, 5, and 6 year fish it follows that we can not know the production of any particular escapement until 6 years have passed, and we have now, therefore, complete returns from only two of the known escapements—those for 1921 and 1922; but from now on we will add each year one figure to our series of data on the production of known escapements. It will undoubtedly require many years before we will have a sufficient number of data to warrant final conclusions, and in the meantime these investigations must be carried on as a matter of routine. Only in this way can we expect to understand the escapement requirements necessary to maintain the runs at the point of maximum productivity, and the importance of the problem is such as to fully warrant the establishment of such a long-time study as this must prove to be.

As a result of these studies it has been shown that the escapement of 1921, which was 1,325,000, produced about 4,250,000, approximately 3 to 1; and the escapement of 1922, which was close to 400,000, produced 2,000,000, approximately 5 to 1. Although the 6-year fish from the 1923 spawning are still to come, it appears probable that the product of that escapement, 635,000, will be intermediate between those of the other two. Even these few data indicate strongly that the smaller escapements are relatively more productive than the larger ones, a fact that may well explain the increased resistance to further reduction of depleted fish populations that has been noted by various students of fishery problems. They also emphasize the importance of determining the point of maximum productivity, because although the smaller spawning populations are relatively more productive the larger ones are actually more productive up to a certain point.

Observations on the spawning grounds of Karluk Lake were continued during the past year. Two trips to the lake, one in July and the other in September, were made by Seymour P. Smith and Alan C. Taft. The conditions for spawning appeared to be very favorable; the water in the spawning streams being higher than has been observed for several years. Additional collections of young salmon were made, and limnological data, including quantitative plankton catches, temperatures, and water residues, were secured. The limnological data are being studied by Dr. Chancey Juday of the University of Wisconsin.

The marking experiments at Karluk, in which the seaward migrants are marked by clipping certain fins, were continued. These have been explained in previous reports and are designed to secure information on which to base an estimate of the number of seaward migrants derived from each spawning escapement. Fifty thousand migrants were again marked in 1928. Very satisfactory returns were secured in 1928 from the marking experiment of 1926.

The divisional report for 1927 contained an account of the returns secured in that year from the experiment of 1926, and on the basis of the few 1927 returns it was estimated that the total seaward migration consisted in approximately 13,000,000 fish. On the basis of the much more complete and reliable returns secured in 1928 it is now estimated that the seaward migration of 1926 contained about 8,125,000. Over 1,400 marked fish were actually recovered. These data indicate that the survival of the seaward migrants, once they reach the ocean, is much higher than has ever been reported. The greatest returns secured from the various marking experiments on the Columbia River indicated a survival of about 1 in 20, but the survival of the Karluk migrants of 1926 is apparently greater than 1 in 4 and possibly as high as 1 in 3. A few marked grilse from the experiment of 1927 were secured, but the number was so small that any estimate of the total number of seaward migrants in that year is unwarranted.

Chignik River investigations.—A study of the red-salmon runs to the Chignik River has been undertaken along somewhat similar lines as that at Karluk. Here, as at Karluk, a weir has been maintained since 1922, and it is possible, also, to get a reliable estimate of the number of fish taken by the commercial fishery. This study is being made by Harlan B. Holmes, assistant aquatic biologist, who devoted the greater part of the past season to a study of the seaward migration of the fingerlings. The seaward migration at Chignik is peculiar in that it is distributed over a period of 2 or 3 months, whereas in other rivers with which we are familiar the migration is of much shorter duration. The problems relating to the red salmon of this river are proving to be of unusual complexity. The scales present irregularities that can not be interpreted with certainty until a detailed study has been made of the growth of the fingerlings and the development of their scales. The task of determining the number of fish of each age in the spawning migration is complicated by pronounced and irregular fluctuations in the age composition of the run at different times of the season. The study is further complicated by fluctuations in the time at which the bulk of the run is passing the commercial fishery. The run is in progress for approximately 20 weeks, but half or more of the fish may pass during a period of two weeks. This peak in the run may come as early as June or as late as August. The run is not always concentrated into a pronounced peak; in some cases it has remained quite constant for a period of 10 or more weeks. As a result of these irregularities in age composition and time of the run, scale samples upon which an age analysis of the run is to be based must be much more extensive than those required in cases in which these conditions are less variable. The problems of sampling and scale interpretation are to be given special attention next season.

COLUMBIA RIVER SALMON

Salmon-marking experiments, which are being conducted on the Columbia River in cooperation with the Oregon Fish Commission, have been continued under the supervision of H. B. Holmes. One new experiment was started during the season. This was designed to determine at what age fingerlings of the fall run of chinook salmon should be liberated in order to give the greatest number of resulting mature fish. It may be argued that since the young of the fall run of chinooks normally migrate to the ocean soon after they hatch, it would be best to permit the hatchery-reared fingerlings to migrate at that time. On the other hand, it is possible that older and larger fingerlings would have greater chance of survival and that it would be better to retain the young fish at the hatchery for a part or all of the first season. The experiment, which is intended to give some information on this subject, consists of liberating groups of fingerlings at different times of the season, each group being distinctively marked by the removal of certain fins from each fish. A similar experiment has already been applied to fingerlings of the spring run of chinook salmon. These marked fish were in their fourth year in 1928 and a few were recovered. The greater part of the fish from this experiment are expected to return in 1929 as 5-year olds.

Marked salmon recovered during the season of 1928 include 21 specimens from an experiment with the landlocked salmon *Oncorhynchus nerka kennerlyi*, commonly known as the little redfish or "yank." These fish were marked for the purpose of determining if it is possible to induce this landlocked variety to become sea run. Practical interest in this experiment attaches to the fact that these fish in their native habitat attain a size of only about one-half pound and are of very little economic value. If they could be induced to become sea run, and if, like the more typical salmon, they would respond to the ocean environment by making a vigorous growth, they could be made to contribute to a valuable resource.

The marked landlocked salmon were in their fourth year in 1928. The 21 specimens that were reported were caught in the Columbia River by commercial fishermen. As far as could be determined by a superficial examination, these specimens seemed to be identical with their nearest relative, the blueback salmon. This resemblance was to be expected, because these two forms have not been shown to differ except in size and life history. With these differences eliminated we should expect them to appear identical. This similarity has led to a possible error in the experiment. Fingerlings of both the landlocked and sea-run forms were reared at the hatchery at which this experiment was conducted; and although extreme precautions were taken to prevent intermingling of the two forms, it is possible that these precautions were not successful and that a few of the sea-run form were marked. It is possible, then, that the 21 marked fish that were recovered were from sea-run parents.

Were it not for this possible error in the experiment, these 21 recoveries could be accepted as reliable evidence that the little redfish can be induced to become sea run, but as it is very little confidence can be placed in the results. This experiment is now being repeated under conditions that will eliminate the chance of confusion in the identity of the fish.

EMBRYOLOGY OF THE CHINOOK SALMON

This study has been continued during the past year by Dr. G. C. Price at Stanford University. In the last divisional report mention was made of the fact that this study had shown that the temperature-unit system for recording development, which is in common use at the hatcheries, is unreliable because the rate of development is not uniformly accelerated by a rise in temperature. During the past year still another complication has been discovered, in that the accelerating effect of a given change in temperature does not act uniformly at all stages in development. It is quite different at early stages than at late stages. It will be impossible to determine the exact relationship between temperature and rate of development without additional data. A report covering the general features of development and presenting the available data on the influence of temperature is in course of preparation.

ALASKA HERRING

The herring investigations commenced by George A. Rounsefell in 1925 have been continued. Owing to the failure of the runs in central Alaska the sampling of catches in this district, from which a series of data was desired over several years, was not as extensive as had been planned. Samples were obtained from several new localities—Puget Bay, Snug Harbor, and Port Fidalgo in Prince William Sound and Zachar Bay and Shearwater Bay on Kodiak Island. Analysis of the vertebral count of these samples indicates that on Kodiak Island the Shearwater Bay herring are distinct from those of Shuyak Strait, thus indicating that the failure of the fishery in the latter locality was not due to any shifting of the schools.

In 1928 the central Alaska herring fishery underwent the greatest failure since the beginning of the industry. In Prince William Sound the usual early summer run in Elrington Passage failed to materialize. Quantities of very small herring, fit only for oil and meal, were taken in Snug Harbor for a few days during the last of June, and small intermittent catches were made during the summer at Macleod Harbor, on Montague Island; but the autumn run of large herring, on which Prince William Sound has been largely dependent for its supply of raw material for pickling, was an utter failure. There has been a decrease from 90,000 barrels of pickled herring in 1922 to about 3,000 barrels in 1928. In Cook Inlet the fishing was also a failure. The August run of large herring in Kachemak Bay, which has been the mainstay of the fishery since the commencement of purse seining in Cook Inlet in 1924, failed to appear. Late in the fall a few catches were made of herring that were unusually small for this area. The purse seiners gathered at Shuyak Strait in July, but caught nothing, although 50,000 barrels of herring were pickled in this area in 1925. Late in the fall a fair run of large herring occurred at Shearwater Bay, as in 1927. This was the only run approaching former size in all of central Alaska.

The almost total failure of the fishery in central Alaska was only partially compensated by the discovery of quantities of herring about 700 miles southwest of Seward at Unalaska in the Aleutian Islands. For many years herring have been known to occur at Unalaska, and very small quantities have been salted from time to time; 1927 was the first year in which they were noticed to be unusually abundant. Owing to the almost complete failure of the central Alaska fishery in 1928, the herring packers, scouting along hundreds of miles of coast, discovered this abundance at Unalaska. Boats and gear were rushed to the scene and 25,000 barrels were pickled, the pack being limited chiefly by the lack of sufficient facilities for handling. An explanation of this unwonted abundance at Unalaska is given by an age analysis of a portion of our samples, indicating that about 70 per cent of the catch were 6 years of age, all of the other age classes combined making only about 30 per cent. This would imply that the appearance of such enormous quantities of herring at Unalaska was due to the survival in 1922 of unusually large numbers of fry. That such enormous differences in the numerical importance of age classes are not unusual has been shown by our analysis over a 4-year period of the ages and lengths of herring from Prince William Sound.

The catches at Unalaska were virtually all made inside of Dutch Harbor, a tiny bay 1½ miles in length by one-half mile in width and only 18 fathoms in the deepest spot. This exemplifies a peculiar situation found in the Alaska herring fisheries. Over hundreds of miles of coast herring will be abundant only in certain bays. All of the gear is concentrated in a limited area, and enormous catches result, with a consequent reduction in the population.

Preliminary analysis of growth rates shows enormous differences between the localities considered. The Shumagin Island and Unalaska herring are about equally fast growing. The Unalaska herring at 6 years of age will weigh 19 per cent more than those of Halibut Cove, Cook Inlet; 62 per cent more than those of Elrington Passage, near Latouche; and 280 per cent more than those of Stephens Passage, near Juneau.

Analysis of preserved material from southeastern Alaska shows the existence of separate stocks of herring at Craig on the west coast of Prince of Wales Island, in Stephens Passage near Juneau, and in Chatham Strait. During 1929 an additional investigator will be assigned to the herring investigation, allowing the field work to be extended so as to include this most important section of the fishery.

CONSERVING FISH BY MEANS OF FISH SCREENS AND FISH LADDERS

For years the great salmon industry of the Northwest has suffered from the loss that occurs when the young fish on their migration to the sea enter irrigation and power diversion ditches and are destroyed. Among migratory game fish a similar loss occurs. Further loss of fish life is occasioned when the mature fish, journeying upstream to spawn, encounter obstacles to their progress in the form of dams and the tailraces of power houses, over or around which adequate fishways have not been provided.

With the situation arising from these destructive influences rapidly becoming critical, a meeting of interested State and Federal agencies, the commercial interests, and sportsmen was held at Yakima, Wash., in January, 1928, and an organization known as the Western Food and Game Fish Protective Association was formed. Recognizing that some of the irrigation projects of the United States Government were occasioning great loss of fish in this manner, representatives of this association went to Washington, D. C., and were successful in securing from the Seventieth Congress the passage of "An act to provide for the conservation of fish, and for other purposes," appropriating $25,000 to investigate and determine the best means and methods of preventing the destruction of fish occasioned by ditches, canals, and other works constructed or maintained by the United States.

Shirley Baker, a consulting engineer of San Francisco, was appointed to conduct the investigation for the Bureau of Fisheries, assisted by U. B. Gilroy, civil engineer.

During the 6 months since this investigation began, field examinations were made of practically all types of fish screens and fish ladders then in operation or abandoned because of failure. This examination embraced the States of Washington, Oregon, Idaho, and Montana. Numerous designs and models submitted to Federal and State fish and game bureaus were studied, and such pertinent literature as is available was examined. In the case of the electric fish screen the fundamental scientific studies of Prof. F. O. McMillan, department of electrical engineering, Oregon Agricultural College, and Y. E. Yates, of the Pacific Power & Light Co. at Portland, were especially useful, and upon the Tieton Canal of the Yakima reclamation project full-scale experiments were made with an electric screen operating under actual field conditions.

The preliminary report of the investigators is quoted as follows:

It is emphasized that the successful operation of any of the installations considered in this report will depend upon proper inspection and maintenance. Responsibility for the care of any installation should be definitely fixed.

Fish ladders.—For dams up to heights of 50 feet we believe that fish ladders can be made effective if properly designed. Every fish-ladder installation is an individual problem, but the cardinal points working for the success of any fish ladder are (1) location of the entrance in water which the fish naturally seeks, (2) pools of adequate size and free from sharp or constricted turns, (3) proper regulation of flow through the pools.

At high dams (100 feet or more) we have found no fish ladders or mechanical lifting devices in successful operation.

Fish screens.—The screening of irrigation and power diversions against the entrance of fish should, if possible, be done at the head of the main diversion. Such location of the screening device obviates building and maintaining lengthy by-pass channels back to the main stream and eliminates the necessity of screening any branch ditches.

The small diversions can be positively and economically protected against the entrance of fish by a mechanical screen of the type which constantly revolves in the direction of the current, the motive power being derived from the flow of the ditch.

The success of such a mechanical screen depends upon:

1. Adequate strength of construction and proper housing.
2. Perfect sealing of the revolving screen to the bottom and sides of the ditch.
3. Mesh of the proper fineness to screen out the smallest fish likely to be encountered.
4. The provision of suitable trash racks ahead of the revolving screen to prevent its injury by large drifts or débris.
5. The provision of a suitable by-pass channel through which fish encountering the screen may return to the main stream channel. Experience gained from the Cobb screen, located on the Congdon Ditch near Yakima and successfully operated throughout the 1928 irrigation season, seems to recommend that at least one opening of such a by-pass should be located at the bottom of the ditch, directly beneath the revolving screen.

Any type of mechanical screen which even momentarily allows the screened cross section of the ditch or any portion of same to be open for the passage of accumulated débris under, around, or through the screen is undesirable. * * *. Shutter screens of either the horizontal or vertical type, in which the diverted water is separated from the main flow by an arrangement of adjustable vanes or shutters calculated to screen out the fish, so far have proved impracticable due to liability to clogging.

Electric screens.—Diversions of any size can be effectively and economically protected against the entrance of fish by means of the electric fish "screen," "stop," or "diverter." The electric field of such an installation can be established and controlled so as to prevent injury to the fish.

The Burkey electric fish diverter, used on the experiments in the Tieton Canal of the Yakima project, has proved itself a practical device.

The proper location for an electric fish screen is outside the head gates, with the electric field set up diagonal to the plane of the gate openings. An ideal location is just behind the shear boom which is commonly placed in front of the gates and at an angle with them for protection against large drift and débris. With the electric screen so placed a fish encountering the electrified field of water in front of the head gates is immediately diverted from further progress toward the gate openings and finds in the entire flow of the stream past the diversion the most natural avenue of escape from unpleasant stimuli.

The electrified zone of water which the fish encounters should be of graduated strength, the electric effect increasing in intensity as the head gates are approached. An electric field set up by a direct current which is interrupted and reversed and which operates at a low frequency (approximately 6 to 10 cycles per second) proved effective at the Tieton experiments.

Electrodes of chain are regarded favorably because of their flexibility, which aids natural cleaning in the passage of small drift and débris.

INVESTIGATIONS PERTAINING TO FISH-CULTURAL OPERATIONS

EXPERIMENTAL TROUT CULTURE

Feeding experiments with trout, which have been carried on for several years at the experimental hatchery at Pittsford (formerly known as the Holden station), were continued during the season of 1928 by Russell F. Lord under the direction of Dr. H. S. Davis.

Because of congested conditions at the hatchery it was impossible to begin the experiments as early as usual, but they were continued somewhat later in the fall than in previous years, which to some extent compensated for the delay in getting the experiments under way. It is unfortunate that, owing to local conditions, it is impossible to carry on feeding experiments at this station throughout the year.

During the summer of 1928 the feeding experiments were confined almost entirely to brook trout. The experiments with fingerling trout were conducted in hatchery troughs as in previous years, an entire trough being allotted to each lot of fish. There were 28 experimental lots of brook-trout fingerlings, each lot originally containing 1,500 fish. In addition to the brook trout, six lots of rainbow fingerlings were kept on experimental diets.

The feeding experiments with yearlings were confined to brook trout, which were held in raceways under as nearly identical conditions as possible. The raceways were divided into 16 compartments, the fish in each compartment being kept on a different diet. The compartments were covered with wire screens to prevent losses from birds or other enemies, which had caused some trouble in previous years. Each compartment contained from 200 to 425 fish, depending on the size of the compartment.

Owing to the continually increasing cost of the fresh-meat products commonly used for feeding trout, the experiments during the past season were planned primarily to determine what substitute for fresh meat can be utilized most advantageously. Since it is well known that trout will not flourish unless some fresh meat is included in the diet, dry meals in various proportions were combined with the former in making up the experimental rations. In practice it was found best to moisten the meals first with warm water to the consistency of a thick mush and then incorporate it with the ground meat. The amount of water absorbed by different meals varies from 1½ to 2 times the weight of the dry meal. The same amount of water was always used with each meal, so that the percentage of dry meal in the diet would remain constant.

In the experiments with fingerling trout the controls were fed a mixture of equal parts beef heart and beef liver, as previous experience had shown that this ration gives the best results of any of the straight meat diets. Only one of the experimental rations proved to be superior to the beef-liver and beef-heart mixture. This was a mixture of equal parts of beef liver and clam meal, which gave better results than any other diet used, both as regards growth and mortality. Clam meal, which is manufactured from the refuse of clam canneries, has uniformly given the best results of any dry product that has been tested. Unfortunately only a limited supply of this meal is available.

A ration composed of 85 per cent beef heart and 15 per cent dried skim milk gave nearly as good results as the beef-liver beef-heart mixture. Unlike other dry products, it is necessary to add the dry milk directly to the ground meat, otherwise most of it will be lost in solution. This gives a more concentrated ration than any of the others used, which is, no doubt, largely responsible for the favorable results obtained with this mixture. Since the cost of dry skim milk is more than double that of the animal meals, this ration is also relatively expensive.

Haddock meal, shrimp meal, and a superior grade of cod-liver meal also gave satisfactory results when mixed with an equal quantity of beef liver. The experiments indicate that the use of these meals in combination with an equal quantity of fresh meat will form a satisfactory ration for fingerling trout at a considerable saving in cost over a straight meat diet. The results with menhaden meal were less encouraging.

In feeding these dry products the physical nature of the food has an important bearing on the results. The mixture must be of the proper consistency to be taken readily by the fish and also to reduce to a minimum the loss of nutrient constituents by solution. It has been found that in most instances mixtures containing as high as 50 per cent of the moistened meal are of about the right consistency for feeding, but if the amount of meal is materially increased above these proportions the fish do not take the food as readily and a considerable percentage may be lost.

Several experimental lots were fed fresh fish, either alone or in combination with liver. The fish products used were "bone loaf," composed of the waste in filleting haddock and ground herring. When fed straight, both of these products produced only a medium growth, and after several weeks there was a heavy mortality in both lots of fish. Better results were obtained when "bone loaf" was fed in combination with liver, but the growth was inferior to that obtained with several other rations and the mortality was comparatively high.

The rations fed yearling trout were in most cases quite different from those used in the experiments with fingerlings, since previous experience had shown that trout of this age will do well on many foods that can not be used successfully with the latter. Owing to the high cost of beef liver it was not considered advisable to use it in making up the rations for yearlings, and consequently pig liver and sheep plucks were adopted as the standard meat foods. These products were fed straight and in combination with several animal meals, wheat middlings, and soy-bean meal.

It was found that with both pig liver and sheep plucks much better results were obtained when the meats were combined with animal meals than when they were fed straight. As in the case of fingerlings, clam meal proved to be much superior to any other dry product used. Shrimp bran was next in value to clam meal, while menhaden meal was a poor third. Haddock meal was not used in these experiments. Wheat middlings and soy-bean meal in combination with sheep plucks gave results that were markedly inferior to those obtained with either of the three animal meals previously mentioned.

Pig liver gave somewhat better results than sheep plucks when fed in combination with either clam meal or shrimp bran, although the difference was not great. When fed straight, however, pig liver was much superior to sheep plucks both as regards growth and mortality.

The poor results with sheep plucks were not anticipated and may have been largely due to its physical nature, as there is more waste from light portions of the lungs, which float upon the water and may be carried against the screens or blown ashore. There is also a great deal of indigestible connective tissue. Cooking the plucks was found to be inadvisable, the fish refusing to take them readily. Pig liver appears to be superior to sheep plucks for practical use and costs but little more. When ground, the former is quite wet and very sticky, making it an admirable binding medium for whatever dry foods are added to the ration.

The results indicate that a considerably smaller percentage of fresh meat is permissible in the diet of yearlings than in that of fingerlings. In several instances excellent results were obtained when only one-third of the ration was composed of fresh meat, and it is probable that considerably smaller amounts could be used without affecting the fish adversely. In striking contrast to the fingerlings, yearling trout fed ground mackerel and herring showed a very low mortality, but the growth was much inferior to that obtained with fresh meats combined with animal meals.

It is evident from the results obtained in these experiments that various dry products can be substituted successfully for part of the meat in the diet of trout at a very considerable saving in food costs. It is also apparent that as the fish increase in size considerably larger percentages of the dry products can be used. Since in all our experiments animal meals have given much better results than cereals or beans, it is doubtful if at present prices there is any economy in feeding the latter to trout, either large or small.

Selective breeding of brook trout forms another important phase of the work at the Pittsford hatchery. As there was no stock of fish at this station when it was taken over by the division of inquiry, it was impossible to accomplish anything in this direction during the first two or three years. Some preliminary experiments along this line were undertaken in 1926 and again in 1927, and while the results have been very encouraging, of course nothing of permanent value has yet been obtained. The work has now reached a point, however, where it is possible to undertake experimental breeding on a more extensive scale, and during the spawning season of 1928 thirty-four pairs of brook trout were mated and the offspring of each pair will be reared separately. All fish thus mated are tagged, and a complete record is kept of each individual fish, including weight, body proportions, color, contour, and general condition.

One of the greatest difficulties in trout breeding is to evaluate correctly fish of different parentage. In order to provide a common basis of comparison, as free as possible from error, all fingerlings produced in the breeding experiments will be reared during the first season under virtually identical conditions. These precautions will not be confined to the young of selected pairs, for it is planned to rear representative samples of all lots of fingerling fish under the same conditions, so that direct comparisons can be made in every case.

While the chief purpose of the breeding work is to obtain a superior strain of fish for propagation purposes, it should be pointed out that the data acquired in these experiments will have an important bearing on other phases of trout culture.

PATHOLOGY OF FISHES

Investigations by the pathologist, Dr. H. S. Davis, on the diseases of trout were continued at the experimental hatchery at Pittsford, Vt. Special attention was directed to two bacterial diseases that cause serious losses at many hatcheries.

The gill disease, which was first recognized at this station, is caused by a specific bacterium that develops on the gill filaments, and in the fry is also found on the body and fins. This disease is now known to occur at many hatcheries in the east and middle west, and during the past summer was found in fingerling salmon from the Birdsview (Wash.) hatchery. There is also evidence that it sometimes occurs in wild fish. If allowed to run its course the disease usually causes a heavy mortality, especially among fry and young fingerlings. In some instances there has been virtually a total loss among fish of this age. Fortunately, the disease can be controlled easily by dipping the fish in a 1 to 2,000 solution of copper sulphate if they are treated on the first appearance of the infection.

The investigations during the past summer indicate, however, that it will be very difficult, if not impossible, to eradicate the disease from a hatchery, as it has been found that fingerling trout may become infected from yearlings and older fish that show no evidence of the disease. This indicates that the bacteria may occur in small numbers for an indefinite time on perfectly healthy fish, which thus act as carriers. This is another illustration of the inadvisability of allowing trout to remain in a spring or pool from which a hatchery obtains its water supply.

Observations made during the past year indicate that "fin rot" is much more prevalent in trout hatcheries than has been realized. Apparently the organism varies greatly in virulence, and in many cases the disease occurs among fingerling trout as a comparatively mild infection, which causes a small daily mortality without assuming the proportions of an epidemic. In such cases a majority of the fish recover from the disease without suffering serious injury, and the fins rapidly regenerate the parts that have been destroyed.

There is evidence that Gyrodactylus may be an important contributing factor in fin rot. This parasite is often found associated with the disease, and it seems probable that fins that have been injured by it are more susceptible to infection than would otherwise be the case.

An epidemic among fingerling trout at the York Pond (N. H.) station was found to be due to infection with *Costia necatrix*, a small protozoan parasite that occurs on the body and gills. This disease has recurred at about the same time each spring among small fingerlings held in raceways supplied with water from York Pond. As the pond contains large numbers of trout of various ages, it appears probable that the parasites are carried from these fish to the raceways.

As in previous years the pathologist was consulted by a number of State and commercial hatcheries regarding the occurrence of parasites and diseases among hatchery fish. Diagnoses were made and treatments recommended, with beneficial results in all cases in which treatment was practicable.

POND CULTURE

The investigations on pond culture under the general direction of Doctor Davis at the Fairport (Iowa) biological station, which were begun in 1926, were carried on in 1928 by Dr. A. H. Wiebe, assisted by the station staff. As in previous years, special attention was devoted to the largemouth black bass, although other species were propagated to some extent.

One of the most important features of the work at Fairport has been the utilization of forage fish in the spawning and rearing ponds. Three years' experience with forage fish has shown conclusively that by their proper use the production of fingerling bass can be greatly increased at little additional expense. No attempt has been made to rear forage fish in ponds devoted solely to this purpose, except in a few instances in order to insure having a supply on hand for stocking the bass ponds. In virtually all of the experimental work the bass ponds were stocked with adult forage fish early in the spring, so that they would have an opportunity to spawn in the ponds and thus provide a supply of small fish for the bass fingerlings.

Further experience with the golden shiner and blackhead minnow supports the opinion expressed last year that the golden shiner is the better of the two species for forage purposes. This is well shown by the results in the "E" ponds. These are small ponds of approximately the same area and situated side by side. Two of these ponds were stocked with golden shiners and the other two with blackhead minnows. Later 3,900 bass fry were liberated in each pair of ponds. When drawn in the fall there were 1,507 fingerling bass in the shiner ponds with a total weight of 220 ounces. On the other hand, the ponds stocked with blackheads yielded only 307 fingerling bass weighing 116 ounces.

The best production was obtained in pond D–7, which has a surface area of 1 acre. This pond was stocked with 434 adult shiners and 21,750 bass fry. When drained in the fall approximately 10,000 fingerling bass, averaging about 3 inches in length, were taken from the pond, showing a survival of 46 per cent. Only 301 adult shiners were found in the pond, and there were no young shiners present, indicating that the pond was understocked with forage fish. It seems reasonable to assume that if the pond had not been understocked with shiners the yield of bass would have been considerably greater.

Heretofore no attempt has been made to propagate smallmouth black bass at Fairport as conditions in the ponds were not considered suitable for this species. However, in the spring of 1928 one pond, with an area of 0.6 acre, was stocked with 20 adult smallmouth bass and 258 adult golden shiners. When drained in the fall 4,393 fingerling and 19 adult bass were found in the pond. The shiners had disappeared entirely. This is a production of approximately 7,300 fingerling bass per acre, which, under the circumstances, is considered a very satisfactory return.

Quite satisfactory results have also been obtained with both black and white crappie. These fish do well in the same pond with bluegill sunfish, such a combination showing a production of 10,000 to 12,000 fingerling crappie per acre, with an even larger number of bluegills.

Further experience with application of fertilizers to the ponds has fully confirmed the results of the previous year. The fertilized ponds in variably show a much greater production of fish than the unfertilized. The mixture of dry sheep manure and superphosphate adopted in 1927 was used in 1928, also, but in most instances in smaller amounts with equally satisfactory results. Under the conditions that obtain at Fairport it appears that 500 to 1,000 pounds of the mixture per acre of pond area will give virtually as large a production of fish as when greater amounts of fertilizer are used. The fertilizer should not all be applied at one time, but small amounts should be distributed during the spring and early summer in the shallow water around the margin of the pond.

Limnological observations were made on both fertilized and unfertilized ponds and also on small concrete pools devoted solely to plankton production. As a result of these observations extensive data have been obtained on the temperature, transparency, pH, dissolved oxygen, free and half-bound carbon dioxide, dissolved phosphorus, organic phosphorus, nitrogen as free ammonia, as nitrite, as nitrate, and as organic nitrogen, dissolved chlorides, dissolved silica, net plankton, total plankton, and organic matter.

Although temperature and transparency are of great importance, they do not appear to be limiting factors as far as production of ponds is concerned. The results also show that pH as such is of relatively little importance either in plankton production or to the fish. Free carbon dioxide may, at the height of photosynthetic activity, momentarily become a limiting factor. This is shown by the fact that on bright sunny days not only is the free CO_2 used up but also a large share of the half-bound CO_2.

Nitrogen is not a limiting factor in the Fairport ponds, since no instance has been found where the water was devoid of free ammonia or of nitrate nitrogen. This means that there is at all times an available supply of inorganic nitrogen for algæ and higher plants. Organic nitrogen was even more abundant, so there was a plentiful supply for the zooplankton.

Since phosphorus has been held to be an important limiting factor by some investigators, it is interesting to find that this is not ordinarily the case in the ponds at Fairport. Dissolved phosphorus does decrease rapidly while plankton is on the increase and at times may disappear completely. A considerable amount of organic phosphorus is always present, however. This organic phosphorus is a source of dissolved phosphorus, which as a rule is reformed quite rapidly. For this reason dissolved phosphorus is never absent for any great length of time. Total absence of dissolved phosphorus has been observed only in ponds that were not fertilized or were fertilized only at long intervals. It thus appears that in unfertilized ponds dissolved phosphorus may at times be a limiting factor, but this is not the case in ponds that are fertilized regularly at frequent intervals.

If dissolved phosphorus is a limiting factor it is certainly not the only chemical constituent that may function in this capacity. In one of the small concrete ponds the dissolved phosphorus dropped from 1.8 to 0.045 p. p. m. during a period of great synthetic activity. The plankton and organic matter increased until the phosphorus reached the lower level, then both declined. Since 0.045 p. p. m. is a relatively large amount of dissolved phosphorus the sudden decrease in plankton and organic matter can not be attributed to lack of an available supply of this element.

In another concrete pond of the same size the amount of organic matter was very high while the dissolved phosphorus was very low. As the season advanced the organic matter decreased and the dissolved phosphorus increased, but this increase in phosphorus was not followed by a corresponding increase in the growth of algæ. The results show very clearly that phosphorus is used by algæ and is again liberated when the algæ die and undergo decay.

These investigations indicate that if the problem of productivity is ever solved it will be found that there is no one limiting factor but that productivity depends on a group of factors, some of which are probably of relatively greater importance than others.

INVESTIGATIONS IN THE UPPER MISSISSIPPI WILD LIFE AND FISH REFUGE

During the summer of 1928 investigations on the ponds and sloughs of the recently established upper Mississippi wild life and fish refuge were begun by Eugene W. Surber under the general direction of Doctor Davis. The inclusion of the bottom lands of the upper Mississippi in our field of operations has enabled us to widen the scope of our aquicultural investigations very materially. The work at Fairport is necessarily confined to artificial ponds, and it will now be possible to supplement and amplify this work by investigations on fish under natural conditions.

In the past there has been much discussion regarding the feasibility of increasing the production of desirable fish in natural waters, but little real progress has been made in this direction. It is now planned to apply the principles of practical aquiculture to favorable waters in the refuge in an attempt to increase the production of such areas. The periodical overflows to which all ponds in the refuge are more or less liable will no doubt prove a serious handicap to such a program. Certain ponds and sloughs, however, afford much more favorable opportunities for experimental work than others, and it is planned to concentrate on these for the present.

In order to obtain a comprehensive idea of conditions in the refuge Mr. Surber was engaged during the past summer in making an inventory of the ponds and sloughs available for aquicultural investigations. With the aid of a houseboat he was able to cover the most important parts of the refuge and collect data that will be invaluable in developing a comprehensive program for future work.

During June and July, while awaiting completion of the houseboat, observations were made on the fish, bottom fauna, plankton, and physical and chemical factors in a number of typical sloughs. Later an inventory was made of the sloughs that lie in the bottom lands between Lake Pepin and the mouth of the Wisconsin River. The unusually high stage of the river during September and October interfered with the work to some extent but made it possible to cover a much larger territory than would have been possible in a normal season.

The flood plains of the upper Mississippi River are dissected by running-water sloughs or dead-water sloughs, depending upon the stage of the water and alluvial or other obstructions at their origins. These sloughs may be offshoots from tributary rivers or, as is more often the case, offshoots of the main river itself. From the standpoint of aquiculture these sloughs may be classified in five groups as follows:

1. *Running-water chutes.*—These are long, narrow channels, from 20 to 250 feet wide, with abrupt, often undercut, banks. The banks are usually lined with densely foliaged trees of the mature flood-plain forest. Because of strong currents and high turbidity these sloughs are considered unsuitable for fish-cultural purposes.

2. *Quiet-water sloughs.*—Long, narrow sloughs, which were formerly chutes but which now have closing dams or natural alluvial deposits built across their origins. Consequently they have been converted into sluggish sloughs or still-water lagoons with a depth of from 8 to 10 feet. The banks are usually quite abrupt and, due to the deep shade cast by the trees lining the banks, there is ordinarily little aquatic vegetation. Many of these sloughs are considered favorable for aquicultural development.

3. *Short, narrow sloughs.*—These sloughs are usually from about ⅛ to ½ mile in length and from 25 to 200 feet wide, with high banks on both sides sloping rather abruptly into water 5 to 12 feet

deep. A small percentage of the sloughs in this group are oval-shaped ponds. The usual flood-plain forest trees are to be found on their banks. Emergent aquatic plants occur only rarely along their shores, and the zone of submerged vegetation is much restricted. Many of the sloughs in this class appear to be desirable for aquicultural purposes.

4. *Marshy ponds.*—This group includes small ponds, usually from ½ to 4 acres in area. They are characterized by gradually sloping shores and have a maximum depth of 5 to 6 feet. Around the margin of these ponds there is a dense growth of emergent aquatic plants composed of bullrushes, bur reed, and arrowhead, while the deeper parts are covered with submerged vegetation. The surfaces of these ponds are not infrequently covered with floating-leaved aquatic plants such as water lilies and the American lotus. Owing to the dense vegetation in these ponds they can not be utilized for fish-cultural purposes until some practicable method of controlling the aquatic plants has been worked out.

5. *Bottomland lakes.*—The lakes in this group are characterized by their relatively large area. They are usually shallow, and the aquatic vegetation is similar to that of ponds in Group 4 with the addition of *Potamogeton crispus* and wild rice. In the larger, deeper lakes large expanses of open water occur, allowing enough wave action to prevent the growth of arrowhead and weeds along their shores.

Data gathered from about 30 seine hauls made in landlocked or isolated sloughs show that the young of the black crappie (*Pomoxis sparoides*), yellow perch (*Perca flavescens*), bluegill sunfish (*Lepomis incisor*), pumpkin seed (*Lepomis gibbosus*), largemouth bass (*Micropterus salmoides*), golden shiner (*Notemigonus crysoleucas*), common shiner (*Notropis atherinoides*), and spot-tailed minnow (*Notropis hudsonius*) are the most important slough fishes. The young of the black crappie were particularly abundant. Bullheads (*Ameiurus melas* and *A. nebulosus*) are, however, probably more abundant than the catch would indicate, for, like the carp, they burrow into the mud when approached by the seine and thus escape. Very few adult fish were taken in proportion to the number of young, indicating that the larger fish were able to respond to the falling water and return to the main channel or to permanent ponds and lakes leaving their offspring to encounter the vicissitudes of life which these sloughs present in variety.

OYSTER INVESTIGATIONS

Oyster investigations carried out under the direction of Dr. P. S. Galtsoff consisted in the experimental study of oyster culture in New England, North Carolina, and Georgia, in a study of the physiology of the adult and larval oysters, in the survey of natural oyster bottoms, and in an investigation of the biology of the oyster drill.

EXPERIMENTAL STUDIES ON OYSTER CULTURE

Studies on oyster culture were carried out at Onset, Mass., Milford, Conn., Beaufort, N. C., and Doboy Island, Ga. The work consisted in the examination of the conditions controlling spawning and setting of oysters and in testing the method of collecting spat in wire bags filled with shells. At Onset the field work was done by H. C. McMillin, who made daily temperature and salinity records during the period from June 25 until September 10. To study the distribution and behavior of the oyster larvæ quantitative plankton samples were taken at various stages of tide and in different sections of the bay. A study of setting was greatly facilitated by the fact that the method of planting wire bags filled with shells was adopted by one of the oyster companies, which planted about 1,000 bags over the bars of Onset Harbor. The first oyster larvæ were noticed in the water on July 2, but intensive spawning took place only on July 12. The first set appeared on shells on July 24. Setting was heavy and in certain areas amounted to 69,000 to a bushel of shells.

Special attention was directed to a study of the vertical and horizontal distribution of setting over the bars. A series of wire bags filled with oyster or scallop shells was planted at different levels from 2 feet above low-water mark to 6 feet below it. It has been found that the heaviest setting on all the bars was between mean low-water mark and 1.5 feet above it. No spat were found at the level of high water (3 to 4 feet above low-water mark). Below low-water mark oysters set only in the bag collectors, and the shells scattered over the bottom caught no spat. Bags planted in Shell Point Cove, which is regarded by the oysterman as a body of water unsuitable for planting of shells and where previous attempts to catch spat made by local oystermen were unsuccessful, caught from 6,800 to 7,900 spat per bushel.

The work in Milford Harbor and adjacent waters was carried out by H. F. Prytherch. Under his direction wire bags filled with shells were planted in Milford Harbor by the Connecticut Oyster Farms Co., in New Haven and East Haven Harbors by the Mansfield Oyster Co., and in Branford Harbor by E. Ball & Co. In every locality the plantings were successful, the production of seed oysters ranging from an average of over 15,000 spat per bushel in Milford Harbor to 5,150 spat per bushel in East Haven Harbor. Complete counts of the shells in many of the bags showed that the setting of oyster spat within them had been uniform, and that less than 1 per cent of the shells failed to collect spat. The most intensive setting was found to have occurred in the bags planted just above low-water mark in Milford Harbor. The shells on the bottom of these bags were covered with from 47 to 195 spat each, while those in the top of the collector had from 10 to 35 spat. In this zone the total number of spat collected per bushel of shells ranged from 20,000 to 25,000. Shell samples taken at random over a 10-acre portion of Milford Harbor showed that on this area over 30,000,000 seed oysters had become attached or set on the shells and gravel. The experiments with the shell bags in the several localities mentioned showed clearly that this method of seed-oyster collection can be applied with profit on a commercial scale in inshore areas of this type.

During the reproductive season of oysters in the vicinity of Beaufort, N. C., a series of field experiments was made by Dr. A. E. Hopkins for the purpose of testing methods of spat collecting. Throughout the season wire bags of oyster shells were placed in favorable locations for the collection of spat. Altogether 500 bushels of shells were used and the results studied. Larvæ were found in the water for the first time on May 25, and spat on planted shells were first observed on June 8. After these dates larvæ and spat became more numerous. The peak of the setting period occurred from approximately June 20 to July 15, after which time setting became less and less abundant, although a few new spat were found up to September 1. Natural setting of oyster larvæ in the Beaufort region was very rare for unknown reasons. Because of this the efficiency of the method of collecting spat on oyster shells in wire bags was well demonstrated. Bags of shells left on oyster beds throughout the season collected from three to six spat per shell, depending upon location, while shells scattered over the beds collected a negligible number of spat. Hence, it is apparent that this method is as valuable for North Carolina waters as for waters farther north.

In cooperation with the tidewater commissioner of Georgia, experiments on oyster culture were carried out during June to August by Dr. J. H. Weatherby at Doboy Island. A program similar to that adopted at Onset was followed and consisted in taking temperature and salinity records and in studying the distribution of oyster larvæ. To study the setting of oysters, brush and wire-bag collectors were placed on mud flats and on the bottom of the sound. Few oyster larvæ were found present in the water early in June. On July 4 their number reached the maximum of 400 in 100 gallons of water. A second maximum was noticed on July 20. The first spat were observed on June 10, and setting continued throughout June and July. Heaviest setting took place in the zone between 1 foot below low-water mark and 3 feet above it.

Setting on the wire collectors was fair, varying from 6 to 15 spat per shell, but only occasional spat were found on the brush. The results of the experiments show that the method of using wire-bag collectors can be employed advantageously in Georgia waters.

PREDICTION OF SPAWNING AND SETTING IN LONG ISLAND SOUND

Recent studies have demonstrated that fluctuations in the yield of seed oysters in Connecticut waters can be correlated with variations in hydrographical and climatological conditions. The analysis of these conditions over a period of several years, made by H. F. Prytherch, has shown that the temperature of the water and range of tide were the most important factors in controlling the time of spawning and setting and the production of seed oysters. These investigations proved to be of value not only in understanding certain phenomena in the life history of the oyster but, from a practical standpoint, could be utilized to assist the oyster grower in his cultural operations. This assistance was given in the form of bulletins, which supplied the oystermen with advance information as to (1) whether there would be a crop of seed oysters and how heavy it would be, (2) when the oysters would spawn, and (3) when setting would occur, or, in other words, the date on which shell-planting operations should be completed. These predictions were issued more than a month in advance and for 1928 were as follows:

1. The oysters will be ripe and in spawning condition by July 15.

2. The majority of the oysters on the inshore beds will spawn on or about the 26th of July, while on the offshore grounds spawning at the best will be very light and will occur about August 5.

3. The heaviest setting of the summer will take place about August 10 and will occur chiefly on the inshore areas.

4. The present indications are that the set will be light and slightly better than that obtained in 1923, when conditions were very similar.

Before arriving at these conclusions several cruises were made over the oyster grounds for the purpose of determining the location of spawning beds, the quantity of adult oysters, and the amount of spawn which they contained. Three-year-old oysters were found to be the predominating size and contained approximately one-third as much spawn as was found in the oysters in 1925, when there was a heavy set. Measurements of representative samples of oysters showed that the layer of reproductive tissue in various individuals ranged in thickness from 1 to 5.5 mm. and on the average was 4 mm. thick. The degree of gonad development in 1928, like that of the previous years, could be correlated with the departure of temperature from normal from April to August, which this year was slightly above normal and favorable for a light spawning. The supply of adult oysters on suitable spawning areas was found to be low in comparison with that of previous years and did not serve to increase the chances for obtaining a set.

Generous cooperation was obtained from the Connecticut Oyster Farms Co. and the State shellfish commission in furnishing boats and material for these studies. In order to keep the oyster growers informed as to the trend of conditions on the oyster grounds, bulletins were issued from time to time by the bureau's investigator at Milford, Conn. The bulletins and predictions were turned over to the Connecticut shellfish commission, which distributed copies to the many oyster-growing concerns.

Results of predictions.—The spawning of oysters was predicted to occur on July 26, at the end of spring tides with a new moon. In July the increased range of tide at such times results in considerable heating of the water on a greater area of tidal flats, bringing the temperature to the point (20° C. or above) that is necessary for oyster spawning. This year the water temperature in Milford Harbor increased during this period from 16.5° C. to 22.8° C. on July 26, with the result that harbor oysters spawned on July 23 and oysters on the inshore lots in Long Island Sound on July 26 and 27. The time of spawning was determined by examination of adult oysters, by collection of 24-hour-old larvæ, and was checked by carefully observing the time of setting of the larvæ on planted shells. Setting has been observed to occur on the average 15 days after spawning, when the mean water temperature for this interval is 21.5° C. During the past summer the heaviest setting was found to occur on August 9, 10, and 11, or from 14 to 16 days after spawning, which coincided with the time of setting that was predicted on July 1.

The intensity of setting, as indicated by the number of spat or seed oysters per shell, was such as would be termed a light set. Shell samples that were collected from several lots off Stratford Point and in New Haven Harbor showed an average of 9.5 spat per shell in the former region and 12 per shell in the latter. Examination of these areas late in the fall showed that a high percentage of the spat had survived and had grown materially.

In summarizing these studies, brief mention should be made as to their application and practical value in the field of oyster culture. In Connecticut and other northern waters the decline of oyster production and the unprofitable operation of oyster farms has resulted largely from repeated failures to obtain a crop of seed oysters on shells planted at considerable expense. An advance knowledge of spawning and setting enables the oyster grower to govern his shell-planting operations so as to obtain the best results at the least expense. On the basis of the predictions for the outlook for each particular year the oyster grower is able to determine (1) the quantity of shells to be planted, so as to take full advantage of the years when heavy setting will occur, (2) how rapidly shell-planting operations must be carried on in order that they may be completed before setting occurs, and (3) the areas or beds that are most favorable for obtaining a set under the existing seasonal conditions.

PHYSIOLOGICAL STUDIES

Spawning.—A study of spawning of the female and male oysters was continued by Doctor Galtsoff at the Woods Hole laboratory. Experiments have demonstrated that the spawning reaction of the female oyster takes place only when the temperature of the water is above 20° C. The experimental evidence is in accord with previous ecological observations, which have shown that there exists a correlation between the rise of the temperature of the water above 20° C. and the appearance of oyster larvæ in the plankton.

Further analysis of spawning reactions carried out under laboratory conditions disclosed the fact that male oysters can be stimulated to discharge sperm by the addition of eggs into the surrounding water. Contrary to what happens with the females, which, after spawning, become for a few days insensitive to the addition of sperm, the reaction in the males can be repeated a number of times, the response occurring immediately after the addition of eggs.

Respiratory exchange in the oyster.—The study of gaseous exchange in the oyster was undertaken by Doctor Galtsoff and D. Whipple as part of an extensive study of the physiology of the oyster and with the hope that it might shed some light on the hitherto unsolved problem of the nature and causes of the green pigmentation of the oyster.

Following the lead of Bruce, two methods were devised for determining the oxygen consumption of oysters under standard conditions. In the first method a water-tight closed chamber was employed, in which six oysters were placed; samples of water were removed at given time intervals and analyzed for oxygen and pH. The difference in the readings showed the oxygen consumption for the time interval and for the total number of oysters used. After a short while it was decided that the muscular activity of the oysters was appreciable and must be controlled. The method was then modified so that determinations were made on single oysters and a kymograph tracing of the number and extent of the contractions was recorded. Winkler's method for determining oxygen was used, and McClendon's method for estimation of CO_2 from pH and excess base. Using this method the metabolic activities of the oyster under varying conditions were studied. The oxygen consumption of a normal oyster at a temperature of 24.5° C. was found to be approximately 10 cc. oxygen per hour per 10 grams dry weight, the limits being 6.45 to 15.03 cc.

Oysters are relatively insensitive to changes in the amount of oxygen in the water until a level of about 1 cc. per liter is reached. Below this amount a direct correlation exists between the amount of oxygen consumed by the oyster and the amount present. The oyster does not close when the oxygen tension is low but continues to filter water and to consume small but appreciable amounts of oxygen.

The products of metabolism seem to have little effect on oysters. When allowed to remain in a small quantity of water until virtually all the oxygen has been consumed, they come back to a normal rate of metabolism when the oxygen supply is replenished.

Changes in hydrogen-ion concentration produce results similar to those brought about by lowering the oxygen tension. Oysters are not affected by alterations in the H-ion level until a pH of about 6.2 is reached, but below this point there is an appreciable decrease in oxygen consumption. It is of interest to note that at pH 6.0 the buffer action of the shell comes into play, and calcium carbonate is dissolved until the acid-base balance is restored.

The rate of oxygen consumption can be increased by adding to the water readily available food material, for instance, glucose. The rate increases until a certain optimum concentration is reached; if this amount is exceeded the oyster abruptly closes and its exchange with the outside world ceases.

The relation of metabolism to the green pigmentation was not striking. The average value of 5 determinations on white normal oysters was 9.03 cc. oxygen per 10 grams dry weight of oyster, and the average of 6 determinations on deeply pigmented oysters was 11.74. The readings were consistently a few points higher throughout for the green oysters, but whether the slight difference is significant could not be determined.

The copper content of white oysters varied from 8.22 to 13.733 mg. and that of the green oysters from 124 to 272 mg. per 100 grams of dry tissue. The "greening" of oysters still remains a problem for further investigation.

Feeding.—At Beaufort, N. C., and at Woods Hole, Mass., experiments were carried out by Doctor Hopkins on the effect upon oysters of variations in the salt content of seawater. It is know that the water in bays and harbors is subject to considerable change in the relative amount of certain salts. It has been found that a small excess of a salt in the water causes the oyster to close and therefore cease feeding, and also that different salts are very different in their effect on the muscular activity of the oyster. In general, it may be said that in the order of their potency, from high to low, the cation series is as follows: Potassium, ammonium, sodium, lithium, and magnesium. The anion series falls into the order: Iodides, bromides, nitrates, sulphates, and chlorides. Potassium is of especial importance, for all compounds of it have a highly stimulating influence upon the oyster, causing it to close when only a minute excess of the compound is present. In general the sensitivity of the oyster to chemical changes is remarkable. The oyster's organs for testing seawater are to some substances more sensitive than is the organ of taste in man.

Records of the shell movements of oysters, showing hours spent open feeding and those when closed and unable to feed, have been kept over periods of several months. Contrary to previous observations by Galtsoff an analysis of these records shows a parallel between the brightness of the daylight and the time oysters remain open. The specimens remained open much more during the day than at night. Soon after sunrise the specimens would open if they were closed. Opening occurred most often during the hours of brightest illumination and least often in darkness. It appears that light is one of the factors influencing the feeding habits of oysters. Opening, however, is not due entirely to light, but light is probably only an external factor that has an effect upon the physiology of the organism.

Attachment of the oyster larvæ.—The attachment or setting of full-grown oyster larvæ was not only observed in detail for the first time but was actually produced or imitated under controlled laboratory conditions, and microphotographs were made of each step in the process. Observations made by H. F. Prytherch on the behavior and setting of over 30 larvæ indicate that the swimming or crawling larva first releases a transparent, sticky, fine thread or byssus, which anchors it to the first clean surface with which it comes in contact. The velum or swimming organ is drawn into the shell, and the larva proceeds to crawl rapidly back and forth over the substratum by means of its long muscular foot, from the base of which the byssus is being released constantly. For a period ranging from 3 to 15 minutes the crawling continues but becomes gradually slower and slower until finally the shell is held motionless in an upright position. In the next instant a sticky fluid is secreted by the byssus gland, and the left valve of the larva is brought down into this cementing fluid and held tightly in position against the substratum. The foot and connecting muscles manipulate the shell at this time and hold it in the cement for only a few seconds. The actual period of fixation—that is, from the discharge of the cement to the withdrawal of the foot—is of short duration, rarely lasting over 15 seconds. In one minute from this time the cement was found to be hardened sufficiently to prevent detachment of the newly formed spat by vigorous washing. The orientation of the larva on slides held in a vertical position was always the same—that is, the hinge or dorsal portion of the shell uppermost—while on horizontal surfaces the larva became attached in various positions. Spat on vertical surfaces were found to grow spirally, in a clockwise direction, until the position of the body was just the opposite of that at the time of attachment.

The studies on the attachment of the oyster larva show that setting or the metamorphosis of the larva into a spat is a rapid process, which, when once initiated, proceeds to its ultimate end regardless of whether or not the larva finds a suitable surface for attachment. For the survival of the organism it is essential, therefore, that the larva come in contact with a surface that is firm and sufficiently clean to insure adhesion of the cementing fluid. The nature of the stimulus necessary to induce setting and its physiological effect upon the oyster larva are at present under investigation.

Response of oyster larvæ to currents of water.—An exact knowledge of the behavior of free-swimming oyster larvæ in currents of water of various velocities is of practical importance in that it may provide an explanation of the "zones of setting" found in many localities and also explain why setting does not occur in certain localities where oysters are known to spawn and larvæ to be present in the water. A preliminary study of this problem was carried out in Milford, Conn., by Dr. R. H. Luce. Two methods of attack were used. The first consisted in finding the distribution of oyster larvæ in a continuous open channel of rectangular cross section in which the water was kept in motion by a paddle wheel. The second method consisted in determining the response of the larvæ to a streamline current of water in a glass tube having a circular cross section.

The diverse results obtained by the two methods may indicate that oyster larvæ respond to currents of water only when there is a sudden and sharp difference in velocity in the water striking the velum and the shell, and that any sudden change in velocity of the water impinging upon the extended velum of an oyster larva may cause withdrawal of the velum, closure of the shell, and a sinking of the larva to the bottom.

SURVEY OF OYSTER BARS OF THE LOWER POTOMAC RIVER

At the request of the Maryland conservation department a survey was made by Doctor Luce in November and December, 1928, of the bottoms of the lower Potomac River for the purpose of determining the extent and condition of the oyster bars in that region. The program in which the Bureau of Fisheries and the State cooperated included the delineation of the principal oyster-producing regions and the determination of the abundance or scarcity of oysters in these regions as the basis for recommendations for greater development of the oyster fishery and the most successful utilization of the oyster grounds.

The area surveyed included about 37 miles of the Potomac River between Persimmon Point on the upper side and Piney Point and Ragged Point on the lower. Ten bars, ranging from 30 to 620 acres in extent, were surveyed on the Maryland side of the river, and six bars, ranging from 60 to 500 acres, were covered on the Virginia side. Some 2,500 acres were covered carefully by the method of triangulation and plotted dredge courses, and in addition large areas were dredged but found to be barren.

The hyrographical and physical data obtained show certain important factors that must be considered in any program of oyster culture in this region:

1. The bars on the Maryland side of the river extend well out into the stream and consist of hard, firm bottom of sand and a mixture of hard mud and sand. The water over these bars ranges from 6 to 30 feet in depth, with an average depth of about 20 feet on the center of the bars.

2. The bottom on the Virginia side of the river is generally mud, which varies from a very soft silty mud in the region of Upper Machodoc Creek to Rosier Creek to hard sticky mud on the section designated "Wakefield." Certain sections on this side of the river were found to be covered with stone about the size of a man's head. The shoals running along Nomini Cliff consist of hard sand ridges with intervening mud sloughs.

3. The bottom from Colonial Beach to Upper Machodoc Creek is liable to shift greatly during northwest storms.

The records of the salinity of the water show that Popes Creek is about the upper limit for the growth of oysters. Certain marked differences in salinity were found between the different sections. A salinity of only 7.12 parts per mille was found off Persimmon Point. Going down the river, the following salinities were found: Lower Cedar Point, 7.97 and 9.16; Swan Point, 8.98 and 10.54; Cobb Point, 10.95 and 11.44; Heron Island, 12.45 and 13.60; Poseys Bluff, 14.38 and 14.61; and Herring Run, 15.15 and 16.37.

The currents were found to be affected largely by the wind. The tidal range is generally less than 3 feet, but in the case of a strong northwest wind the high tide of one day may be lower than the low tide of the previous day. The currents over the bars show a variation from 0 to 20 cms./sec., but the point of observation must be considered for each reading. At Swan Point, for example, there is no flood current near the shore line; the current simply comes to slack and then starts ebbing again. Current observations made on the center of the bar, well out in the river, showed both an ebb and a flood current, with velocities ranging from 3 to 15 cms./sec. At Herring Run Bar, near Piney Point, a strong, downward, eddy current was found at the surface on a flood tide, while slack water was found at the bottom. Is is clear that no general statements can be made concerning the currents setting over the bars. Each bar must be considered by itself, and, should detailed information be desired, must be the object of individual study.

Oyster population on the bars examined.—All of the bars examined were found to be greatly depleted, and, with the exception of Lower Cedar Point and Swan Point bars, all are so denuded of shells and oysters that they must be considered as barren ground. Previous surveys of oyster-producing bottoms have established a minimum of 25 bushels of marketable oysters per acre as indicative of depletion. The greatest density of large oysters in the Potomac was 4.8 bushels per acre at one section of 25 acres at Lower Cedar Point. The other bars had from 0.2 to 1.6 bushels per acre, with an average of about 1 bushel. The condition in regard to small oysters was even worse. Lower Cedar Point and Swan Point bars were the only bars having a sufficient number of small oysters to make an estimate as to the total population possible. These estimates were 3.2, 0.6, 0.7, 0.3, and 0.6 bushels per acre on the sections examined. In regard to spat, it was found that virtually no "set" occurred during the summer of 1928. Only one section of 25 acres at Lower Cedar Point was sufficiently covered with shells. The other bars were completely stripped of shells, so that a dredge could be dragged as much as 1,000 yards without being filled.

The report submitted to the conservation department of Maryland and published by it contained definite recommendations concerning the program to be followed in the rehabilitation of the oyster beds. These recommendations include (1) the extended closing of the Potomac River to oystermen, (2) the planting of shells and seed oysters, and (3) the establishment of spawning beds of large oysters to aid in producing a set.

OYSTER PROBLEMS OF THE PACIFIC COAST

A preliminary survey of the oyster problem of the Pacific coast was made in October–November by P. S. Galtsoff and H. C. McMillin, who visited the oyster-producing areas in the States of Washington, Oregon, and California. Owing to the general conformation of the coastal waters, the bottoms suitable for oyster culture are very limited and are found chiefly in certain sections of Puget Sound and Willapa Bay. The oyster industry of the Pacific coast deals with three species of oysters—*Ostrea lurida*, *O. virginica*, and *O. gigas*. The first is indigenous to the waters of the Pacific Ocean, while *O. virginica* is imported from the Atlantic coast and *O. gigas* from Japan. Neither Japanese nor Atlantic oysters propagate on the Pacific coast, apparently because of the low temperature of water.

Because the cultivation of the native oyster, *O. lurida*, is of greatest importance from the commercial point of view, it is planned to begin in the new fiscal year a comprehensive study of the biology of this species and to carry out experiments with a view to improving the present method of its cultivation. The work will be undertaken in cooperation with the department of fisheries and game of the State of Washington.

OYSTER-DRILL INVESTIGATIONS

During the past year oyster-drill investigations have been carried on at the Beaufort biological station by Dr. Henry Federighi. The studies, which included experiments on migration, feeding, the effect of lowering salinity, the geotropism and rheotropism of the animal, and on the efficacy of traps, were continued along the same lines as those made at Hampton Roads, Va., in the preceding year. The problem has progressed far enough to permit one to make the following conclusions and recommendations: The drill (*Urosalpinx cinerea*) inhabits hard bottoms (not sandy) wherever oysters are present and wherever the salinity does not fall below 15 parts per mille for any great length of time. It is nonmigratory, depending primarily on the planting operation of man for its distribution. During the winter months the animal does not feed, but as soon as the temperature rises above 15° C. it becomes a dangerous enemy of the oyster, as each drill can kill from 30 to 200 oysters in a single season. The young do not have a free-swimming stage but develop within a leathery capsule, so that they are protected from enemies.

On hatching they immediately attack the oyster spat, causing great damage to the industry. During their months of activity the snails are negatively geotropic and move against the current. Control measures are limited to the following: (1) The use of forks instead of shovels during planting operations; (2) screening of infested oysters, much as sand is screened from gravel; (3) dredging the infested areas with a dredge originally described by Moore (1897) and slightly modified by the investigator; and (4) floating infested oysters for about one week in water of a salinity sufficiently low (about 10 parts per mille) to kill the drills but not to injure the oysters. This last method is undoubtedly the most effective because it also kills the newly hatched drills, which in other methods usually escape.

PACIFIC RAZOR-CLAM INVESTIGATIONS

In 1928 field work on the Pacific razor clam was carried out in April and September by H. C. McMillin. During April commercial canning operations were in progress on the Washington coast and the regular census of the commercial catch was made. The census of 1923 showed a dominance of 6 and 7 year old clams; in 1927 4-year-old clams predominated; and the 1928 census showed a still further reduction in the age of the commercial catch, 2 and 3 year old clams being most numerous. The taking of these small clams constitutes a great economic waste because they are growing very rapidly at this time and have not reached an age when they are important as spawners. The older age groups have disappeared entirely from the beaches, and the entire picture is one of serious depletion.

This depletion has occurred without a reduction in the commercial pack. In fact, the average pack for recent years has shown a slight increase over the period from 1920 to 1924. This case illustrates the danger of relying on the total yield of a fishery as an index of depletion. The decline in the number of clams has been compensated by an increase in the digging effort, the number of diggers having increased more than tenfold during the last 10 years. A crisis in the industry is imminent, as further increase in the digging effort will soon fail to maintain the normal pack and commercial operation will no longer be profitable. Legal restrictions have been proposed that would protect the immature clams and control the catch taken for personal use. The autumn census of the young on the Washington beach showed that a very slight set had occurred during the summer. This fact forecasted still greater need for protection of clams at this place.

Field work in Alaska was suspended for the summer of 1928. Further analysis of data from all localities has been continued by Dr. F. W. Weymouth and H. C. McMillin. It has been proved that all clams upon which growth and other records have been secured belong to one species. Two varieties recognized by conchologists were found to be identical. The characters used to distinguish them were found to change with age or environmental conditions, and no evidence of genetic difference could be discovered. For example, the width of the shell was one character used for separation of the subspecies. It was found that this measurement changed with age in a remarkable manner. In the very early stages the animal is nearly round; as growth proceeds the shell becomes elongated, until at a length of 4 centimeters the width is about a third of this figure. Further growth is accompanied by an increase in relative width, until at 16 centimeters in length the width is about 43 per cent. The position of the umbo and the thickness of the shells also change with age. Thus, the young from all localities were placed by some conchologists in one subspecies and all old specimens in a different one. Since the life span is short in the southern beds and long in the northern beds casual observations indicated a difference in forms that were thought to be of varietal rank.

Differences between sexes have been found in other mollusks and were sought in the razor clam. Samples of 150 of each sex from Swickshak Beach and Cordova, Alaska, failed to reveal differences, and a like number from Copalis Beach gave similar results. A sample of 115 males and 113 females from Hallo Bay, Alaska, showed a difference in the growth rate between sexes, but other facts make the findings inconclusive.

Analysis of the growth data on the razor clam was continued. A series of growth curves for the same species under 10 environments has been collected. The data for each locality represent the results of the operation of the laws of growth under a certain composite of environmental factors that are in no way artificial. Certain characters of the course of growth are common to all localities, and certain other characters show orderly differences that bear a direct relation to the geographical position of beds.

These data are unique in growth studies, and advantage has been taken of the unusual opportunity to apply the current conceptions of the course of growth, such as those developed by Robertson and by Brody, to this series of curves for a single species grown in different environments. Our data indicate that growth is not an autocatalytic phenomenon, as regarded by Robertson. Brody has claimed that prior to the inflection the growth is in short stages of constant velocity, which pass from one into another by abrupt changes, which are comparable to metamorphosis in insects and other animals. Our data show that this viewpoint is unsound, as no abrupt changes in the rate of growth occur. The concept of the course of growth expressed by Minot seems the most logical from a physiological viewpoint and corresponds most closely to our findings.

The data on the growth of the razor clam and on other forms to which the same method has been applied show that growth follows the compound-interest law, but the rate is constantly decreasing. There is also a body of evidence that indicates that the rate of decrease is constant over long periods of time. The presence of an inflection in the growth curves and other peculiarities can be explained on this basis.

SCALLOP INVESTIGATION

The bay scallop is a mollusk of considerable economic importance, ranking third in value among edible bivalves of the country. In North Carolina, where J. S. Gutsell has made his investigations, it ranks second, is taken commercially in only one county, Carteret, and is of very great local importance.

Of the information obtained in these investigations, the following is worthy of mention here. In North Carolina scallop spawning is primarily autumnal in contrast with more northern areas, where, according to investigations, it occurs in late spring or early summer. As shown by the varying growth and size of scallops on near-by areas, scallops shift little after an early stage. Growth is very rapid and maturity attained in one year. Nearly all are taken before the market season closes in the spring, that is, before the majority are more than 20 months old; only a few survive to be 2 years old. Except for the work of man, the heaviest destructions of adult scallops or of those beyond small size is caused by freshets. In 1927 a rare trematode parasite of the gills was described, and in 1928 a common parasite of the stomach.

At present all attempts at conservation are regulatory. All or nearly all that may be accomplished by such means may be accomplished by a proper closed season beginning some time in the spring before the young scallops are marketable and ending when they have completed spawning. May 1 to January 1 is recommended. If conservation is to be sought by more active means, as some form of scallop culture, it is important to know that scallops shift little and that certain areas produce larger and more valuable scallops than others. If these are depleted they might well be stocked from areas that produce inferior scallops. The quickness with which scallops die out of water offers special difficulties to the planter. On the other hand, the rapid growth, early maturity, and high value offer special inducement.

One report based on these investigations and entitled "Scallop Industry of North Carolina," Bureau of Fisheries Document No. 1043, has been published. Another, embodying the biological studies and provisionally entitled "Natural History of the Bay Scallop," is substantially complete.

FRESH-WATER MUSSEL INVESTIGATIONS

MUSSEL CULTURE

For several years interest in mussel investigations has focused upon the work of Dr. M. M. Ellis, professor of physiology at the University of Missouri, at the Fairport (Iowa) station during the summer and at the university during the college year. Doctor Ellis has been engaged since 1926 in developing a system of mussel culture in which mussel spawn or glochidia undergo, in a nutrient solution, the development that ordinarily occurs while attached to fish as parasites. During the 1927 season, many of the problems that arose in connection with the use of the culture solution were solved successfully, but it was not until 1928 that artificial propagation of mussels on a commercial scale was finally worked out. After Doctor Ellis's return from an extensive European tour in the spring of 1928, six units of mussel-culture apparatus were constructed, each capable of handling at one time upwards of half a million glochidia. The apparatus was set up at Fairport about the first of July, at which time ripe glochidia were scarce. Sufficient were obtained, however, to give the apparatus a thorough and successful trial.

The scarcity of ripe spawn brought to a head another problem. There was found in the marsupia of almost all gravid mussels a protozoan parasite known popularly as Clark's bug, and believed to belong to the genus Conchotherius. This protozoan interfered greatly with the mussel-culture work, for it could not be destroyed as easily as the bacteria also found associated with the glochidia, and when introduced with the glochidia the protozoan increased in numbers rapidly, soon causing the death of all the glochidia. The few gravid mussels available were so infected with the organism that after the test of the mussel-culture apparatus it seemed worth while to make an effort to locate possible sources of gravid mussels free of the protozoan. To this end a trip was made by Doctor Ellis and Mr. Chamberlain in August to mussel waters in a number of States. No glochidia were found that were free of the protozoan parasite.

After returning to the University of Missouri Doctor Ellis continued his studies with the help of several assistants and succeeded in making two valuable discoveries. One was a simplified method of removing from a lot of spawn all glochidia infected with the protozoan parasite. This makes it possible to make use of ripe glochidia as obtained, the infected glochidia being removed and destroyed and the healthy ones utilized.

The second important discovery dealt with the life history of the two species of mussels that have been most extensively propagated by the bureau in the past. These species belong to the genus Lampsilis and include the most valuable of fresh-water mussels, the yellow sandshell, *Lampsilis anodontoides*, and the far more plentiful and, in the aggregate, far more valuable species, the river mucket, *L. ligamentina*. It has been generally believed that the glochidia of these mussels are held in the marsupial pouches of the female in a "ripe" or fully developed state throughout the winter and released, to begin their parasitic life without further development in the spring and early summer. It was found that at least a large proportion of the glochidia are really not quite "ripe" until just before they are released in the spring, even though they are developed enough after the preceding midsummer to attach themselves and live for a time on their host fish. This would seem to indicate that all of the old type of mussel-propagation work that has been conducted after midsummer is of little value.

To meet the situation and prolong the mussel-culture season it is important to find out where the ripe spawn may be obtained earliest in the spring. Presumably this would be in the Southern States. The latest ripe spawn will probably be obtained from such northern waters as Lake Pepin, a widened portion of the Mississippi between Minnesota and Wisconsin, where a valuable species of the genus Lampsilis is found, *L. luteola*, the lake mucket, also called grass mucket and fat mucket.

The immediate plans for mussel culture do not call for additional units of mussel-culture apparatus during the remainder of the fiscal year 1929 because of the likelihood of improving the design in the interest of increased efficiency.

The six units of apparatus now constructed will be returned to Fairport in the early spring and used to full capacity. An estimated production of at least 1,000,000 young mussels is anticipated from these units during the spring period.

A pressing need appears to be to prepare for the intelligent distribution of the young mussels after they are produced. Since the publication of statements regarding the development of the bureau's mussel-culture investigations many requests have been received for allotments of young mussels. A knowledge of the factors favorable to the growth of mussels and the condition of the waters to be stocked is essential for the choice of the most suitable species for each unit of water area. Hence, an extensive study of many waters is planned for the coming summer to assist in drawing up a list of requirements for the use of the bureau to be met by all applicants for young mussels.

MUSSEL SURVEYS

Two mussel surveys were made during the summer of 1929. The first was at Lake Pokegama, Minn., during July, and the second was at Lake Pepin in August. Both bodies of water have been large producers of mussels of value to the pearl-button industry in past years. Also, at both lakes the bureau has conducted mussel propagation work for many years.

During the summers of 1920, 1922, 1923, 1924, and 1925 mussel suveys were made in various bodies of mussel-producing water by the Fairport station, but in each case the crowfoot rig was used for collecting the mussels, and this method is considered inaccurate for such detailed studies.

It was apparent that accuracy could be expected only from some appliance that would show all the mussels present in a given unit area, or at least all the mussels in this unit area not entirely submerged in the bottom material. To this end, T. K. Chamberlain, director of the Fairport station, spent a portion of the summer of 1927 working upon such appliances and finally developed a clamshell type of bottom dredge that would remove from a sand, gravel, or mud bottom all adult commercial mussels over 6 square feet of surface, which were not entirely submerged in the bottom material. This would include all those mussels that might, under the most ideal conditions, have been taken by the crowfoot rig. The dredge was found to have some obvious deficiencies and would not work on stony bottom or a bottom having much wood débris. On the other hand, a crowfoot rig would not work in such places either, so it may be stated that the dredge would work on any bottom where a crowfoot rig might be used and would give more accurate results.

The dredge was used on both Lake Pokegama and Lake Pepin. Lake Pokegama had been closed to shelling for 11 years, during which time the bureau had inoculated fish in the lake with 1,000,000,000 glochidia at a total cost of $15,000. It was found that the lake had not recovered its mussel population to the degree to be expected from the amount of propagation work done. A study of the growth of the mussels from the lake by T. K. Chamberlain also showed the rate to be unusually slow. The quality of the shell was also much inferior to what it had been 15 years earlier. The full responsibility for the adverse situation is attributed to the unfavorable chemical changes in the lake through the changing of the course of the Snake

River, a mussel-producing stream that formerly flowed through the lake. About 12 years ago this river was given a new channel around the lake instead of through it, leaving a channel that is insufficient for proper exchange between the two bodies of water.

The Lake Pepin survey conducted by H. O. Hesen and H. C. Minch showed that the lake has been subjected to heavy shelling but is still the source of an extensive commercial mussel population. It seems to be a desirable locality for the planting of juvenile lake muckets.

GROWTH STUDIES

For the past two years T. K. Chamberlain has been engaged in studies on the rates of growth of mussels from various localities with a view to using this information as an aid in determining where to plant to greatest advantage the young mussels to be produced by the bureau's new mussel-culture system.

Up to this time actual growth determinations have been made for the most valuable of all fresh-water mussels, the yellow sandshell, *Lampsilis anodontoides*, as found in the Mississippi River in the vicinity of Fairport and as found in the White River of Arkansas; for the lake mucket, *L. luteola*, as found in Lake Pokegama, Lake Cross, and Lake Pepin, while at present growth measurements are being made on the river mucket, *L. ligamentina*, as found in Fox River and in the St. Joseph River.

DIAMOND-BACK TERRAPIN CULTURE

Experiments in terrapin culture at the fisheries' biological laboratory at Beaufort, N. C., under the direction of Dr. S. F. Hildebrand, except for an epidemic of sores among the brood of 1927, progressed satisfactorily. The hatch increased from 6,887 in 1927 to 9,095 in 1928.

The epidemic of sores referred to occurred among both the winter-fed and the hibernating animals of the brood of 1927. While the disease is not new, it previously seldom had reached epidemic proportions. With the hope of gaining some information about this disease and possibly finding a preventative or cure, the services of Dr. Herbert Fox, a pathologist of the University of Pennsylvania, were secured. Doctor Fox soon found the disease to be a complicated one, and during the limited time that he could devote to its study he was unable to develop a preventative or a cure. The disease may attack any part of the animal. It most often attacks the tail, however, and it occurs not infrequently underneath the plastron, being visible externally as pale or yellowish areas on the shell. The earliest symptom of the disease is the appearance of a pale spot on the skin. The skin in such a place soon sloughs off and a sore covered with a "scab" results. It is for this reason that the disease has been termed "sores." The sore gradually eats into the tissues attacked. On the tail, for example, it generally starts at or near the tip, with the result that the member is gradually destroyed. When the gradual deterioration reaches the vent, or near that point, death invariably results. Sometimes, although not often, the sores heal after a part of the tail has disappeared, and the animal recovers. When the disease attacks the feet or legs it is much less destructive. Plastron cases are less numerous than tail cases but apparently equally fatal. This disease is particularly annoying because it most frequently attacks the largest and most rapidly growing animals.

In the brood of 1927, among 3,730 winter-fed animals, a loss of 13.4 per cent was ascribed to sores. A further loss of 15 per cent was ascribed to "soft shell," which was rather lower than the usual loss from this source. Soft shell is a condition correlated with a failure to feed, resulting in emaciation and often in death. Soft shell occurs almost exclusively among terrapins that probably never have taken food and never have gained growth.

During the year 2,323 young terrapins that had gained considerable growth and had passed through the most critical stage of life were liberated.

A new terrapin house 65 feet long and 20 feet wide was built during the year. This house is provided with a steam-heating plant, making it possible to provide a more uniform heat than was possible previously when a stove was used. The brood of 1928 is housed in this building, and to date (January 16, 1929) there is no indication of a recurrence of last year's epidemic of "sores," although a few cases are present.

A general account of the many experiments in diamond-back terrapin culture that have been conducted at Beaufort, showing the results achieved to date, was prepared during the year and is in course of publication.

STUDIES ON INTERIOR LAKES

In the summer of 1928 the bureau's investigation of growth rates of fishes in Wisconsin lakes by Dr. Stilman Wright was continued with the collection of data and scales from 5,000 fish of several species. Field collections were made by J. B. Goldsmith and C. E. Juday, temporary assistants. For the present work is being restricted to a study of the scale material of 1,200 ciscos taken from eight lakes. A preliminary study of a small series of scales from each lake shows unquestioned evidence of marked differences in the rates of growth in different lakes, but in most cases the data must be considered inadequate to serve as a final basis of comparison. It seems probable that several hundred individuals will be needed from each lake for final results. If the data at hand appear to justify it, collecting will be continued and extended in the summer of 1929.

The bureau again cooperated with the State geological and natural history survey in limnological studies of the lakes of northeastern Wisconsin. Buildings were provided by the State conservation commission on the shores of Trout Lake, and chemical and other laboratory equipment was installed.

The first observations on the lakes were made on June 22 and the last on August 29. Between these dates observations were made on 227 different lakes, 85 of which were visited for the first time, the other 142 having been visited one or more times in previous years.

The field party consisted of E. A. Birge, C. Juday, J. R. Hickman, E. B. Ruth, and Hugo C. Baum, biologists, and Rex J. Robinson, Lloyd Setter, and W. H. Woodstock, chemists. B. L. Browning,

F. H. L. Taylor, and C. H. Winning made chemical analyses of the residues that were sent to the chemical laboratory of the University of Wisconsin.

The chemical and biological work followed the same lines as indicated in the reports for 1926 and 1927 for the most part. A more extensive quantitative study of the bottom fauna was begun in 1928 and the results obtained will be considered in a subsequent paragraph.

As indicated in previous reports, the field studies included such physical items as the temperature, transparency, color, and conductivity of the water, as well as the rate at which the water cuts off or absorbs the sun's energy. The chemical items included hydrogen-ion concentration, free and fixed carbon dioxide, dissolved oxygen, free ammonia, nitrite, nitrate, and organic nitrogen, soluble and organic phosphorus, silica, and chlorides. The biological phases of the work consisted of quantitative studies of the plankton and of the microscopic bottom fauna. Several large samples of centrifuge plankton and of townet catches were secured for chemical anaylses.

During the summer about 550 hydrogen-ion determinations were made and a somewhat larger number of free and fixed carbon dioxide and dissolved oxygen determinations. More than 400 determinations of nitrogen compounds, phosphorus, silica, and chlorides were made, and a similar number of determinations of the dry organic matter in the centrifuge plankton. Also, 415 residues were obtained by evaporating 2 to 5 liters of water; these residues are being used for more complete chemical analyses according to micro methods that have been used for the past four years. Two research assistants appointed by the University of Wisconsin are now engaged in determining the quantity of organic nitrogen, organic carbon, ether extract, and sulphate-ion in these residues. A third chemist is working out field methods for the rapid determination of calcium, magnesium, and sulphate ions.

As indicated in previous reports, these lakes show a wide range in the amount of mineral and organic matter that their waters hold in solution. The amount of dry residue in surface samples, for example, ranged from a minimum of about 9 mgm. to a maximum of 107 mgm. per liter. The hydrogen-ion varied from pH 5.4 to pH 9.1. The fixed carbon dioxide ranged from 0.2 to 29.0 mgm. per liter; in the great majority of the lakes the quantity fell between 1 and 15 mgm. per liter. Free ammonia and nitrite nitrogen were rarely found in the surface water, and then only in traces. The nitrate nitrogen varied from 0.008 to 0.050 mgm. per liter and the organic nitrogen from 0.13 to 1.36 mgm. The surface water of a few of the lakes contained no soluble phosphorus, or only a trace, while a maximum of 0.012 mgm. per liter was noted in two lakes; in most instances the quantity ranged from 0.003 to 0.006 mgm. The organic phosphorus varied from a minimum of 0.007 to a maximum of 0.085, a twelvefold difference.

The quantity of dry organic matter in the centrifuge plankton of the surface water varied from 0.28 to 6.36 mgm. per liter, which is almost a twenty-three fold difference. In general, the soft-water lakes yielded a smaller amount of plankton than those that had a larger amount of electrolytes in solution.

During the summer two of the biologists devoted their whole time to a quantitative study of the larger organisms that live upon and in the lake bottom. They obtained something over 1,200 samples from 51 different lakes. The largest number of samples was obtained from Trout Lake; in general the number of samples taken in the other lakes varied from 6 up to 25, depending upon the size and depth of the lakes. The bottom population consisted primarily of insect larvæ and amphipods. A few of the samples did not contain any of the larger organisms, while a maximum of 8,900 insect larvæ per square meter was obtained in one lake; the latter represents a dry weight of 167 pounds per acre.

FISHERIES BIOLOGICAL LABORATORIES AND FIELD STATIONS

The bureau's fisheries biological laboratories at Woods Hole, Mass., Beaufort, N. C., and Fairport, Iowa, were occupied and operated during the entire year of 1928, although only the latter two have permanent directors. In addition to these, laboratory quarters of more or less temporary character have been furnished to field units of the bureau's scientific staff by the College of Fisheries, University of Washington, at Seattle; the museum, University of Michigan, at Ann Arbor; the natural history museum at Stanford University, Calif.; and the Museum of Comparative Zoology of Harvard University at Cambridge, Mass.

The fisheries laboratory at Woods Hole, Mass., served as headquarters for several investigators of the Middle Atlantic staff during the winter and was opened to private investigators for the summer season from June 20 to September 15 under the directorship of Elmer Higgins, in charge of the division of scientific inquiry. During this period the oyster investigations under Dr. P. S. Galtsoff, the mackerel investigations under O. E. Sette, and the Middle Atlantic fishery investigations under R. A. Nesbit were centered here, all of which have been discussed already. Important studies of the physiology of respiration in fishes were also continued by Dr. F. G. Hall of Duke University and Dr. Irving E. Gray of Tulane University.

In adition to the bureau's staff, a number of independent investigators were engaged on various problems of general biological significance. Dr. N. A. Cobb, of the Department of Agriculture, with a staff of six assistants, continued his studies on nematodes. Three of the university tables were occupied—Harvard by H. E. Bowen, Johns Hopkins by Dr. John C. Hemmeter, and Princeton by Samuel E. Hill. Space was assigned Dr. Edwin Linton, University of Pennsylvania; Dr. Attilio Rizzolo, national research fellow; Paul Conger, diatomist of the Carnegie Institution; Dr. Howard B. Stough, University of Idaho; and Miss Ruth Schwartz of the University of Colorado.

Numerous repairs to the laboratory building and residence were made during the season. A new laboratory room for biochemistry was equipped; an oceanographical laboratory room was refinished, and the storeroom entirely rebuilt and completely equipped, all of which materially increased the efficiency of the laboratory.

During the summer season a series of special lectures was presented to large and appreciative audiences of investigators, and motion pictures of fisheries and bureau work were shown on two occasions. The lecturers were Dr. P. S. Galtsoff on " The chemistry of the sea "; Dr. F. G. Hall on " Respiration in fishes "; Dr. A. G. Huntsman, director of the Atlantic Biological Station, St. Andrews, N. B., on " Limiting factors in the sea "; and Dr. H. B. Bigelow, Harvard University, on " Oceanography and fisheries."

At the invitation of the Bureau of Fisheries, the National Association of Fishery Commissioners held its annual meeting at the Woods Hole biological station on September 7 and 8. The program presented was unique in many ways, for it consisted primarily of an elaborate demonstration of the bureau's scientific investigations in oyster culture.

Among those who addressed the convention were Col. Harry Houston, the president of the association, Congressman Charles W. Gifford, Lewis Radcliffe, and Dr. P. S. Galtsoff. Motion pictures of the industry were shown by Howard W. Beach.

The main laboratory of the fisheries station was given over to exhibits illustrating the oyster investigations, in which live animals were utilized as far as possible. The exhibits were arranged under subject headings, so as to tell a complete story. Printed descriptions were posted on each table, and, in addition, members of the staff acted as guides in explaining the significance of the experiments and how to operate the apparatus. The following exhibits were presented:

FEEDING

1. Apparatus showing the current produced by the oyster gills.
2. Effect of temperature on the function of gills; cessation of feeding caused by low temperature.
3. Ciliary movement of the gill epithelium; motion of food particles along the surface of the gill.
4. Ciliary motion under microscope.
5. Transverse section of the gill.
6. Apparatus for collecting the water after it has passed through the oyster gills and for measuring the pressure inside the gill cavity.
7. Charts and diagrams showing the effect of temperature on the amount of water passed through the gills.
8. Diagram showing chemical sensitivity of the oyster.

OPENING AND CLOSING OF SHELLS

1. Apparatus used for recording the opening and closing of the shell.
2. Diagram showing the frequency distribution of the periods of opening.

SPAWNING

1. Apparatus used for studying the spawning of female oysters, consisting in constant-temperature bath, kymograph, electric clock, stirring mechanism, and æration mechanism.
2. Series of kymograph records showing how spawning reaction in the female oyster can be produced by the addition of a small amount of sperm to the water.

GREEN OYSTERS

1. Specimens of green oysters from Long Island Sound.
2. Blood cells containing copper.
3. Apparatus for studying the metabolism of the oyster.

OYSTER CULTURE

1. Spat collector (wooden crate) from Onset containing 75,000 spat to a bushel.
2. Wire bag filled with oyster shells and used as spat collector in Wareham River and Onset, Mass.
3. A series of spat on oyster shells, 1 to 42 days old, taken from experimental oyster ground at Onset.
4. Live spat attached to glass microscope slides.
5. Series of diagrams showing setting conditions in various waters and probable effect of tides on distribution of setting zones.
6. Bulletins issued in June predicting time and intensity of spawning and setting in Long Island Sound.
7. Diagrams and charts explaining the method of predicting spawning and setting.

ANATOMY OF THE OYSTER

1. Series of sections through various organs of the oyster, showing gills, digestive tract, development of gonads, structure of mantle, and tentacles.

OYSTER DRILL

1. Development of the drill and its growth.
2. Boring mechanism of oyster drill.
3. Specimens of shells bored by the drill.
4. Charts showing time required to bore various shells.
5. Specimens of live drills.
6. Outline of measures for combating drill.

In addition to the above exhibits, aquaria containing specimens of various shellfish that live in the vicinity of Woods Hole and their principal enemies were displayed. The following exhibits of the Pease Laboratory (Inc.), of New York, were shown:

1. Charts and diagrams showing bacteriological examinations of oysters at Hampton Bar, Va., and in Rhode Island.
2. Charts and kymograph records showing the effect of chlorine on opening and closing of the shell and on ciliary activity of the oyster gill.

Approximately 75 persons attended the sessions of the convention, including State fishery or shellfish commissioners of Massachusetts, Connecticut, Maryland, and Virginia; public health officers of these and other States; private investigators; and leading oyster producers and dealers.

The work of the Beaufort (N. C.) biological station is mentioned elsewhere in this report in connection with investigations pertaining to young fish, oysters, scallops, and diamond-back terrapin culture. The regular staff of the station was augmented by the addition of one boatman, who has charge of a new 46-foot, 2-cabin type cruiser secured during the year. The working facilities of the station were increased further by many improvements and repairs and some new equipment. Notable among the improvements perfected or under way to January 1 are the construction of a new terrapin brooder house, described eleswhere, the installation of a central heating plant, new electric wiring and fixtures throughout, and new and additional plumbing.

The collection and the study of young fish, mentioned elsewhere in this report, were carried on by Dr. Samuel F. Hildebrand, the director, assisted by James S. Gutsell and Louella E. Cable. Doctor Hildebrand, assisted by Charles Hatsell, the foreman, also carried on a large series of experiments in diamond-back terrapin culture, of which a more extended account occurs elsewhere. James S. Gutsell continued and virtually brought to a close an investigation on the bay scallop begun in the summer of 1925. Louella E. Cable conducted some scale studies of the pigfish. Drs. A. E. Hopkins and Henry Federighi carried on investigations pertaining to problems in oyster culture during the greater part of the year.

In addition to the investigations already mentioned and carried on by the bureau's staff, 24 other workers, mostly private investigators, visited the station during the course of the year.

Experiments pertaining to wood preservation and ship-bottom fouling, conducted by the Chemical Warfare Service at this station for several years, were continued and extended under the direction of H. W. Walker of that service. Bernard Gehauf, of the same service, performed an extended series of tests relative to the toxicities of ship-bottom paints on larval barnacles.

Prof. H. V. Wilson, of the University of North Carolina, assisted by James T. Penny, studied the cell behavior in the regeneration of sponges from dissociated cells.

Dr. Bartgis McGlone, of the University of Pennsylvania, assisted by Charles B. Tatnall, continued his studies on the effects of hydrogen-ion concentration of sea water on the fertilization of marine eggs. A similar line of studies was undertaken by Dr. Ferdinand A. Ries, of the University of Maryland, assisted by Leo C. Drummy. However, owing to an illness suffered by Doctor Ries, virtually no headway was made by the last-mentioned investigators.

Prof. A. S. Pearse, of Duke University, and assistants made some preliminary studies of the ecology of brackish-water animals, using pricipally crabs, of which 10 different species from different habitats were studied for evidences and methods of and reasons for migrations from sea to land and fresh water.

Dr. C. W. George, of the University of North Carolina, was engaged principally in writing and revising a manuscript on some work done on the blood cells of ascidians during previous years at the station.

A. S. Rose, of the University of North Carolina, a student under Doctor George, spent several weeks at the station studying under his professor's supervision the structure and classification of local fishes.

Dr. E. P. Churchill, of the University of South Dakota, devoted his attention to the study of the blue crab, principally the juvenile stages, which remained in part undescribed.

Dr. Ellinor H. Behre, of the University of Louisiana, assisted by a student, Lillian O. Henderson, continued studies of two previous summers on the effect of light on fishes.

Dr. Hoyt S. Hopkins, of New York University, carried on some studies on the respiration and contractibility of muscles in clams.

Dr. H. W. Manter, of the University of Nebraska, examined 303 fishes belonging to 50 different species for parasites, principally for trematodes. These parasites were found in 37 of the 50 species examined and were retained by Doctor Manter for further study.

Others who spent several days at the station are Prof. Duncan S. Johnson, of Johns Hopkins University, assisted by Duncan S. Johnson, jr., who collected some plants on the "banks"; Dr. Waldo Schmitt and Clarence Shoemaker of the National Museum, who collected crustaceans; and B. C. Indrambarya, Siamese Government student, who also collected crustaceans and who came to obtain first-hand information concerning the means and methods employed in diamond-back terrapin culture.

During the calendar year of 1928 the regular scientific staff of the fisheries biological laboratory at Fairport, Iowa, consisted of the director, T. K. Chamberlain, who, in addition to the administrative duties of the position, had immediate charge of the fresh-water mussel investigations, and A. H. Wiebe, who conducted the pond-culture studies referred to elsewhere. During part of the year E. W. Surber made the station his headquarters, and during the summer several temporary scientific assistants were employed. The work of the station has been fully described elsewhere in this report under the heads of mussel culture and pond culture.

The station at Key West, Fla., remained inactive during the year pending its final return to the original owners of the property.

Part II.—DIVISIONAL CONFERENCE, JANUARY 2 TO 5, 1929

THE CONFERENCE

The division of scientific inquiry held its second general biennial conference on January 2 to 5, 1929. In addition to the bureau's staff of about 50 investigators, including both the departmental and the field service, a considerable number of well-known aquatic biologists and fishery officials from universities, State commissions, and commercial organizations were in attendance.

The first two days of the conference were devoted to the presentation of papers upon the more general phases of fishery biology and its applications; during the last two days the conference divided into three sections for discussions of technical details of the bureau's various investigations. One of these groups considered commercial fishery investigations, another fresh-water fisheries and aquiculture, and the third shellfish problems.

The sessions on January 2 and 3 were held in the National Museum and the section meetings on January 4 and 5 at the Bureau of Fisheries. The following program was presented:

Wednesday, January 2

1. Opening address. Henry O'Malley, Commissioner of Fisheries.
2. Purposes of the conference. Elmer Higgins, in charge, scientific inquiry.
3. A review of the fishery situation. Lewis Radcliffe, deputy commissioner.
4. What biology may do for the commercial fisheries. H. F. Taylor, vice president for research, Atlantic Coast Fisheries Co.
5. Progress of fishery biology on the Atlantic coast. O. E. Sette.
6. The Passamaquody project and the fisheries. Dr. H. B. Bigelow, Harvard University.
7. Studies on respiration in fishes. Dr. F. G. Hall, Duke University.
8. Fishery conservation in California. Dr. J. O. Snyder, Stanford University.
9. The international halibut investigation. W. F. Thompson, International Fisheries Commission.
10. Progress of fishery biology on the Pacific coast. Dr. Willis H. Rich.

Thursday, January 3

1. Biology and the cultivation of shellfish. Dr. P. S. Galtsoff.
2. Artificial culture of glochidia of fresh-water mussels. Dr. M. M. Ellis, University of Missouri.
3. Progress of fishery biology on the Great Lakes. Dr. John Van Oosten.
4. Investigation of Wisconsin Lakes. Prof. Chancey Juday, University of Wisconsin.
5. Cooperative Lake Erie investigations. Dr. C. J. Fish, director, Buffalo Museum of Science.
6. Some fresh-water sport-fishery problems. Seth E. Gordon, conservation director, Izaak Walton League of America.
7. Progress in fish cultural investigations, Dr. H. S. Davis.

Commercial fisheries section. January 4 and 5

Dr. Willis H. Rich, presiding.

Salmon Investigations. H. B. Holmes, Columbia and Chignik Rivers; A. C. Taft, Karluk River.

Pacific herring investigations. Geo. C. Rounsefell.

Pacific halibut. W. A. Dunlop, International Fisheries Commission.

Great Lakes investigations. Dr. John Van Oosten, "Fishery situation in Lake Erie"; H. J. Deason, "The pike-perches"; Ben H. Hill, "Effects of fishing gear."

North Atlantic investigations. Dr. Wm. C. Kendall, "Smelt"; Wm. C. Schroeder, "Cod"; O. E. Sette and E. W. Bailey, "Mackerel."

Middle Atlantic investigations. R. A. Nesbit, "Squeteague"; H. A. Hanson, "Statistics of yield."

South Atlantic investigations. Dr. S. F. Hildebrand, "Larval fishes"; Isaac Ginsburg, "Texas fishes."

Aquiculture section. January 4

Dr. H. S. Davis, presiding.

Prof. G. C. Embody. Stocking fresh waters.

M. C. James. Recent developments in the division of fish culture.

R. F. Lord. Trout culture.

A. H. Wiebe. Pond culture.

Eugene W. Surber. Upper Mississippi survey.

Dr. Stillman Wright. Growth of fish in Wisconsin lakes.

Shellfish section. January 4

Dr. P. S. Galtsoff, presiding.

Dr. H. D. Pease. Scientific work of the Oyster Dealers and Producers Association.

Prof. R. V. Truitt. Oyster investigations in Maryland.

H. F. Prytherch. Oyster studies at Milford, Conn.

Dr. A. E. Hopkins. Physiological studies.

H. C. McMillin. Pacific coast oyster problems.

Dr. R. H. Luce. Oyster survey of the lower Potomac.

Dr. Henry Federighi. Oyster-drill control.

J. S. Gutsell. North Carolina scallops.

T. K. Chamberlain. Fresh-water mussels.

The following papers are selected from the first two sessions of the conference. Unfortunately not all the addresses can be published. Some were not presented from prepared manuscripts and others were too technical or detailed to be suitable for this report. Because of the comprehensive treatment of the subjects here presented it is believed that the general reader will gain a better understanding of the recent work of the division of scientific inquiry and its relation to fisheries biology than could readily be obtained otherwise.

OPENING ADDRESS

HENRY O'MALLEY, *Commissioner of Fisheries*

I am very glad indeed to welcome you here again for the second general conference of the division of inquiry. I am especially happy to greet the new members, most of whom represent additions to our scientific staff rather than replacements. I am also glad that there are so many of the bureau's friends and associates here who are interested in fisheries conservation, although not officially connected with the bureau. Some may even be regarded as alumni of the bureau—former members of the staff who have received training in our organization and have graduated to larger fields of endeavor.

It was remarked, following the conference of two years ago, that the undertaking was an experiment, but that it could hardly be doubted that the efficiency of the bureau's work would be increased materially by overcoming the isolation of the field investigators, by bringing them into contact with workers in associated fields and by permitting the exchange of ideas and criticisms. Results of the first conference have been so favorable that it has been deemed worth while to repeat the experiment this year. Hence we are assembling again to consider anew the objectives for which we are striving, the progress which we have made since the last meeting, and the means by which we may improve our methods of attaining our goal.

The ultimate objectives of the bureau's work have changed but little since the establishment of the bureau 57 years ago, and they are so well known that they scarcely need repetition; but the methods of realizing these aims have changed and developed along with the growth of biological knowledge and with changes in material circumstances. There may have been times in the past when the bureau failed to appreciate the magnitude of the forest because of the density of the trees in its path, but we are now again in open country, and I am confident that real progress is being made toward utilizing the nation's fishery resources to their fullest extent without encroaching upon the supply of the future—in short, toward real conservation.

I shall not attempt to outline for you the progress made during the past few years. It is *my* job to direct your policies. It is *your* job to develop and apply the methods of successful investigation. That your work is good is evidenced by the increasing confidence of the public and the industry in the results of the bureau's investigations and dependence on our recommendations.

In my last official report I stated that the enlivening of the public conscience to the need for proper husbandry of our fishery resources is the most heartening feature of the present fishery situation. Coincident with the rapid development of the commercial fisheries of the country is the growth of a greater appreciation of the work of the scientist in placing fisheries research on a more practical basis. The fisheries biologist has demonstrated the value of such research and has thereby created a greater demand for his services. But fishery science is rapidly developing. Fads and enthusiasms will inevitably arise. Hence, I feel moved to warn you, as pioneers in a new field of scientific research, not to lose sight of your main objective or become engrossed so deeply in the development of technical methods or abstract principles that you forget the practical applications. It is only by continued application of this newly acquired knowledge of fishery biology to the practical problems of fishery administration and development that the confidence and support of the public can be maintained.

A convincing evidence of public approval is the increased cooperation on the part of State and private organizations in fishery investigations. Demands for investigations still exceed the facilities of the bureau, but the bureau's effectiveness has been materially extended through the close association of its own trained investigators with the State commissions. Few States have the resources or the organization to maintain a staff of biologists. They have accordingly furnished boats, men, gear, and funds for cooperative surveys and experiments, and at our suggestion several States are actively engaged in the collection of fishery statistics that are sufficiently detailed and extensive to be useful to the biologist in studying abundance. This increased activity has brought our investigators into closer contact with the local officials, and matters of administrative and even political nature have been forced upon their attention.

While all of you are specialists and are deeply engrossed in your individual scientific work, I urge you to report every unanswered problem encountered, together with your recommendations for work in new fields or along new lines. It is our duty to be far in advance of the actual needs of the industry, to anticipate its problems, and to be ready with helpful suggestions. The only way that the bureau can maintain close contact with the fishing industry is through its field staff, and I urge upon you the importance of being alert to every opportunity for service.

This conference is intended to give each of you an opportunity not only to review and criticize the work of others but to examine your own task, to defend your own plan of work, and to assess the value of its results. I hope that no false modesty or real shyness will prevent you from entering freely into the discussions. Let no question remain unanswered and no statement of doubtful principle or fact go unchallenged. The bureau's program of work must be examined and overhauled in the light of the present and future needs of the fisheries; all weaknesses repaired; all faulty timber removed.

While the bureau's policy must be announced by its official head, it must be largely determined by the combined judgment of its entire staff. *You* are the Bureau of Fisheries, not the commissioner's office or the offices of chiefs of divisions. The results of your whole-hearted cooperation during the past two years have been very gratifying. We now have before us the responsibility of planning more wisely and executing more efficiently and more faithfully.

PURPOSES OF THE CONFERENCE

ELMER HIGGINS, *In charge, Division of Scientific Inquiry*

I shall not burden you with a long recital of the purposes of this meeting. The commissioner has already told you that we have met again to reexamine the objectives of our investigations and to review the progress we have made in realizing them.

I have heard many comments, particularly from the younger men, concerning the inspiration received from the last conference, and because of our belief in the real benefits derived by all of you from rubbing shoulders, comparing notes, and matching wits with the other fellow we have planned this second conference. I sincerely hope that the discussions during the next few days will be of even more benefit than before. It appears from the number present that it will be of benefit to a greater number at least. This conference will certainly be worth while if the isolation of the field workers can be overcome in any degree. Everyone benefits from more intimate contact, but much of the benefit will be lost if the contacts made at this meeting are allowed to lapse. Certainly everyone can receive help from someone else on the staff having similar problems, and I hope that many of you may feel free to seek this help by correspondence throughout the year. I suspect that many of us have overlooked this source of effective and expert aid.

As will be seen from the program, the conference will be divided into two parts; the first part is intended to acquaint us with the outstanding work in fisheries biology during the past two years; the second half of the program is intended to review the individual programs of the various investigators. Our organization is now so large that it is difficult to permit full discussion of the many undertakings in a single general meeting. The program would be too long or else many would be neglected if such a plan were followed. The first part of the program will, therefore, by synoptic and general dealing with aims and results of investigations, with what has been studied and what should be studied; the second part should be detailed and exhaustive, permitting free and full discussion of methods and means. I do not propose to limit discussion to-day or to-morrow any more than is absolutely necessary to complete the program within the allotted time. In the section meetings reports of about 15 minutes' duration have been requested from each investigator, but these are only intended to form the basis for as much discussion as is desirable; and if it appears worth while, the sections can be continued even into next week.

I know that none of you wish to become involved in Government red tape any more than is absolutely necessary, but I believe that you will be interested in a brief review of some phases of the division's business during the past two years. The funds for the continuation of the work of the division of scientific inquiry are furnished by seven different appropriations, totaling for the present fiscal year over $243,000; and, in addition, a special appropriation of $20,000 has been provided for construction, repair, and improvement at the fisheries biological laboratory at Beaufort, N. C. Aside from this special fund, only two of these appropriations are used exclusively by the division of inquiry, hence the figures are given in round numbers and the amount varies from year to year.

The commissioner has spoken of the evidences of increased approval on the part of the public of the scientific work, but so far as we investigators are concerned this approval can be gauged only by the funds Congress provides. Judging by this standard, there is no doubt of popular sanction, for the appropriations have more than doubled in the past five years. Considering the two appropriations, "Inquiry Respecting Food Fishes" and the combined salary rolls of inquiry, the annual totals from 1924 to 1929 are as follows: $91,000, $118,000, $129,000, $144,000, $175,000, $208,000. Besides these funds, the amount for the operation of vessels for scientific work has also been increased in accordance with the demand. These have permitted the purchase of a new motor vessel and a small launch for the Beaufort laboratory and extensive repairs and alterations on the *Albatross II* for North Atlantic work and on the *Shearwater* for Lake Erie work, better fitting them for fishery investigations, as well as providing and repairing boats and launches at the stations. The salary appropriations since 1924 have nearly doubled, also, increasing from $51,000 to $100,000. This is due in part to an increase in the number of Civil Service positions and in part to promotions within the ranks and increases provided at the last session of Congress by the liberalized compensation act of 1928.

The personnel of the division has also undergone considerable change in the past few years. In 1924, 18 regular investigators were employed on a full-time basis; at present there are 33. The bureau, however, has always had active cooperation from investigators in universities and private institutions, many of whom have held brief appointments from time to time, particularly during the summer season, but who have in most cases continued their interest throughout the year. Among those recently employed on this basis are Dr. H. B. Bigelow, of Harvard University; Dr. R. E. Coker, of the University of North Carolina; Dr. M. M. Ellis, of the University of Missouri; Dr. Herbert Fox, University of Pennsylvania; Dr. C. H. Gilbert, of Stanford University; Dr. F. G. Hall, Duke University; Prof. Chancey Juday, Dr. George Kemmerer, and Dr. Samuel Lepkovsky, of the University of Wisconsin; Dr. G. C. Price and Dr. J. O. Snyder, of Stanford University.

In reviewing the changes in personnel during the past two years I must first report the passing of the bureau's most beloved and respected counsellor, Dr. C. H. Gilbert, who died at Stanford University on April 20, 1928. Others have been separated from the service but can not be counted as losses because they are still with us in fisheries work, performing greater services than when official members of our scientific staff. These are Dr. and Mrs. C. J. Fish and M. C. James. Dr. Walter Koelz and I. L. Towers have resigned from the field staff, and from the office staff we have lost J. V. Greene and R. A. Coleman by retirement and W. A. Lyons by transfer. The scientific staff has grown by the appointments of Dr. A. E. Hopkins and Dr. R. H. Luce to the oyster work; Dr. Stillman Wright, B. H. Hill, and H. J. Deason have joined the Great Lakes staff; H. A. Hanson, V. E. Heffelfinger, E. W. Bailey, and Henry M. Bearse are engaged on the Atlantic coast investigations; Seymour Smith and A. C. Taft are working on salmon; E. W. Surber is surveying the upper Mississippi River; Miss Louella E. Cable is stationed at Beaufort, N. C.; and Alonzo Thomas, W. C. Neville, and Miss Helen Guy have been appointed to clerical and laboratory aide positions in the field and Clarence E. Werback in the Washington office.

Of interest to all of you is the prospect of increased compensation during the coming year. The liberalized compensation act of 1928 gave each of you a slight increase in salary on July 1, and there is considerable hope of further congressional action in raising the salaries of the lower paid employees throughout the Government service. Furthermore, reclassification of the field service is now under way. Much work in this direction has already been accomplished by the Personnel Classification Board, and although not everyone in the field service will receive salary increases on that account, all will be benefited by the adjustment of salary ranges to accord more closely with the duties actually performed. In 1925, through the first reclassification act, the salaries of the bureau's investigators were materially increased and placed on a basis comparable to those in first-class universities and further improvement in salary rates are very encouraging.

I have been recounting for you a very satisfying picture of the material success in bureau organization, but I believe there are prospects for great future development. At the last session of Congress Representative White, chairman of the Committee on Merchant Marine and Fisheries, introduced a bill providing for a well organized program of expansion for the Bureau of Fisheries during the next five years. This bill passed both House and Senate but received the pocket veto at the end of the session. The matter is not dead, however, for I understand that the same bill is to be introduced again with some possible modifications that will probably win for it united support. Scientific inquiry's part in this program of expansion includes increases in appropriations during the five years amounting to $250,000. These funds are to provide both permanent salaries and operating expenses for investigations in all of the major geographical districts. On the North Atlantic coast the haddock, flounder, and mackerel should receive adequate attention; in the Middle Atlantic section the shad and menhaden; in the south Atlantic and Gulf the mullet and shore fishes and shrimp; on the Pacific coast the salmon and the herring; and in the interior waters expansion of the work in experimental fish culture and mussel propagation and the study of stream pollution are projected.

As the commissioner has told you, our present fortunate position is due to the public's appreciation of your work in the applied science of fisheries biology. If this program of future development is to be accomplished it must be by continued devotion to the work of making fisheries conservation practical and effective.

REVIEW OF THE FISHERIES SITUATION

LEWIS RADCLIFFE, *Deputy Commissioner of Fisheries*

Few lands have been blessed by so rich fisheries resources as the United States. And yet, within a century after the Declaration of Independence, or on February 9, 1871, to be exact, a joint resolution of Congress was approved appointing a commissioner of fish and fisheries to conduct investigations to determine the facts and causes of the alleged diminution of the fish supply and the feasibility of remedial measures. At this early period an established market demand for certain species of fish and shellfish existed. Included in this list were bluefish, cod, halibut, trout, mackerel, mullet, shad, salmon, squeteague, clams, lobsters, oysters, and terrapin. Because of their abundance, popularity, or importance in the markets of the country they may be classed as staples in the fish trade of that period.

During the first phase, when we depended very largely on a relatively small number of well-known staples, the record catch was attained for such epicurean products as clams, lobsters, oysters, shad, sturgeon, smelt, and whitefish. Following are the maximum catches, compared with the present level of production:

	Maximum in pounds	Present level in pounds	
Clams	23,000,000	13,000,000	(Atlantic).
Lobsters	30,000,000	10,000,000	
Oysters	186,500,000	115,000,000	
Shad	50,500,000	12,000,000	(Atlantic).
Sturgeon	18,000,000	800,000	
Smelt	1,800,000	700,000	(Atlantic).
Whitefish	21,500,000	4,500,000	
Cisco (Lake Erie)	39,000,000	2,350,000	
Total	370,300,000	158,350,000	

Other illustrations, such as the Atlantic salmon, will occur to you. Since the nineties other species have attained their maximum and are now on the decline, but prior to that time the dangers of depletion were less evident and the effects of replacement less noticeable. This is particularly true of regions such as the Pacific and Gulf States, more distant from the great centers of population in the East.

During the second phase, beginning about 1900, new fisheries were being rapidly developed to supply the demands of our growing population or to make up for the decline in the catch of the staples. In the New England area the fishery for haddock has assumed a position of much greater importance, as shown by the following:

Year	Catch in pounds
1900	46,000,000
1910	62,500,000
1920	85,000,000
1925	108,300,000
1928	180,000,000

In the Chesapeake area, with the development of markets, the catch of the blue crab increased to one of large proportions, as shown below:

Year	Catch in pounds
1880	3,300,000
1890	9,500,000
1915	50,300,000
1925	30,000,000

In the South Atlantic and Gulf States the shrimp came into prominence, the catch of various years following:

Year	Catch in pounds
1890	8,200,000
1908	18,500,000
1918	46,000,000
1923	70,800,000
1927	98,800,000

In the Great Lakes the catch of the three species of pike-perch increased from 10,000,000 pounds in 1903 to 27,000,000 pounds in 1915 and declined to 12,000,000 pounds in 1927. In no fishing area has a fishery developed with greater rapidity on so large a scale as that of the pilchard fishery of California, the basis for the valuable sardine canning industry, the catch for certain years following:

Year	Pounds
1904	1,000,000
1916	15,000,000
1917	105,000,000
1918	157,000,000
1925	315,000,000

Economic factors limited the catch of 1920–1922.

With the development of markets for canned tuna, fisheries for the several species of tunas grew with great rapidity. Prior to 1915 the catch rarely exceeded a half million pounds. In 1915 it was 21,500,000 pounds; in 1920 nearly 46,000,000; and in 1925 nearly 55,000,000. The catch of Alaska herring increased from 9,400,000 pounds in 1915 to 28,800,000 pounds in 1918 largely as a result of the bureau's introduction of the Scotch cure; fell off during the postwar depression; then increased to the record catch of 77,000,000 pounds in 1925. By the granting of permission to use pilchards for reduction purposes the British Columbia fishery assumed large proportions almost immediately. In 1924 the catch was 2,750,000 pounds; in 1926, 97,000,000 pounds; in 1927, 137,000,000 pounds; and in 1928, 161,000,000 pounds.

Attention has been called to some of the more important instances in which the catch of a species has been greatly increased during the last quarter of a century. Many others will come to mind, such as the fisheries for whiting and tilefish off our northern coast; Spanish mackerel, groupers, and drums in the South; suckers and sheepshead in the Great Lakes; and barracuda, halibut, mackerel, and sablefish on the Pacific coast.

It is by the development of such fisheries that we have been able not only to maintain but to increase our annual yield. This period of exploitation is drawing to a close. Except possibly in the North Pacific, there remain no huge undeveloped fishery resources. For nearly every one of our great fisheries the maximum catch has probably been attained. The North Atlantic bank fisheries are being prosecuted with the greatest intensity in their history; the halibut fishery of the North Pacific is now prosecuted coastwise for a distance of about 1,800 miles; failing in a sufficient domestic supply off the coast of California, the volume of fishery products taken from the waters off the coast of Mexico has risen with amazing rapidity. As a result of the greater demand created through improved methods of merchandising millions of dollars are being invested this year in new vessels and gear preparatory to taking a still greater toll of our fish supply. This is the situation which confronts fisheries biologists, executives, and the fishermen. It is a situation which commands the best thought and effort we can give to it.

The two principal phases of modern fisheries biology, as we know it to-day, are (1) the conservation of our national fishery resources, and (2) supplementing the natural supply through the development of aquiculture. In this respect we are far behind agriculture, in that long ago the natural supply of land products ceased to be of primary importance except in such fields as forestry. In the fisheries we still place our chief dependence on the natural supply and must continue so to do until the science of aquiculture is much further advanced than now.

Your first concern is to keep posted on the status of the fish population of each important species, to detect any changes, and recommend measures needed to maintain the fishery at the highest practicable state of productiveness. In Alaska you not only do this, but you have an opportunity to make practical application of your findings. The biologists of the bureau are, therefore, on trial with respect to the perpetuation of such anadromous fishes as the highly priced salmons, which furnish nearly half of the world's supply.

The biologists of the halibut commission are also on trial as to their ability to solve the problems of a great sea fishery. Unless they can succeed, what of the future of our other great sea fisheries, shall they be swallowed up by the greed of man? We have the further complicating factor of the ability of nations to put into effect the recommendations of the fisheries experts regarding fisheries of the high seas. Heretofore such attempts have not been particularly successful. As to their failure I am inclined to believe the biologists share the burden because their recommendations were not always convincing to the layman and not well founded on a sound investigative program. We have a comparable problem on the Great Lakes; but here I expect final success, because if the States themselves do not do the things they should do, we shall see a centralization of authority in an international fisheries commission or some other central organization, which will supersede the present division of authority. Many problems of the high seas, such as the conservation of whales and other marine mammals, the great sea fisheries of the North Sea, and our North Atlantic bank fisheries await settlement.

The annual catch of cod alone on the east coast of North America exceeds a billion pounds annually, of which 49 per cent is credited to Newfoundland, 20 per cent to Canada, 17 per cent to France, 12 per cent to the United States, and 2 per cent to Portugal. With the development of factory ships for freezing, canning, and reduction of fish waste the intensity of fishing and the number of countries and vessels taking the toll of our Grand Banks fish supply may be expected to increase. We have already observed what is happening in the haddock fishery. Will it not be necessary to restrict fishing thereon by international agreement? Will the biologists be prepared to state what restrictions are necessary when that day comes? In 1927 over 25,000 whales were killed. The seas of the earth are combed for these huge mammals. Great factory ships with reduction plants, storage capacity of upwards of 3,000,000 gallons of oil, and some with provision for drawing the whales on board for cutting up, with a fleet of smaller killer vessels visit the Antarctic each year. Already the League of Nations is giving the matter of conserving the supply of whales attention, but can the biologists make definite recommendations as to what steps should be taken?

The Passamaquoddy power project excellently illustrates what I have in mind. This hydroelectric power development will control the tidal flow between two natural basins in this region, which happens to be the center of the young herring fishery on which the sardine-canning industry depends. Suddenly and without previous warning the biologists are called into conference to determine the probable effect of this development on the fishery. Our knowledge of the oceanography of the region and of the factors that make this huge mixing bowl so suitable for the herring is very incomplete. Without this mixing this body of water would be very little different from other points on the coast. Unless the advice given as to the probable effect of this development on the fisheries is correct, it will tend to discredit fishery biologists. This is an excellent illustration of the need for accumulating the necessary knowledge about our great fisheries, for from now on we may expect similar calls at any time.

In our inland-water areas we find the fisheries situation greatly complicated by the results of our rapid industrialization. Not only are the fishes more susceptible of attack, but we have added to the hazards of the fishes themselves through deforestation, pollution of our waterways with domestic sewage and trade wastes, destruction of the nursery grounds by reclamation and drainage projects, cutting off the runs of anadromous fishes en route to the spawning grounds by dams and other barriers, and the rapid development of good roads, the increased use of the automobile, and the shorter hours of labor making the inaccessible places accessible to the growing millions of our people seeking healthful recreation in the great out-of-doors.

In all fishing areas the strain on the supply has been greatly increased by the increased efficiency of fishing gear, boats, and other transporting agencies; by improvements in methods of merchandising and distribution; by the better understanding of the richness of aquatic foods in elements essential to good health. To illustrate: The first otter trawler for engaging in our North Atlantic bank fishery was built in 1905. In 1929 it is expected there will be at least 50 such vessels operating out of New England ports. The use of the motor truck for transporting the catch to market is of comparatively recent origin, yet in 1924 New York City alone received 22,000,000 pounds of fishery products by this route; in 1928 it is estimated that the volume of products shipped in this manner will be double the 1924 figure, or about 45,000,000 pounds. The packaging of fresh and frozen fish as fillets, steaks, sticks, and pan-dressed, initiated in 1921, has grown in seven years to a great industry utilizing about 150,000,000 pounds of fresh fish. The landings of haddock, the principal species packaged, increased from 46,000,000 pounds in 1900 to 62,500,000 pounds in 1910, to 85,500,000 pounds in 1920, to 144,000,000 pounds in 1927, and 180,000,000 pounds in 1928. On the South Channel grounds, along Cape Cod, the catch per acre per annum increased from 16 pounds in 1910 to 50 pounds in 1925 and 114 pounds in 1927.

How long may we expect the fishery to stand up under such intensive fishing? Thus, on every hand the strain on the natural supply is increasing at a rapid rate, and when the strain is reflected in greatly reduced catches you biologists will be harassed to supply a sure and instant relief. At least one progressive fishing company has already considered adding a biologist to its staff. This is but one of many signs of a growing interest in determining the present status of our fisheries and insuring a greater degree of control over fishing operations. Eight years ago when we were rapidly forging ahead in the field of fisheries technology, we recognized that ultimately this would bring about the situation with which we are faced to-day, but few of us realized the rapidity with which the change would come. Improvements have resulted in greatly enhancing the value of fish. Enhanced value and heavier investments in turn result in raising the importance of the biologist and his output.

Confronted with this possibility of the exhaustion of the natural stock, our attention is turned to discovering means for replacement or additions to natural stock. With the drawing to a close of the era when replacements may readily be made, we are brought to the second phase of fisheries biology to which I referred, namely, aquiculture. What is more natural than for man to attempt to duplicate his successes with land crops by attempting to grow water crops? Fish culture as we know it in this country, particularly as practiced by Federal and State Governments, is, of course, a phase of aquiculture. Just as in many other branches of human endeavor, the development of the mechanics of operation has taken precedence over close study as to means of improving the product itself. In fish culture we have been more concerned about volume of output and not enough concerned with what happened to the billions of nearly helpless fry released to shift for themselves. Fortunately in recent years we have been rapidly developing the fundamentals which will assure a larger return on our investment and do not place as much trust in numbers alone.

Among the bureau's activities are numbered various phases of experimental work in aquiculture. At Holden, Vt., we are solving the problems of trout-cultural operations—feeds, diseases, selective breeding, etc. At Fairport, Iowa, the growing of basses and other warm-water fishes—fertilization of ponds, introduction of forage fishes, and other experiments to increase the productivity of water areas.

In the coastal waters remarkable success is being achieved in the development of oyster farming. To-day the greatest retardants to the rapid increase in oyster acreage under cultivation are antiquated State laws, which virtually prohibit engaging in the enterprise on a scale necessary to attract capital. We now produce about 17,000,000 bushels of market oysters annually. We have areas of suitable bottoms for cultivation capable of producing 100,000,000 bushels, or six times the present harvest.

Terrapin culture and mussel culture experiments now in progress belong to the field of aquiculture. In addition to what the bureau is doing, other examples will readily come to mind, such as goldfish farming, commercial trout culture, and the raising of bait minnows.

Thus, as our natural stock of fishes decreases we will place greater dependence on aquiculture for replacement. But how much food will an acre of water grow? How does it compare with the land in productivity? While our knowledge of the subject is far from complete, glimpses here and there indicate that water areas can be made fully as productive as land areas and in some cases will far exceed the land in productiveness. A few random illustrations may be of interest:

	Pounds per acre
Oyster meats, Atlantic coast	100
Fish, South Channel, Cape Cod (catch)	122
Beef, cultivated land	140
Fish, Lake Pepin, Mississippi River (catch)	145
Carp, cultivated ponds	150
Bluegill sunfish, Fairport Pond	272
Pork, cultivated land	300
Goldfish, Fairport Pond	450
Clams, coast of Washington (catch)	535

A careful analysis of the quantity of water crops that may be produced per acre, their market value, and the cost of operations I believe will convince you that the day is at hand when aquiculture will be an established and attractive pursuit capable of adding its quota to our harvest of the natural stock and replacing shortages or caring for growing demand for water products.

The subject of aquiculture has been dealt with at considerable length because of the increasing attention which the subject is receiving and fully merits. We shall continue to place dependence on the great sea fisheries for the great bulk of the catch, and these merit serious study for their proper administration. As biologists observant of the slowness with which your recommendations are acted upon, you undoubtedly wonder at times whether your efforts are worth while, whether they are appreciated, and whether you should perhaps have chosen some other calling. As to their being worth while, I know of no period in the history of this bureau when it has had a more practical program or when it has rendered greater service. This is reflected in increased appropriations, more demands for service, and greater reliance on the recommendations which the bureau makes. Our problem is to keep pace with the demand for information necessary to the proper husbandry of our resources.

Usually when the authorities awaken to the need for action they want to know immediately what to do. We have had an illustration of that in the Great Lakes States. Some morning we will find the haddock question on our doorstep and will be expected to state the remedy at once. Thus, the demands for our service will increase, and if we give good service our work will be appreciated. Not only that, but just as happened in the technological section, our trained experts particularly in such fields as aquiculture, will be in demand by industry itself. I know of no more fitting demonstration as to the practicality of our program of research.

WHAT BIOLOGY MAY DO FOR THE COMMERCIAL FISHERIES

H. F. Taylor, *Vice President for Research, Atlantic Coast Fisheries Co.*

It is scarcely necessary to expatiate on the desirability of some mutual understanding between the marine biologists and those who are engaged in the fisheries industry. The fact that the bureau has honored me with an invitation to discuss this subject sufficiently demonstrates that the need for mutual understanding is recognized and that the bureau proposes to do what it can to promote it.

Recent trends and developments in the fish industry have been such that they raise sharply certain biological questions; to answer these questions it may be necessary for the marine biologists to place emphasis in directions other than those they have been following. Perhaps it may be advisable first to describe the trends in the fish industry, the biological significance of which will then become apparent.

Until a few years ago, of the four great basic industries, agriculture, mining, forestry, and fisheries, only the fisheries remained unaffected by what is variously known as the "industrial revolution" or the "scientific revolution." The industry was (and still is, to a large extent) in the hands of individual fishermen, small firms, partnerships, commission merchants, and retail stores. Any man with a few dollars capital could buy a boat and go fishing or set up in business as a commission merchant or a retailer. Needless to say, in this kind of organization of the industry no specialization was possible, and nothing much was to be hoped for by way of applying scientific methods to the capture, preservation, and distribution of sea foods. Losses in this kind of industry are necessarily great and quality far too often poor.

The corporation has now made its appearance in the fish industry, with its specialists in scientific research, engineering, business analysis and accounting, marketing, advertising and traffic problems, factory management, and finance. Everybody now knows the efficiency of a diversified and specialized corporation as compared with the one-man business. Though for sentimental reasons we may not like corporations, the trend of modern business has been in their direction for many years, until they now dominate it in almost every branch. In the fish business the research laboratory is applying chemistry and physics to the solution of the problems of preservation, preparation, and distribution of perishable sea foods; engineers are designing and installing intricate machinery for manufacture and in capture; ocean areas are being charted into units; elaborately equipped ships fish these areas and are daily in touch by radio with headquarters, from which operations are directed; experts in merchandising are applying the arts of salesmanship to the nation-wide advertisement and distribution of the products. We are just now adding a biologist to the Atlantic Coast Fisheries' research department, whose function will be to apply biology in operations at sea.

All of this is not intended to imply that the corporation will or can take over the fish business. Some 300 species of fishes are commercially exploited in this country, each having its locality and period of abundance, and most of them are classified into size groups. They do not all readily lend themselves to nation-wide distribution. Much of this business must for a long time be in the hands of local firms, if for no other reason than because there are too many varieties of fishes for the general public ever to become familiar with all of them and their relative merits.

Highly important in a national system is standardization of process and a product which can be nationally advertised. Plants must be kept going as near continuously as possible and prices must be stabilized. These requirements point to species of fishes that occur in large numbers and can withstand heavy exploitation. Fisheries biologists know that there are relatively few such species—cod, haddock, salmon, mackerel, shrimp, oysters, and halibut. These species differ among themselves, as we know in a general way, in their fecundity, rate of growth, age at maturity, and general ability to support extensive exploitation. Greater exactness in this knowledge is highly desirable. Mistakes of judgment of fisheries companies based on assumptions or inadequate information regarding supplies of raw materials of these and perhaps a few other specis would be disastrous, not only to the erring company but to the fishery as well. My first suggestion to the biologists may therefore be formulated as follows: Studies of the biology of these important species of fishes should be made with a view of determining the extent to which they may be exploited safely. Incidentally such studies can not fail to yield other valuable information concerning locations where they may be taken most economically, periodic fluctuations of abundance, and possible measures of promoting the supply.

Viewed in a broad way, the fisheries industry may have a very prosperous future ahead of it, or it may have to be satisfied with a much more modest success. Populations of the world are rapidly on the increase. A glance at history shows that the older countries have been living to a large extent off the new frontier countries, but these latter are rapidly outgrowing frontier conditions and are becoming industrialized and thickly populated on their own account. Argentina, Australia, New Zealand, and Canada may not for many more years continue to ship meat to the older countries. The sea covers 71 per cent of the earth's surface, receives 71 per cent of its quota of sunshine, and is the world's great reservoir of chemical compounds necessary for life. The ocean basin hoards untold millions of tons of phosphates, nitrates, and other chemical building materials, including the rarer ones that are being found essential to life. Every factor of material and energy is present in the ocean in magnitude almost beyond human conception. Can the fishing industry look upon the sea as a vast future source of food for mankind, or must we, at great effort and expense, solve the problems of capture, preparation and distribution, get things going, establish distribution, create public demands, and then in two or three years see international commissions hoisting danger-signals of depletion and bills introduced in Congress and legislatures to restrict capture here, close seasons there, and impose limitations elsewhere? The total of living substance extracted from the sea is a merest trifle compared with the total productivity and a tiny fraction of the foods otherwise available to man. Is it illusory to suppose that we can really exploit the sea, and is the cycle of life so ingrown that we can really get only a trifling amount from it?

Coming more specifically to the haddock: We have lately been hearing much alarmed discussion of a possible depletion of this valuable fish. Figures when printed, containing long strings of zeros all divided up into groups of three, are impressive, especially since they are rapidly growing larger. In pounds we are taking, say, 250,000,000 in 1928 and may take, at the present rate, nearly 300,000,000 in 1929.

I have with me the operating charts for the coming year for our own company, which, by the way, is not public information, but I do not mind giving you a few facts from it. The anticipated production from our vessels, of which there will be 18 this year, is 56,697,000 pounds of haddock to be landed in New York and Groton, Conn., which will produce 20,111,000 pounds of finished fish for the market, of which some goes to every State in the United States. Every State in the Union is covered, and a great deal of it goes to California, I might say, and to the North Pacific States, from the Atlantic coast.

Until December, 1927, the Atlantic Coast Fisheries Co. had 4 trawlers in operation. From December, 1927, to June, 1928, 9 trawlers; in the summer of 1928, 7 trawlers with 2 laid up; from October 1, 1928, 14 trawlers; and within the next few weeks 18, which will probably operate the year round. This represents a new addition of 14 trawlers by our own company within one year. The Boston fleet has also been increased by some new trawlers, and several vessels of other types have been fitted for the haddock fishery.

This rapid expansion of the haddock fleet raises some important biological questions, chief among which is, of course, danger of depletion. Now, if it is important for anybody to know the extent to which haddock can be captured with safety, it is the fishing companies, which must do much work and invest large amounts of capital on the prospects. We have, therefore, every reason to desire the truth without exaggeration or disparagement. I have seen no valid evidence, other than mere magnitude of figures, that indicates one way or another whether or not the haddock is in danger of depletion; but we do know that depletion has occurred in the North Sea, which definitely proves that there is a real and attainable limit in the extent to which we can take this fish. Depletion is indicated when the average size of individual fish diminishes. This sign does not occur suddenly, but gradually. We have had, during the past November and December, a marked drop in catch of haddock on the banks, and there has been some concern lest this means a beginning of depletion. That it probably does not is indicated, first, by our records, which show that this drop in catch of haddock occurs regularly every year during November and December, sometimes in January, and is followed from January onward by a marked increase; second, by the fact that the short catches are not marked, so far as we have observed, by any diminution in average size of individual fish; and third, that the drop in catch occurred suddenly, which is contrary to experience in depletion. An important service to the industry can be performed by a careful watch for signs of depletion, those mentioned above and any others that the biologists can discover.

If this November-December scarcity of haddock does not represent depletion, but is temporary, what are its causes? Even if it means nothing worse, it imposes an extra cost on capture and disturbs the market. It would be important to discover what becomes of haddock during these months. Probably the cause will be found in a horizontal or vertical migration of the haddock from their usual habitat to others for one or more of the following reasons, viz, (1) scarcity of food, (2) presence of enemies, (3) some connection with spawning. (4) temperature or salinity of the water, or both. Of these four possibilities, scarcity of food or conditions of the water appear most likely, because dogfish are out of season in these months, and spawning does not begin with the haddock until January or February. We have no information on the food supply of the haddock during these months. Since, however, the food of the haddock is bottom invertebrates, whose food in turn is the "rain" of organic matter from the surface, we would expect most rapid growth of the haddock in the months following vernal bursts of planktonic growth at the surface, allowing for a certain lag between the two. It may be that by November the season's growth of bottom invertebrates is almost exhausted; but even if this theory is correct, it tells us nothing of the whereabouts of the haddock. It would be useful to know this. Records show that the peak of capture of haddock on Georges Bank is in March, April, and May. When they are scarce on the bank in November, they are more plentiful in shore waters. The following figures, taken from our records, show the average catch of ground fish per boat per month for certain points, in thousands of pounds (000 omitted):

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1925	166	252	364	276	882	348	266	307	358	246	259	218
1926	180	265	386	295	431	424	375	473	440	340	343	361
1927	259	882	488	356	451	500	408	508	495	358	306	258
1928	366	462	543	504	606	400	447	424	354	403	262	------
Average	248	340	445	358	467	418	374	428	412	337	292	279
Percentage 1928 over or under 1927	+50	+21	+12	+42	+34	−20	+9.5	−17	−28	+12	−14	------

These figures (which are not corrected for the influence of stormy weather on fishing) agree with a theory that haddock seek the bank for spawning, then, after feeding there through the summer, scatter over the Gulf of Maine in fall and in shallower shore waters in winter. They do not contain any evidence of depletion. From all the above it is obvious that a general knowledge of the movements and habits of haddock would be useful.

So far only the questions of depletion and facilitation of capture of a steady supply of haddock have been considered. If we wish to exercise foresight while we have haddock, can we do anything whatever to promote its productivity? For one thing, I have suggested that during the spawning season it would not be difficult to fertilize mature eggs aboard the trawlers and dump them overboard immediately. In order to determine the feasibility of this procedure some little investigation would be necessary to ascertain (1) whether the eggs and spermatozoa of trawl haddock are still viable when they come on deck and (2) whether a sufficient number would be mature where fishing is done to justify the effort. Perhaps the bureau is already prepared to answer these questions; but if not, the necessary investigation might profitably be done at an early date. I can speak for the Atlantic Coast Fisheries Co., that we are willing to cooperate with the bureau in every way looking toward the carrying out of such a project.

This proposal, however, only raises another question. To what extent is the depletion of the haddock fishery (or of any fishery) caused by deficiency of fertilized eggs? If the limiting factor that determines the amount of haddock is the number of eggs hatched, then the obvious thing to do is to hatch every possible egg. I have believed for years that the matter was much more complicated than this simple proposition would indicate. The prodigious fecundity of haddock and, in fact, of most fishes is well known.

Let us estimate an average production of 300,000 eggs by each female haddock and accept the estimate of Bigelow and Welsh of a haddock population of 150,000,000 of marketable size in the Gulf of Maine. These will, of course, not all be of the same age class, but more likely in some such ratio as four of the age of 5 years, three of 6 years, two of 7 years, and one of 8 years. If this assumption be correct, 40 per cent of the adult haddock population, or 60,000,000 fish, must reach maturity each year. If 100 per cent of eggs survived, 200 females would be sufficient to supply this number.

Now, let us further suppose that we catch annually 250,000,000 pounds of haddock, averaging 3½ pounds per fish, or 71,500,000 individual fish, leaving in the water 78,500,000, of which 50 per cent, or 39,250,000, are females. We thus have 39,250,000 mature females to produce enough eggs to make up for the failure to survive of the eggs of 200 females, which would perpetuate the supply if all survived. This gives us a survival ratio of one in 197,500, or 0.00051 per cent. If we fertilize all the eggs from all fish caught, we change the necessary survival ratio from 0.00051 per cent to 0.000267 per cent, against which must be applied some unknown factor that represents the diminishing chances of survival with increasing numbers of eggs.

Now, it will be noticed that in the above reckoning we are catching 71,500,000 haddock, while only 60,000,000 are reaching maturity, and an unknown number are being destroyed by enemies other than man. If the estimates be anywhere near correct, we are already depleting the fishery; but we must take it for granted that Bigelow and Welsh did not propose their estimate of 150,000,000 population as much more than a guess. Biologists might secure some factual data from the average catch per set of the trawl, the area of bottom covered, and the number of sets. These calculations could be further refined by a study of age-group ratios and of the average fecundity of mature haddock.

Of course, the above figures are merely assumptions. The point is, however, that where conditions are favorable for propagation a relatively small number of fertilized eggs is sufficient; but if conditions are unfavorable no number of eggs will avail to perpetuate the kind. Conditions on the Pacific coast being favorable, the shad have increased in number without artificial propagation.

The purpose of these remarks is not at all to criticize the bureau's activities but to give point to the suggestion that what is needed is a general theory of population of marine animals. The fixed limit for any one species would seem to be, in most cases, the amount of food available for that one species; or, perhaps, the basic characteristic rate of growth. If we remove from the water more pounds of haddock than the available haddock food is able to nourish, then we are headed inevitably toward depletion. What would happen under such circumstances would seem to be what does happen in depletion; that is, the fish are smaller and smaller when caught, or, in other words, they do not grow to a sufficient size by the time they are caught. This again, however, is purely theory, though it may be part of the truth.

To illustrate, suppose the haddock had no enemies at all, not even fishermen. The bottom would be scoured for food, and the total growth would be determined by the amount of food; but growth would be slow in the extreme. Other species competing for this food would further retard growth, and vigorous body activity necessitated by the unceasing search for food would still further retard it.

Now enter the fishermen. By reducing the number of fish the fisherman reduces competition, and likewise the necessary activity of the haddock in search of food, actually increasing the amount of fish up to a certain point, this point being reached when the number of fish is not sufficient to consume the available food, and the rate of growth is that of fish which get all they can eat, it being assumed that the net used filters out only the larger individuals. This is, of course, not a complete theory, for it becomes more complicated the more we contemplate the problem. It may boil down in final analysis to how fast a fish can grow—the characteristic or basic rate of growth of a fish under the best of conditions. If, on careful analysis, such a theory should be confirmed, it would be important experimental work to measure the basic rate of growth.

Our European friends have proposed the theory that because young plaice are more rapid growers than old ones, it is fundamentally sound to catch them to the limit. Survival may, and undoubtedly does, vary greatly from year to year. Pelagic haddock eggs are part of the plankton during their natural period of incubation and, as such, are subject to being consumed by organisms that feed on miscellaneous plankton. The time of incubation of haddock eggs is a function of temperature; that is, temperature near the surface. Thus, in seasons of low surface temperatures the eggs would be subject to being eaten for a longer time than in seasons of warm surface temperature, when they hatch quickly. Coexistence of larvæ with an abundance of copepods on which they feed may have much to do with survival. Other questions relating to the life history of the haddock require study. Harold Thompson in Scotland states that in "good" seasons as much as 50 per cent of haddock may spawn at the end of the second year and all in the third. Bigelow and Welsh say that the haddock spawns from the first year on, and others say that the haddock spawns from the second year on. This certainly does not agree with our information regarding American haddock. It has an obvious bearing of importance on the question of the productivity of haddock.

Again looking to an improvement in haddock productivity, we have the question of enemies. Technology must solve the dogfish problem. Of course, no ocean fish can ever be exterminated by exploitation—haddock or dogfish. Depletion merely goes to a point beyond which capture is unprofitable, and stands at an equilibrium thereabouts. Biologists might be able to tell us whether the dogfish problem is really as serious as most fishermen think. Assuming that all dogfish caught at present are killed before they go back in the water, no advantage to the fishery itself would be brought about by utilization unless a special fishery for dogs were created. In fact, the advantage might be the other way about, for dogs thrown overboard perhaps sink and become food for the bottom invertebrates, indirectly feeding the haddock. The same argument may well apply to the disposal of guts at sea, concerning which there has been some thought of utilization. Perhaps we might work out some means of utilizing them, but would it be worth while? Pollock do not seem to be sufficiently abundant, at least on George's bank, to be a serious factor as an enemy of the haddock; our figures show less than 1 per cent of the total catch to be pollock. In other parts of the gulf they may be more serious.

Another factor that may have a bearing on the future of haddock is the practice of bringing in scrod. It is interesting to note that in the British haddock fishery the total catch on all grounds diminished from 316,000,000 pounds in 1906 to 174,000,000 pounds in 1913, and that meanwhile the percentage of the classification "extra small" (9 inches long) increased 64 per cent from 1905 to 1911. Because of the practice, at that time on the increase, of bringing in more and more small fish, it can not be determined what part of this increase in small fish was caused by the growing practice of bringing in the small ones and what part by depletion. Perhaps the former was a contributing cause of the latter, though the theory of ocean population I have hinted at would say not.

It is also interesting to observe that the height of the British capture was about what ours promises to be this year; but that does not include the part taken by continental countries. If our waters are comparable in productivity with theirs, we have at least some rough idea of the order of magnitude of possible haddock fishery, which should be a great deal larger than it is at the present time.

Tagging experiments as far as we have had opportunity to know, seem to show that haddock move about considerably in and around the Gulf of Maine. If this suggestion is confirmed it may prove that intensity of fishing in South Channel is not likely to deplete that particular area because it is supplied by migrations from the entire gulf. We shall await with much interest further reports on this work.

So much for the haddock; it is discussed at some length because just now it is of widespread interest. Similar discussion might be made of other species, such as mackerel. The bureau is already studying this fish, and the results that flow from this study will be timely indeed, for without a doubt the mackerel will be exploited to its limit before long.

I wish to say in conclusion that the work already being done by the bureau is of the greatest value, and its officers may be sure that the results are being followed closely and profitably. The monumental works of Doctor Bigelow and his associates deserve especial praise, and large as they are, it is to be hoped that they are only a beginning.

SUMMARY

1. Studies of the biology of the more important species of fishes should be made with a view of determining the extent to which they may be exploited safely.

2. Though specific data would, of course, be out of the question, it would be useful to derive from biological study some estimate of the extent to which the vast oceans can really contribute to the food supply and discover what factors, in a broad way, fix the limit to this supply.

3. A systematic vigilance should be maintained for definitely recognizable signs of depletion in the more important species.

4. With respect to the haddock, (*a*) Are we approaching the limit of safe exploitation of haddock? (*b*) What are the general movements of haddock in water that explain fluctuations in the supply at the usual points of capture? (*c*) Is it advisable to commence hatching operations for haddock aboard the trawlers? (*d*) Can anything be done about the enemies of the haddock? (*e*) How serious a matter is the practice of bringing in the scrod haddock?

5. A general theory of fish population of the sea is needed, comprehending the several factors which account for the number of any one species in ecological equilibrium at any one time, and including the effect of artificial hatching upon it.

PROGRESS OF FISHERY BIOLOGY ON THE ATLANTIC COAST

O. E. Sette, *In charge, division of fishery industries*

Judging from the program of this conference we are to hear about the details of fisheries investigations from the biologists themselvss, so that this will be only a general review of our progress, a review which I hope will help us all to get a perspective of the work that is under way and the relation of our specific problems to the ultimate goal of the bureau.

In making this survey of progress, I hope I will be forgiven if I reiterate some of the principles that govern the relative usefulness of our results. These, no doubt, are familiar to all of us, but it is dangerously easy to apply our thoughts and energies so closely to the immediate details that we may be sidetracked from the real aim of our work.

The previous addresses have made it clear that our prime duty, as concerns the marine fisheries, is to know at all times whether they are suffering from overfishing or other harmful influences, and to be able to tell administrators what may be done to correct such conditions. We will all agree that this is a large order. It involves a multitude of interrelated factors, many of them unknown or so poorly known that it is difficult to appraise their importance.

Stating the problem in simplest possible terms, we need to know, in the case of each kind of fish, whether they are growing scarcer or more plentiful, how much so, and what can be done about it, if anything. Although it is a simple matter to detect scarcity when it has become extreme, it is a more difficult thing to recognize it in its early stages when the remedy may be more readily applied without being so drastic as to find insurmountable opposition. For recognition of depletion in its early stages and of other moderate changes of abundance we require a quantitative measure. This involves the interpretation of suitable statistics by a biologist who knows, and knows intimately, the fishery with which he is concerned.

In many cases, or I might correctly say in most cases, no body of suitable statistics exists. This is due in part to the administrative and technical difficulties in the way of collecting the right kind of statistical data, but it is due also to the failure of the biologist to study his fishery and design a method suitable to show its changes in abundance. There are some general principles in the collection of statistics which will show real abundance, such as fixing the relation between a quantity of catch and a unit of fishing effort, but the definition of practical units is a thing that varies in each fishery and must be worked out for specific fisheries and specific localities.

At one time I was under the impression that it might be possible to have a statistical program that would automatically record the data on the fisheries so that they would be available when wanted by the biologist at a future date. Perhaps it is possible to do so, but our experience in the division of fishery industries is that it is exceedingly difficult to mobilize the funds and personnel for such work unless it can be shown that these statistics will have early application to the problems of the fisheries. Even where statistical programs are under way, they will fall into disrepair unless put to use through biological analysis. After all, the statistics are but the biologists' instrument for measuring abundance, and we all know that it is difficult to get an instrument unless the powers that be are convinced that it will be put to good use. Furthermore, we know that an instrument, neglected and allowed to go unused, will almost certainly be found in disrepair or be lost entirely when it is finally wanted.

This is but an analogy, and I have always been suspicious of analogies. I have used it because developments in fishery statistics have indicated the correctness of this illustration. The California system was planned and instituted by biologists, and if the biologist had not been putting those statistics to use the system, I little doubt, would have disintegrated by this time. In the Great Lakes region there is being developed a system with merit, but it would not have been done without the active participation by our fishery biologists and will be in danger of disintegration if not used by them during the next few years.

I may have dwelt overmuch on fisheries statistics, but it is perhaps not amiss, for we biologists are so likely to become immersed in our life-history studies and the like that we forget all about the prime question—the abundance of fish. We can, perhaps, leave the subject with the conclusion that the biologist can not expect to have his statistics furnished him ready-made but must bestir himself to see that this tool is being developed along with his other instruments. The statistical and biological studies must go hand in hand.

Given a quantitative measure of change in abundance, we may turn to the next question: What caused the change? We are interested in two kinds of causes, the so-called "natural" and the so-called "artificial" or man-made causes. Both may be traced to the three variables, which determine sizes of populations—birth rate, death rate, and migrations. In the fisheries these can not be directly observed. Unlike similar variables in the human population, we can not count the fishes in the sea, nor are their births and deaths registered. Instead, we must measure these factors indirectly. The progress of biology in the fisheries is contingent on the development of a technique that will enable us to observe these changes. The greatest advance in this respect was the scale method of determining ages of fish. By this means the fish in an adult population can be identified with their year of birth or "year-class," and the survival of a year-class may be followed from year to year. Thus, the study of age is not an end in itself. It is merely the means to an end, and unless employed for this purpose its value is largely lost.

Migrations may be studied both directly by tagging and indirectly by biometrical methods to determine subspecific differences. The data on migrations are invaluable in defining the units of fish populations, as well as to indicate whether or not conservation may be a local problem.

Once knowing the variations of birth and death rates, we are still far from our goal, for we must then seek their causes if we are to distinguish the natural ups and downs of the fisheries from the scarcity caused by overfishing. The very nature of the fluctuations and year-class changes from year to year may give a clue as to the cause, but a final answer must rest on a more intimate understanding of how the organism fits its environment and how it responds to changes in environment. In other words, we must look to a combination of oceanography, ecology, and physiology to lead us to the primary causes of fluctuations. Thus, we are involved in research that goes all the way from the economics of the fishery to the life history of the fish and to the responses of the fish to the physics, chemistry, and biology of its environment.

Obviously, to pursue all investigations to such fundamental causes is a well-nigh hopeless task. At least there would be danger of the fisheries being entirely depleted and experiments being stopped through lack of material before we arrived at the end of our quest for fundamental causes. Needless to say, the fishery biologist can bring aid to the forces of conservation long before he has reached the ultimate cause of changes in abundance. It takes careful planning to provide practical results at an early date, and for this reason the principles of investigation are being strongly emphasized.

Our progress in providing such contributions in the Atlantic coast investigations will probably indicate the extent to which this work has been directed to the more immediate requirements of the conservationist as well as to the laying of a suitable foundation upon which to build in the study of population flucutations.

Virtually all sciences begin with descriptive or qualitative studies. In the case of the fisheries this is the matter of describing and cataloguing our aquatic animals so that they may be recognized and their relationships understood. This phase of fisheries science was at the height of activity during the end of the last century, and by the early 1900's practically all important fishes were known at least in the mature stages of life. That the work is not yet complete is shown by the discovery during the past year that what we thought was one species of sea trout on the Gulf coast is really two separate species, both of them of commercial importance.

With respect to the egg and larval stages of our fishes the descriptive work is far less complete. North Atlantic species are fairly well known, thanks to the oceanographic work in the Gulf of Maine and at the Woods Hole station. Middle and South Atlantic and Gulf of Mexico forms are very imperfectly known. The larval stage of the fish may be the most important in the natural fluctuations of the fisheries. It shows the most promise of providing the key to the causes for the ups and downs that are so prominent in many of our marine species and make it so difficult to distinguish the natural fluctuations from the changes in abundance due to man's activities. Progress in this branch may be reported by the bureau's Beaufort station, where weekly plankton collections are made for the purpose of catching fish eggs and fry, and where their study is being actively pursued. Since the eggs and fry of very few of the species are recognized, progress is necessarily slow; but each identified species narrows down the possible identity of the remaining kinds. Several of the species have already been identified, and results will be accelerated with the continuation of this work. Additional materials are being collected incidental to the mackerel investigations off the coast of New England and the Middle Atlantic States and will facilitate completion of this phase of the descriptive work. Such descriptive studies offer but little immediate aid to the administration of the fisheries except to explode some fallacies about the time and place of spawning and the possibility of man's interference with spawning grounds. There need be no apologies for this work, however, for it is the groundwork upon which our bricks may be laid in the future.

Let us turn to the progress of fishery biology on the Atlantic coast as distinct from the descriptive phase. The work in the northern portion has been favored by our long-established biological station at Woods Hole and the oceanographic studies in this region. It may not be exaggerating to say that through the cooperation of the Museum of Comparative Zoology the physical oceanography and plankton of the Gulf of Maine are better known than in any other body of water in North America; and, thanks to the Canadian Fisheries Expedition of 1914 and the work of the St. Andrews station, the Gulf of St. Lawrence and the coast of Nova Scotia are also partially studied.

Of investigations on other fisheries proper, that on the cod has shown the most interesting results. Since migrations promised to be most important in this fishery, an intensive tagging program has been pursued for a number of years. In the beginning the work was restricted to inshore grounds through lack of a suitable vessel for offshore fishing. With the *Albatross II* the bureau has been able to extend these operations to offshore grounds, such as Georges and Brown's Banks. Results indicate that in some localities the cod population is resident the year round. This is true of the Mount Dessert region along the coast of Maine. In other localities seasonal migrations take place. The Nantucket Shoals codfish form an illustration of this type of population. Most of the cod on this ground spend their summers on the Shoals but go to the coast of New Jersey and even down as far as Chesapeake Bay in winter, returning to Nantucket Shoals again in the spring. Preliminary results on the offshore banks indicate that the codfish there do not make regular seasonal migrations, but the fish move about considerably more than those in the Mount Dessert region.

We can, perhaps, derive the most important conclusion from the tagging work in the fact that it has demonstrated well-marked differences in the habits of codfish of various regions, which means that any study of the fluctuations of this fishery must deal with separate populations. This is complicated by the interrelation of grounds through the drift of cod eggs and larvæ. Oceanographic studies of the region have shown ocean circulation of a type that leads one to believe that few codfish grounds are self-perpetuating. A particular study was made of Massachusetts Bay and has shown that virtually all of the eggs that are spawned in the bay are carried out by ocean currents. Some of them, perhaps, finally arrive at Nantucket Shoals, while others may reach banks to the east and north. This makes it clear that although the adult populations on any ground may be fairly stationary, its increment of young cod depends on the success of spawning on other grounds.

Much work still needs to be done before the intricate problems of this fishery are solved.

In the State of Maine some interesting studies on the smelts have been going on for a number of years. These have been directed largely to the determination of subspecific differences, and one of the most interesting and practical results indicates that some races of smelt may be much more useful for stocking purposes than others.

The mackerel investigations are of more recent origin than those just mentioned, but it has already been fairly well established that the violent fluctuations of this fishery are due to either great differences in birth rate or great differences in mortality of the very young mackerel. It seems that in most years very few mackerel survive to augment the stock of commercial sizes, but occasionally we have a very good survival year. When this happens the sea is full of mackerel for the next several years. Two important conclusions may be drawn from this fact. One is that the natural reproductive rate of the mackerel is far more important in establishing the level of abundance than the influence of man's fishing activities. It can not yet be said that man's fishing activities do not have an effect on the population of mackerel, but their effect, certainly in the past at least, has been far less than that of natural fluctuations. The other result is that the abundance of mackerel is determined a year or two before they become of commercial size. This permits a prediction of general abundance of mackerel a year or more in advance. Before such predictions can become very reliable it is necessary to have followed several year-classes through their life cycle; but that some progress has already been made is shown by the results of our tentative prediction of the mackerel catch in 1928.

This prediction was made last March before the season opened. We estimated that the season's catch would be less than 88 per cent as large as that of 1927, perhaps very much less. The season just closed two weeks ago and the preliminary totals indicate that this season's catch was 79 per cent as large as that of 1927.

Biological work is badly needed in two other very important fisheries of New England. The intensity of the haddock fishery is increasing by leaps and bounds. The steam-trawler fleet has virtually doubled in the last two years, and nearly all of the fishing is done in a fairly restricted area. It is very urgent that data be collected as early as possible to show the effects of this increased exploitation on the population of haddock of that region. The flounder fishery has had a similar growth and needs similar attention. A serious effort is being made to collect statistics on the landings of these fisheries so as to provide an index of abundance from year to year, but such data must be accompanied by biological investigations if they are to be interpreted properly.

In the Middle Atlantic States the bureau has recently begun a program of investigations on the coastal fisheries from Long Island to Chesapeake Bay. This investigation is being so organized that pertinent data for population studies on the most important pound-net species are being collected and studied. With only one season's data at hand it is impossible to present conclusive results of this work. The life histories of the various species must be understood before the effects of birth rate, death rate, and migrations can be traced. The squeteague, or weakfish, is one of the most important fishes of this region and is receiving the most attention in the Middle Atlantic work. Thanks to the cooperation of the Bingham Oceanographic Collection, subspecific differences of the squeteague are being studied and will be of aid in this investigation.

Preliminary work has indicated some interesting complications. It appears that in the southerly localities only very small squeteague are ever taken in pound nets, while in other localities various sized fish will succeed each other as the season progresses. Various hypotheses will explain the phenomenon, but only continued investigation can establish the correct explanation. Meanwhile it will be very difficult to determine the age composition of the stock until this problem is solved. This phenomenon, whatever its cause, is significant in showing that in all fishery investigations great care must be taken to assure adequate sampling, both as to locality and time of season, and that the selective effect of different types of gear must be evaluated. The investigator in charge of this work is to be congratulated for having designed his sampling system to bring out this feature adequately.

Before leaving the middle Atlantic fisheries it should be remarked that the dominant species of the region is not receiving attention from the biologists.

This species, the menhaden, is taken annually in quantities exceeding the aggregate of all other fish on the Atlantic coast. An understanding of its fluctuations would be important not only to the menhaden industry but to the general problems of fish fluctuations of the region. The urgency of this problem can not be overestimated.

The mullet fishery is perhaps the most important on the South Atlantic and Gulf coasts. A study of subspecific difference has shown that in general the mullet of a particular region do not mix greatly with those of other regions. This defines the responsibility of individual States in the conservation of this fish. It was formerly the general opinion that North Carolina mullet went to Florida for the winter. This naturally removed all incentive to protect the fishery in either State, for each thought the other might thereby get the advantage. By defining the races of mullet the way has been cleared for State protection.

Recent fishery investigations in the coastal waters of Texas have resulted in a better understanding of the spawning and nursery areas of the more important fishes. A peculiarity of this region is the unusually wide seasonal variations in salinity of the lagoons, which become brackish in the rainy season and salter than the ocean in the dry season. Since this characteristic may be affected by man through the dredging of inlets, it is important to understand the biological consequences of these salinity variations. The studies of spawning areas and nursery grounds have paved the way for more concentrated work on the effects of varying salinity and temperature on the fish populations.

This outlines briefly the progress of the bureau's work on particular fish and fisheries. In summary, we are completing the descriptive work that must precede the quantitative work; work on some phase of population fluctuations is progressing on the cod, mackerel, smelt, mullet, and several important inshore species of the Middle Atlantic. There remain untouched more species than are being investigated, and many of these untouched problems are fully as important as those already under way. We need not be afraid of working ourselves out of our jobs.

I wish that I could present some new developments in theory of fisheries biology as the results of the recent Atlantic fishery investigations. Unfortunately this can not be done; but, instead, I wish to call attention to some interesting questions suggested by these investigations in the hope that through their discussion and the interchange of ideas in this conference there may result some advances in the theory and practice.

The problem of the good and bad years in fish reproduction interests me greatly. This phenomenon seems almost universal in the marine fisheries, though it is much more pronounced in certain species than in others. The Norwegian herring and the American mackerel seem to head the list of extreme contrast in good and poor reproductive years. The European plaice and the Pacific halibut seem to be at the other end of the scale, with but slight variations.

It is not unreasonable to suppose that if the cause of reproductive success or failure were known in the case of a single species it might pave the way for a more rapid determination in the case of other species, in much the same fashion as the first work on determination of age from scales has facilitated it in many other species, although each is a problem in itself and, as such, must be studied critically to assure correct interpretations.

This morning we were discussing the limit in the case of haddock population. I do not believe that the factor of the different phases in the life history of the fish was sufficiently brought out in the discussion. It seems to me entirely possible, and even probable, that the abundance of fish may be limited not by the amount of food available for the adult fish but by the amount of food available for larval fishes, for instance, or other physical or biological conditions that control the abundance of larval fishes that will be supported by the food present at the time when they have just hatched from the egg or at other subsequent times. The real limit of the fish population may be found in the weak link in the stage of fish growth rather than in the effect that might limit directly the abundance of mature fishes; and I think that establishing or at least getting some idea of what causes the ups and downs in a particularly fluctuating fishery like the mackerel is promising an entering wedge for the understanding of other fluctuations.

Another big question in the field of general biology is the interesting matter of survival factors. All existing species have somehow weathered all crises in their existence. As already pointed out, many species have great differences in reproductive success from year to year. When a succession of poor years occurs the population must become much smaller, and a long enough succession of poor years could render a species extinct. In some way existing species have resisted all such periods. The mechanism of this resistance may be highly variable. In some species it may be longevity, by means of which there will still be mature fish left in the ocean to spawn even though no baby fish has been hatched for a number of years. In other species it may be the very prolific spawning of the few adults left. The mechanism, whatever its nature, is important in the theory of conservation, because overfishing during a critical period may seriously impair the mechanism in one case but have little effect in another.

In conclusion, a word should be said about the part which organizations other than the Bureau of Fisheries have contributed to the fishery investigations on this coast. Of most immediate value are the researches carried on by Canadian investigators at their St. Andrews station. These have not only contributed to the knowledge of the biology of fishes, but also to the physiological basis of marine phenomena. The studies of lethal factors and other of their physiological contributions will be of great value in the ultimate understanding, if there be such a thing, of the factors controlling the abundance of fishes. The work done by university research men in the various marine biological centers of the United States makes contributions in the physiology and embryology of marine forms. At the present time the extensive application of their findings may seem somewhat remote, but their true value to us will be realized when we ourselves have progressed farther toward an understanding of the basic causes of fisheries phenomena.

INTERNATIONAL HALIBUT INVESTIGATION

W. F. Thompson, *International Fisheries Commission*

When the International Fisheries Commission began its investigations of the halibut all that was actually known was the existence of a dangerous condition. Its staff had impressed upon it the need of formulating direct and practical measures for remedying this condition in the shortest time possible.

The temptation to begin, as in many another investigation, by general and diffuse biological studies was great. It would have been very easy to take it for granted that the only essential problems were those emphasized in the usual training of a biologist, such as the stages of the larval life-history. No doubt these problems would in the end have led us toward our goal, but to follow this trail many special fields would have to be entered upon, each of them requiring a skilled man and many years of work. One of the first questions to be met was, accordingly, as to the existence of some more immediately practical method of approach. This led directly to a searching consideration of what the problems at issue really were. It was then realized that no real problem had been defined.

The effort to define our problem led to a mode of attack which may be outlined here. This problem was really one of a change in the abundance of halibut, resulting from an artificial increase in the rate of mortality. A parallel could be drawn with the study of the mortality of mankind. To one undertaking such a study, diseases, anatomy, developmental history, and many other things are of interest. But those organizations directly interested in mortality, the insurance companies, proceed directly to a measurement and description of the rate of mortality and its effects without analysis of contributory causes and circumstances. They use great masses of data to overwhelm minor fluctuations and extend their observations over many years to determine the trend despite temporary fluctuations. This, then, was the rational mode of approach to our halibut problem.

The plan adopted was, therefore, first of all to study the vital statistics of the halibut. We planned to discover the statistical history of each section of the banks and the resultant condition. We planned to use this analysis and description as a basis and an indication of what problems of life history were essential to the passing of proper regulations, and we anticipated that when regulations were adopted their effect would be obvious only through a continuation of our studies of these vital statistics.

Last year, in a paper given here, the collection of these vital statistics was described, and it was shown how we had attempted, as the men in the insurance business had done, to make tables and curves of the changes in the halibut stock and its fisheries. To do this we found a great deal of data that had been accumulated by intelligent men on the halibut vessels, and from this we were able to answer some of our questions. It was possible to measure the abundance of halibut by the catch per unit of gear, spoken of as pounds per skate.

Our first result showed that the different areas, or banks, were differently depleted. From Seattle northward each bank was characterized by a different level of abundance. When these levels were plotted we had a curve running from 50 pounds per skate near Seattle to 150 far north and west. But we found that this variation in abundance was the result of economic factors, not primarily of biological. It was a function of the distance from the markets, as the even nature of the change would indicate.

That this variation was a result of the fishery became evident when approached from another standpoint, the historical. Going back to the earliest records of the fisheries it was found that the original level of abundance of halibut was exceedingly different. On the older banks off the British Columbia coast it is now 50 pounds per skate, but it was once well in excess of 500. On the far northwest banks it has never been greatly in excess of what it is now. Were we to have the original curve of relative abundance it would, therefore, have been very different from that of the present. Where now the lowest level is found, there was once the highest. The commercial fishery has completely reversed the trend of the curve throughout the whole range of exploited grounds.

Incidentally this change in abundance was not the only result of the greatly increased rate of mortality on southern banks. The population was greatly changed as regards its composition, whether of ages or sex, and as regards its distribution on the banks.

Hence, it is evident that the southern banks show the greatest change, and it follows that there, if anywhere, it should be possible to study the nature of the decline in abundance, to apply, for positive results, our statistical method of approach.

The study of the decline on the more distant banks might be fruitful in the future, but as far as the past was concerned and as far as present available knowledge is to be obtained the older banks must be concentrated upon. Fortunately, I was already in possession of a great mass of records gathered prior to 1914, which extended as far back as 1902. It was possible to effectively supplement these by collecting records for the years since 1914. These were even more abundant that those for the earlier years.

From a thoughtful consideration of these data the essential problem has become evident. It is one that can be stated in terms of those vital statistics that have already been mentioned. We shall here seek to define this essential problem by means of a brief discussion of our results.

The record of relative abundance from year to year upon the older grounds off the British Columbia coast was determined in detail from the catch per unit of gear, corrected for changes. The catch fell from 300 pounds in 1906 to 50 in 1926, and in 1900 a few records showed 800 pounds. The fall during intermediate years was variable, but its trend was continuous and at the same rate.

For comparison with this rate of decline in abundance a record of the total catch taken year by year was desirable. Unfortunately no such statistics are available. The governments have given us a record of totals from all banks, but since the area of these banks has steadily increased the totals are meaningless except in so far as they failed to rise despite the vastly greater area exploited. Up to 1910, however, the total came from the older grounds alone. In that year the fishery was extended northward and to deeper water. From then until 1926 it seems impossible to reach any decision as to what the total from the older grounds actually was. In that year special inquiry showed that approximately 20,000,000 pounds was a fair estimate. We have concluded that the total catch on these grounds fell from 53,000,000 in 1910 to 20,000,000 in 1926.

This fall is a disaster in itself. It means that the fishery on the older banks is no longer a major one. But that the exact record of this fall is not available is greatly to be regretted for reasons that will be pointed out.

What brought about this great fall in abundance and total catch? From these two records the amount of gear used can be derived. The quantity of the catch divided by the catch per unit of gear should give the total number of units used, namely, about 177,000 in 1910 and 400,000 in 1926. Unfortunately, again, we have no direct records of this gear, from which the intensity can be gauged, and our indirect calculation gives us no record for the years between 1910 and 1926.

From the work we are now doing it is hoped that the future course of these three curves—of abundance, of total catch, and of intensity—can be plotted accurately, for in their course lies the essentials of the problem we face. As I have said before, when the relationship of these three can be expressed in mathematical terms, and when we know the total yield to be expected from a given intensity, then regulation will become exact and scientific, not merely a step in the right direction.

A hint of the significance of the relationship can be gained from what we already know. The abundance of fish has fallen to 17 per cent—from 300 to 50; but the total catch has fallen only to 38 per cent, from 53 to 20 millions. In other words, the present low abundance is producing more, in proportion to the stock existent, than was formerly produced. There is an increasing resistance to the strain, which tends to bring the fishery toward stability. That is a result exactly in line with what has been observed in the North Sea; but there, as here, the exact history of the change is not accurately known because adequate statistics were not kept.

It is plain that were the intensity of the fishery to become a fixed quantity, the decline in abundance might go on only until the increase in resistance to the strain balanced the rate of removal by the fishery. In short, each different degree of intensity might have a stable corresponding level of yield, whatever it might be or however low it might seem. Then regulation would be concerned, for instance, with the question as to whether a low level of abundance with extremely high intensity would be economically better than a high level of abundance with a smaller fleet.

There is no real reason to believe, however, that any such uniformity in this increase in resistance will be found. The increase in resistance may all occur within the first stages of the decline in abundance, and thereafter abundance and total yield may fall together and in proportion to the increased intensity. This would imply that the maximum yield from the banks would be obtained at the time abundance was at a high level, and that subsequently increased intensity would actually be at the expense of the "principal," of which the yield should be the "interest."

To understand this better, it should be stated in terms of concrete details of life history instead of referring solely to these three graphs of intensity, abundance, and total yield. The theory embodied in these details is theory only, but the changes in these graphs which it may explain are definite facts.

Fisheries scientists everywhere have been interested in the speculation regarding the course of events in the plaice fishery. One of the theories advanced is that as the fishery develops and older fish are removed the younger have a greater chance of survival. Moreover, it is presumed that the rate of growth increases. In other words, the rate of inflow of new supplies of fish has increased. The *rate of replacement* is higher. It is supposed that the supply of food left for the young has greatly increased because not used by the old. With a higher survival rate and a faster growth, the resistance to the strain increases so far as it is able to replace the drain of the fishery. The rate of replacement finally equals outgo. Thus stated, this is a rather simple theory.

As applied to the halibut, it seems not so simple, but rather complex. The resistance to a strain and the rate of replacement cease to be necessarily uniform in their increase with declining abundance. For instance, the young fish are not relieved of competition from the adults because they have not had it to a great extent. They have always tended to school together and to inhabit their own banks. The fishery strips the older banks of large fish and leaves them barren and unproductive, so that the rate of replacement may not rise in response to diminishing abundance.

To strip a bank of its population is to pass far beyond the optimum conditions for productivity. It may, indeed, be profitable to remove some of the fish, but surely not so many as to leave the banks barren. In other words, the optimum conditions for survival of the fish have long ago been passed. Perhaps 10 or 15 years ago the banks were supporting their stock of adults to the best advantage, and if this is true the rate of replacement—the interest on the principal, if you please—will not increase, and any further decrease in abundance means the simple removal of the principal itself.

Then, to put the matter concretely, if 500 fish could exist under optimal conditions of growth and survival with a surplus of 50 fish, or 10 per cent, each year for the fishery, the problem is to allow the bank to retain that number. If the numbers are reduced to 100, with no greater rate of replacement than the above 10 per cent, only 10 fish could be taken by the fishery; but if that 100 should be replaced by nature at such a rate that 50 fish, or 50 per cent, could be taken annually, the population might well be allowed to decline to the 100 instead of the 500. It is the change in rate of replacement that is vital to the problem of regulation.

In our halibut problem, then, where did this rate of replacement, this resistance to a strain, begin to change? Where were the optimal conditions? We know little about it now because no one has kept accurate statistics. My plea this afternoon is that the rational course as to our fisheries consists, first of all, in getting statistics of sufficient accuracy over a sufficient period of time to give us an answer to these questions. What is the course of this rate of replacement? What will it be under regulation? We must express this in mathematical terms of abundance, of total catch, and of intensity (effort involved), for the rate of replacement is expressed by the total catch characteristic of each level of abundance.

In determining these statistical graphs or curves we have found in the halibut very great variations. As was said at the beginning, it is only over a period of years that we are able to determine the trends of these things. We can not pause to analyze the causes of all these variations; but we know that, as in the case of human statistics, the laws of mathematics prevail, giving stable averages and stable trends if enough data are accumulated.

To conclude, it has seemed to us obvious that the method of approach to the problem of depletion or overfishing is that of the insurance companies, to get accurate data over a period of years to enable us to describe these things in mathematical terms, taking into account the variation expected under the theories of error. Just as the insurance statisticians keep up their mortality tables and determine their trend from year to year, so must we with the halibut. We can not first analyze the natural causes of changes in this rate of replacement, for these are difficult and complex; but we must determine the rate and its changes and base our regulation upon it. We may not know why it acts as it does, but by the methods of the mathematician we may measure, just as do the insurance men, the constancy of the rate under the conditions met with. Such statistics will require years to secure, and they will be the better for an analysis of the natural history conditions underlying them. Upon such a program must action be based if scientific conservation is to come within reasonable time. In the meantime, sufficient can be discovered to guide us in the right direction, and with each succeeding year we will perfect our knowledge.

PROGRESS OF FISHERY BIOLOGY ON THE PACIFIC COAST

DR. WILLIS H. RICH, *In charge, Pacific coast fishery investigations*

The fishery investigations on the west coast deal primarily with the salmon, halibut, herring, and clam fisheries. You have already heard from Professor Snyder, and Mr. Thompson has told you of the work being carried on by the International Fisheries Commission. However, most of the salmon investigations on the coast—that is, in Alaska and on the Columbia River—have been carried on by members of the staff of the Bureau of Fisheries, and we have also been concerned with investigations of the herring and clam fisheries of Alaska; and just this year the bureau has undertaken an investigation of the oyster industry of the west coast under the very competent direction of Doctor Galtsoff.

I believe I am safe in saying that the primary object of most of the investigations is to discover the present and relative abundance of those several species of fish and shellfish that form the natural resources on which the fisheries are based and the proximal causes of such changes in abundance as may be demonstrated. Such a statement expresses very simply a problem that is tremendously complex, and the study of this problem leads, sometimes, into odd and unexpected channels. You have had illustrations of that put before you to-day.

In the first place we must determine the present abundance of fish of a given species, and this is primarily a statistical problem requiring extensive and accurate statistical data. The collection and collation of these data are, in themselves, tremendous tasks; but even when we have accomplished them we must ask ourselves what is a fair measure of abundance? Can we actually count or estimate the total number of fish of a species? I might say that can be approximated in some instances. On the other hand, is the total catch a good index that will give comparable figures year after year? Is the yield per unit of fishing effort a better index, more nearly comparable year after year? Or, if none of those measures can be applied satisfactorily, what can we use as a measure of abundance?

This first problem—to find a good measure of abundance—is, perhaps, the biggest and most difficult of all, and we may have to try several measures and try them out carefully, critically, experimentally, if possible, in order to determine which one is most reliable and best fitted for the particular problem in hand. R. A. Fisher, in his book on Statistical Methods for Research Workers states: "* * * from the modern point of view, the study of the causes of variation of any variable phenomenon, from the yield of wheat to the intellect of man, should be begun by the examination and measurement of the variation which presents itself."

It may be well to point out here that these studies in relative abundance serve not merely to show the present conditions of the fisheries, but must be continuously applied as long as we have any interest in our fisheries whatsoever. If a fishery is shown to be depleted and a remedy is applied it is just as important to discover the effect of the applied remedy as it was to discover, first, the fact of depletion.

Entering into this problem of the study of abundance, and second in importance only to the accurate measurement of the fluctuations, are the biological problems of migration and local races and the questions of dominant year classes, age at maturity, maximum age, rate of growth, and the like. These all bear more or less directly upon the question of abundance, and their solution will determine to no little extent the sort of measure of abundance we shall adopt, and will affect our interpretation of data bearing on the fluctuations in abundance. Without such data it will never be possible to distinguish depletion from the so-called natural fluctuations due to such causes as migrations, the presence of dominant year classes, etc.

Another important kind of investigation has to do with the causes of the natural fluctuations in abundance. While no sharp line can be drawn, it is important to distinguish the proximal from the more remote and fundamental causes. This may be illustrated by considering the effect of the presence of dominant year-classes. An abundance or scarcity of fish of a given species in a given locality may be due to the abundance or scarcity of fish of certain age groups that enter predominantly into the commercial catch. Such a cause of fluctuation is proximal and may be determined from such biological data as were mentioned a moment ago. Behind this, however, are all the various and more remote causes that may bring about the changes in abundance in the various age groups, such as favorable or unfavorable conditions of temperature during the spawning and incubation periods, and one might go on beyond that to the causes of the variations in temperature, the effect of solar cycles, etc.

Such consideration of the causes of fluctuations in abundance brings us inevitably to the general problem of limiting factors. What are the factors that limit the indefinite increase of a species? They are various in different species and, furthermore, vary from year to year. In the case of salmon, for instance, the capacity of the spawning grounds appears to be one of the most important natural factors limiting abundance; and this will vary greatly from year to year due to water conditions (just as an example we may say water conditions). In the case of many marine and fresh-water fishes, such as herring, halibut, and whitefish, the limiting factor may be temperature at spawning time or some other widespread oceanographic condition. Now, these important limiting factors may change in their intensity, their effect may be reduced or increased and the abundance of fish will be decreased or increased accordingly. There may be more than one limiting factor; in fact, there are sure to be many of them but of different values and operating at different stages in the life history of the species. If the most important factor were entirely eliminated, the species would increase until some other factor became operative and prevented further increase. Or, if a new factor comes to bear upon the species, the abundance may be decreased to the limits imposed by this new factor. This is the effect of the establishment of a commercial fishery; it is of the nature of a limiting factor and its effect is proportional to its intensity. It would be possible to make some interesting speculations, based on the consideration of a commercial fishery as a limiting factor, but I shall not attempt to do that at this time.

Finally, there is a field of investigation that has to do primarily with the methodology of fisheries conservation. In the administration of the fisheries questions are constantly arising as to the best and most efficient methods for overcoming or preventing overfishing. Shall closed areas be established, and if so what shall be their boundaries? Shall restrictions on gear be imposed, and if so what shall they be? Or shall the fishing season be limited, and if so, how? These and other similar questions of the greatest practical importance to the administrator are constantly presented, and an early and satisfactory solution is essential to the success of efforts to conserve the resources. These problems are not necessarily all within the proper province of the biologist, but there are, more often than not, biological facts that must be taken into consideration in making a decision, so that the biologist is necessarily involved whether he will or no. An interesting example of this is a recent study made by Mr. Sette of the daily trap catches of certain traps in southeastern Alaska, on which has been based a complete reorganization of the several fishing districts that were established there for purposes of administration. This is a field that has not received a great deal of attention, perhaps because it is less interesting than the others; but from the practical standpoint it is so important that I look forward to interesting future developments in this field.

I shall now attempt to give you a very brief summary of progress in some of the fishery investigations on the Pacific coast during the past two years.

The herring investigations have been continued by Mr. Rounsefell and have dealt primarily with the herring of Alaska. Sudies have been carried on along the following lines: (1) Racial differences; (2) age determinations, based on scale and otolith examinations; (3) rate of growth; (4) condition—that is to say, the relative fatness; (5) migrations as determined by tagging experiments; and (6) statistical studies designed to show the trend of the fishery.

The racial studies were based on proportional measurements, vertebral and fin-ray counts, and have shown the existence of significant differences between the populations of virtually every locality that has been investigated. It has been demonstrated that the age of herring can be determined with a fair degree of accuracy from the scales, and the study of herring from a number of different localities has shown that dominant age groups are present. The variable success of spawning in different years may, therefore, be the explanation of most of the great changes in abundance of the Alaska herring, although it hardly seems adequate to explain the almost complete disappearance of these fish from some bays where they were formerly abundant. The age of most of the herring found in the commercial catches ranges from 4 to 12 years, with a maximum of 17 years. The scale studies also show that there are enormous differences in growth rate, 6-year-old herring from Dutch Harbor, in the Aleutian Islands, being 6½ centimeters longer than those from Stephens Passage, in southeastern Alaska. Taking these two localities as examples, it appears that the Stephens Passage herring require about 9 or 10 years to attain a size of 10½ inches, while those at Dutch Harbor attain a length of 11½ to 12½ inches in about 6 years. The studies of condition have shown that there are distinct differences in the time of year when the fish in different localities attain their best condition, and that there is also a difference in the condition attained in different years. The tagging experiments did not prove successful, so far as intermediate returns were concerned. No tags were recovered, although over 3,000 were attached in Kachemak Bay, one of the larger arms of Cook Inlet. This tagging was only done last summer and it is possible, of course, that returns will be secured during the next season. The statistical studies of the fishery have shown that there is a lack of continuity of the fishery in any particular locality and that there have been marked shifts in the fishing grounds. These facts, taken with the evidence of a decrease in the average size, indicate that there has probably been some depletion, but it can not be said that the evidence for depletion is clear.

An investigation of the razor-clam fishery has been conducted by Dr. F. W. Weymouth, of Stanford University, and Mr. McMillin on the beaches of Washington, and in several localities in Alaska.

Growth rates and length of life have been calculated for clams from each commercial bed. Racial studies proved that only one species was involved, and the growth curves are directly comparable. The Alaskan beds are recovering, due to present regulations; but the Washington beaches are seriously depleted, although the pack has not decreased. The digging effort has increased 1,000 per cent in 10 years, and a decrease in the catch per person has kept pace. The age has been reduced until 2 and 3 year old clams form the bulk of the catch where 6 and 7 year olds were dominent 5 years ago. Regulations such as are already in force in Alaska would restore the beds in a short time, and such measures are now before the State legislature of Washington.

In the case of the clam studies, those have been carried on as heretofore, although nothing was done during this past season on the clam beds in Alaska. In 1927 a survey of the clam beds was made, but the general investigation of the clams has progressed to a point where now it is not considered necessary to continue the detailed investigations that have been carried on before. In regard to the oyster investigations that are being carried on by Doctor Galtsoff and Mr. McMillin, the work this year has been merely preliminary and no definite results, of course, have been secured so far.

Turning now to the salmon investigations, which are, as you know, those with which I have been personally concerned and which are perhaps the only ones of which I have to speak much to-day, the salmon fishery, particularly that of Alaska, far exceeds in importance any other on the west coast, and naturally a correspondingly large proportion of our efforts is devoted to a study of the salmon resources and the salmon fishery. Furthermore, we have been charged with the care of the fisheries of Alaska and, as a result of this responsibility, it has been especially important to make our investigations such as will be of the greatest practical use in the administration of these fisheries.

The general program of the salmon investigations was outlined at the divisional conference two years ago and has since been published (Document No. 1029). No important changes have been made in this program, so that it will not be necessary to repeat it here, and I shall give you only a summary of the more important advances made during the past two years.

It is possible to report material progress in the work of assembling and collecting the statistics of the Alaska fisheries. Mr. Ball, of the Alaska division, has been working on this for nearly three years, and he and I completed last winter a section dealing with the salmon fisheries of Bristol Bay and the Alaska Peninsula. On account of the very local character of most of the fisheries on the peninsula it is impossible to give any general conclusions except to say that some localities show marked depletion while others do not. If you are interested in the details I refer you to the published report (Document No. 1041).

Certain facts of more general interest developed from the study of the red salmon runs in Bristol Bay. We were able to show that one of the important areas in Bristol Bay, namely, Nushagak Bay, is much more seriously depleted than the other sections. Perhaps I should say *was* more seriously depleted, as the run at Nushagak in 1928 was exceptionally good, contrary to expectations. It seems quite probable that this improvement was due to restrictions imposed on the fishery in 1924, resulting in an increased escapement, because our data show that the majority of the Nushagak fish are 4 years old.

We were able to show, also, from this statistical study, that there is a high degree of correlation between the red-salmon catches in Bristol Bay and in the Ikatan-King Cove-Shumagin Island district on the southern side of the end of the Alaska Peninsula. This corroborates the results of the tagging experiments conducted in 1922 and 1923, which showed that the fishery in the Ikatan-Shumagin Island district drew extensively upon the red-salmon runs of Bristol Bay. As a matter of fact, the evidence, I think, from our statistical data is even stronger than the evidence we secured as a result of tagging operations, although, of course, it is not so direct.

This analysis of the statistics of the Alaska salmon fishery is being continued and will ultimately include the whole of the territory. This winter we are working on the central district, including the fisheries from Chignik to Bering River. Throughout this study we have been compelled to make use of the total annual catch as our measure of abundance. It has proved impossible to get any more refined measure, although, as you all know, the total catch is seldom entirely satisfactory. We are attempting with fair success to segregate the data into small geographical units and with less success to determine the amount of gear used in each locality. There are many difficulties, and the records are not always as complete as we should like, but believe that they show the important fluctuations in yield and the general trends. It will take several years before the study is complete, but I am sure that when it is complete we shall have a series of data of the greatest importance, both from the biological viewpoint and for the practical administration of the fisheries.

An important phase of our investigations is the study of the oceanic migrations of the salmon. This has an important bearing on the relation between the fisheries in different localities. As an example, I refer again to the study of the salmon runs of Ikatan and Shumagin, in which we showed by tagging experiments that the runs there were really a part of the runs of Bristol Bay. It is obviously important to know the relationship between runs of this sort, because, as in the case of the ones to which I have referred, it made a good deal of difference in our attitude toward the fisheries in Bristol Bay when we realized that the resources of Bristol Bay were also being attacked by the fishery at the end of the Alaska Peninsula. From a practical standpoint, if we were going to impose restrictions on the fishery in Bristol Bay it was necessary, of course, to impose as nearly equal restrictions as we possibly could upon the fishery at the end of the Alaska Peninsula.

Our study of these migrations by means of tagging experiments has not been as extensive during the past two years as it had been during the years between 1922 and 1926, partly for the reason that most of the major problems (general problems) of distribution or migration have been well worked out during the 5 years in which we were tagging extensively throughout the territory. At the present time it seems desirable to restrict our tagging operations to specific problems, and we are only using that method of study in cases where we have something very definite that we want to find out.

In 1927 the tagging operations were conducted mainly in southeastern Alaska and were designed to supplement the results of our previous experiments there where a few finer points needed to be worked out. The report has not yet been published.

In 1928 we had a little problem out on the Alaska Peninsula at one of the minor fishing localities, where, for other reasons, we had suspected that the red salmon taken also belonged to the Ikatan-Shumagin run, and we did a small amount of work there this last year. The results were not entirely satisfactory but did show some migration to Bristol Bay, although unfortunately it was performed so late in the season that we could hardly have expected very definite results.

One of our big problems in Alaska is that of ascertaining the normal return from known spawning escapements. You realize, of course, the general habit of the salmon of returning to the streams in which they are hatched. This fact is very well established for the red salmon, the king salmon, and the silver salmon, but in regard to the other two species of salmon, the pink and the chums, our information is very little; practically we have none. We are not sure to what extent the theory applies to these two species of salmon, and the remarks that I shall have to make here refer primarily to the red salmon and to none of the other species. The red salmon, we are convinced from plenty of evidence, do follow the parent-stream theory and return to the stream in which they were hatched.

The problem in regard to the return from known escapement hinges upon the number of spawning individuals necessary to maintain the run in any given stream. This problem also was outlined at a conference two years ago. At present the requirement demanded by law is for a 50 per cent escapement, but there is no assurance that this is the most desirable way of handling the situation. It is possible that in some years 50 per cent is not enough (we are quite sure that under certain conditions it is not enough) and in other years it may be too much.

There is another scheme, however, for handling this situation and getting into the streams an adequate escapement, which is probably better than the 50 per cent requirement, although it is extremely difficult to apply except in a very few places, and that is to demand a minimum escapement of a certain amount. That is being done at two or three of the streams in Alaska where the Bureau of Fisheries maintains counting weirs. For instance, at Karluk and Chignik, both, the requirement is not less than 1,000,000 fish to escape to the spawning grounds. I think this undoubtedly would be an ideal way of handling the situation if it were possible to apply it generally, but that is entirely out of the question.

On account of the great interest that we have in this particular problem of the return from known escapement, we have selected a few particularly favorable localities, the two chief ones being Karluk and Chignik, and are making special studies there. In these two streams weirs are being maintained, and the spawning escapement is counted through, so that we know exactly how many fish escape from the commercial fishery and go up to perpetuate the race.

In addition to that, it is necessary to very carefully sample the commercial catches, taking scales and measurements, so that we may determine the percentage of fish at each age that are captured at any given season. It is necessary to make adequate sampling of the commercial catch and to examine the scales of this adequate sample so that we may know, for instance, just how many fish in 1928 came from the spawning of 1923, how many came from the spawning of 1924, and how many came from the spawning of 1922, and so on. Then, once we have those data over a period of years, it is possible to show just how many fish, we will say, came from the escapement of 1922. But because of the fact that the percentages fluctuate at different seasons it is necessary to have adequate sampling throughout the season. Every week, for example, we should have a large enough sampling so that we can determine the percentage of fish of the different age groups that were taken in the commercial fishery in that week. Thus, we have the data of the escapement and over a period of years the number of fish returning from that known escapement as 4 or 5 or 6-year-old fish as the result of our sampling and scale examinations.

At Chignik we encountered a number of difficulties, and it will require a lot of detailed work over a number of years before we shall probably be able to analyze the situation there in a way that is satisfactory and the way that we are able to do fairly well at Karluk. There are extremely difficult problems in age determination from the scales of Chignik salmon; and, furthermore, it is apparently true that there are certain fluctuations in the percentage of fish of different age groups. You may have in one week, for example, 75 per cent of 4-year fish, and in the next week you will have 75 per cent of 5-year fish and the rest of them 6-year fish.

At Karluk we do not have sudden changes in age composition of the runs. We have gradual changes that extend over the season but nothing of the sort that Mr. Holmes has found in the case of the Chignik fish. This made sampling more difficult, for to get an adequate sample we must have more fish, a big enough sample every week (theoretically we ought to have it every day) so that we could determine for that particular day how many 4 or 5 or 6 year old fish were taken in the commercial catch.

The first year in which the weir was established in the Karuk River was 1921. We got 4-year fish back in 1925 and the 5-year fish back in 1926 and 6-year fish back in 1927. There are a few 7-year fish in the Karluk run, but they are not in sufficient numbers to be of much importance. We can, for practical purposes, say that the important ages there are 4, 5, and 6 years.

In 1927 we had all of the returns from the first two years of operating of the weir—1921 and 1922. We got our 4-year fish back in 1926, 5-year fish in 1927, and 6-year fish in 1928. Now, for all practical purposes, we have two years (1921 and 1922) on which to calculate the percentage of returns from the known escapements. We have most of the returns from the 1923 escapement, but we shall have to wait until the end of the 1929 season before we shall have all of that; and from now on, every year will add just one more figure to our series of data.

It will take a long time before we have enough data to determine the trend, the sort of returns, that we can expect from a known escapement. We have been able, however, with what little we have at Karluk and from examination of the data we have at Chignik, some of which applies to this problem, to satisfy ourselves fairly well that the relationship between escapement and future run follows a regular curve, which rises very rapidly and then slopes off to the horizontal. For example, the return from about a 500,000 escapement has been approximately 2,000,000 fish, and the return from about a 1,500,000 escapement has been about 2,500,000.

Just what will happen as the escapement increases I do not know. The return will reach a maximum, perhaps, and then it is conceivable that it may come down. In other words, it is possible that there is such a thing as overstocking. That is a point that we are not sure of, and we do not like to say very much about; but there is this much to be said,—that in the case of the Chignik salmon there is some evidence of such a thing as overspawning. For instance, in 1927 there was a tremendous run of pink salmon into the Karluk River. The story is almost too much to tell you about, but a rack in the Karluk River was blocked up and washed out with the bodies of these pink salmon that came down there. Probably 4,000,000 or 5,000,000 pink salmon spawned in perhaps 15 or 20 miles of the river, and the decayed and dead bodies were sufficient to take out of the water most of the oxygen (perhaps all of it), with the result that the adult pink salmon that were perfectly normal died. They did not die from injuries or anything of that sort, but they just simply died; and also the small salmon in the river died, and little fish up the river died, and the bullheads died, and the humpbacks died. The next year the return was practically nothing; it was 15,000 or 20,000 fish, whereas in 1924 the commercial fishery took in the neighborhood of 2,000,000 salmon, and there was an escapement into the stream estimated at 4,000,000.

At Karluk we have also another interesting problem dealing with the fluctuations in the rate of mortality. The rate of mortality is, of course, one of the important factors that determines the productivity and relative abundance of a species; and at Karluk we were interested not alone in the discovery of the rate of mortality but in determining something about the fluctuations in the rate of mortality in fresh water as compared with the fluctuations in the rate of of mortality in fresh water as compared with the fluctuations in the rate of mortality in the sea. The question was whether the greatest fluctuations in mortality occur in fresh water or in the sea. If they occur in fresh water it is possible that by means of hatchery operations, or something like that, we can decrease that rate of mortality; but if the greatest fluctuations occur in the sea, it will be much more difficult, if not impossible, to control them.

In attacking this problem we have undertaken a series of marking experiments, and we have marked about 50,000 fish every year since 1926. In that year we did not quite make 50,000, but in the last two years (1927 and 1928) we marked 50,000 of them each year. In the case of the Karluk fish the young remain in fresh water, most of them, until they are in their third year. For instance, fish that are spawned in 1925 in the fall of the year will not go out to sea until the spring of 1928.

In this marking experiment we are trying to determine the number of seaward migrants. We are doing that by very careful sampling to determine the number of marked fish that are taken in the commercial catch. Then, knowing this, it is a relatively simple matter of proportion to work out the total number of marked fish in the commercial catch, and from that the total number of seaward migrants. The matter is more or less complicated by the fact that there are several age groups reported and by the fact that we have several experiments represented. For instance, next year we will get a return from the markings of 1926, 1927, and some from 1928. The whole thing is rather complicated, and it is hardly worth while to go into details at this time; but it is sufficient to say that we can, by means of our sampling methods, determine with what we think is considerable accuracy the number of seaward migrants. Of course, it is far too early to say anything about what are the fluctuations in the rate of mortality. We have fairly complete returns now from this one year from our markings of 1926, but that, of course, is not at all sufficient.

There are several interesting points in connect'on with this experiment, however. One is the fact that the actual percentage of marked fish returned has been very large, higher than anyone had ever imagined it would be. We have made extensive marking experiments on the Columbia River since the beginning of 1916, totaling for both chianook and sockeye salmon 2,000,000 since 1916. The best results we have in any of those experiments on the Columbia River indicated about a 5 per cent return. But in the case of our Karluk salmon, in which we marked the fish that were in their third year (that is, two years plus of age), our returns already are approximately 25 per cent; and after we get our 6-year returns next year I feel quite confident that the returns of marked fish will be in the neighborhood of 30 per cent, or perhaps a little over. That means that one out of every three of the fish we have marked is coming back; one out of every three of the seaward migrants is going to survive and come back as an adult fish ready to spawn. That is unexpected in the case of salmon, and I do not know of any evidence of survival as big as that in any of our fishery investigations.

In 1926 we split our experiment into two parts in order to get some sort of empirical measure of the probable error that was involved. We marked that year approximately 47,000 fish. Twenty-five thousand were marked by the removal of the right ventral fin; 22,000 by the removal of the left ventral fin. This last season we found that our percentage of return in the two halves of that experiment was very close. They were, I think, within about one-half of 1 per cent of one another, affording good evidence that our method of handling of the seaward migrants and our method of sampling the commercial catch for marked fish is adequate.

I do not want to leave the discussion of the fishery investigations of the Pacific coast without first paying such poor tribute as I can to the man who, more than anyone else, is responsible for our gathering here to-day. The sudden and untimely death of Dr. Charles Henry Gilbert has taken from us a real leader; one from whom many of us, either directly or otherwise, received inspiration for research and interest in fishery investigations. It was he who, in 1909, first saw, with characteristic clear-sightedness, the possibility of developing a new branch of ichthyology, and who first brought his remarkable abilities and tireless energy to bear upon the great scientific and practical problems of our fisheries. It can truly be said that he was the founder of modern fisheries science in America.

His own published contributions to this new science were many, but the full measure of what he did can, perhaps, only be appreciated by those of us who were privileged to work closely with him and so to know his great influence and the great aid he gave to the younger men with whom he came in contact. His method of working was always direct; he was concerned primarily with the discovery of facts and not with the development of theories, and his keen, analytical mind was always seeking to select the important from the unimportant, the pertinent from the irrelevant. He realized more clearly than most that his and our observations and studies were only the beginning of a science, and he would not permit himself to publish speculations as to the ultimate causes behind the observed facts. What we need, he thought, is more facts and still more facts; then, in time, out of an abundance of facts, it may be possible to build theories that will explain; but until we have abundant facts he, at least, would not theorize. Some of us shall always regret this, athough it was so fundamental a trait with Doctor Gilbert and one so intimately associated with his analytical faculties; but we know that he thought deeply upon the fundamental principles of the biology of the fisheries and, had he permitted himself expression, his ideas would undoubtedly have been most stimulating. It is left to us to carry on the work that he started, and I, for one, hope that I may be able to carry my small share of the burden in a way that would deserve his approval were he here to give it.

PROGRESS OF FISHERY BIOLOGY ON THE GREAT LAKES

DR. JOHN VAN OOSTEN, *In charge, Great Lakes fishery investigations*

Under the subject "Progress of fishery biology on the Great Lakes" I have been asked to review with you the progress of the entire science in the Great Lakes area, whether the result of bureau investigations or of investigations conducted by private institutions. It is, of course, utterly impossible for me to review all the work that may properly be included in the category "Fishery biology on the Great Lakes." This would involve a consideration of at least 85 scientific papers that deal specifically with the fishes of the Great Lakes proper, of some dozen papers on the parasites of Great Lakes fishes, and at least 60 scientific publications on the food of the fish, on the plankton, and on other subjects that may properly be included under the limnology of the Great Lakes. I must, likewise, ignore the surveys on depths, etc., conducted by the War or Navy Departments of this country and of Canada, and the expeditions of local character or of very limited scope, as, for example, the Shiras expedition to Whitefish Point, Lake Superior.

Time permits only a passing mention of the numerous statistical surveys conducted by the national and local governments of both Canada and the United States. These statistical surveys, 10 of which were conducted by the United States Government, are of immense value to the fisheries. The earlier statistical reports of the United States Fish Commission included, in addition to purely statistical material, valuable information on the history of events that influenced the development of fishing in each important locality on the Great Lakes, on the location of fishing grounds, on the natural history of the more valuable market species, and on methods for the improvement of the fisheries.

We shall confine our review, then, to the more important general surveys that come within the scope of fishery biology and shall consider only those surveys that were conducted on the Great Lakes proper, its connecting waterways, and Lake Nipigon. It seems best to review the subject under three headings—(1) limnological surveys, (2) fishery surveys, and (3) fishery regulations.

Limnological surveys.—Limnological investigations in this country have been restricted almost entirely to small inland lakes, while the Great Lakes have received very little attention. Probably the first paper that deals with the general environmental conditions of the Great Lakes is that of Agassiz (1850) on the physical character, vegetation, and animals of Lake Superior. It was not until 1893 that the first real limnological investigations began on the Great Lakes, and it is interesting to note that economic pressure gave the impetus to this first limnological study. Reighard, in the introduction to his report on "A biological examination of Lake St. Clair" (1895), called attention to the marked decrease in the catches of whitefish in the Great Lakes. This condition continued in spite of the large output of the fish hatcheries, and it was with the hope of determining where in the Great Lakes were to be found the conditions favorable to the whitefish fry that the Michigan Fish Commission established a scientific laboratory on Lake St. Clair in the summer of 1893. The staff of eight men undertook an extensive study of the fauna and flora of the lake and also a study of the food habits of the fish.

Perhaps the greatest significance of their study is that it was the first attempt by American biologists to use methods worked out by Europeans for the determination of plankton productivity of a lake. It also resulted in a great increase in the knowledge of the natural history of our fresh-water flora and fauna. The facts learned were made use of in recommendations for the better planting of whitefish fry in Lake St. Clair.

A year later, 1894, a more detailed study was made of Grand Traverse Bay in Lake Michigan under the direction of Dr. Henry B. Ward. Particular attention was paid to the kind, source, and abundance of food for the whitefish. The investigation showed, in the words of Ward, that "there is a plentiful supply of whitefish food on the fishing grounds. No reason can be assigned for the diminution in the supply of whitefish save overcatching." In closing his report, Doctor Ward emphasized the necessity of having the continued services of full-time investigators to insure the collection and publication of reliable data. It is needless to add that this suggestion fell on deaf ears.

The next survey of interest to us dealt with the pollution of boundary waters and was conducted during the years 1912–1914 under the auspices of an international joint commission. This survey attempted to determine "to what extent and by what causes and in what localities have the boundary waters between the United States and Canada been polluted so as to be injurious to the public health and unfit for domestic or other uses." According to the United States Tariff Commission's report on lake fish (1918), some 19,000 bacteriological tests were made, and these indicated that "although the great body of lake water itself is for the most part remarkably pure, in certain portions of the Great Lakes and in all the connecting waterways serious pollution was shown to exist" (p. 8). The western end of Lake Erie, west of a line drawn from Point Pelee to Sandusky, was most noticeably affected. This area comprises the most extensive spawning grounds of fish in Lake Erie. It must be explained, however that the studies of this commission were made primarily with the view of defining the water areas unsafe for domestic use and not with the view of locating the areas unsuitable for fish life.

Since 1921 the Ontario fisheries research laboratory of the department of biology, University of Toronto, has made extensive studies on the fishes, the hydrography, the plankton, and bottom organisms of Lake Nipigon. Particular attention was given to the productivity of the lake in fish food, both planktonic and benthonic.

Previous to 1926, then, only three limno-biological investigations were carried on in the waters of the Great Lakes proper or its connecting waterways and Lake Nipigon. There have, however, been numerous important contributions made to our knowledge of the productivity of the Great Lakes. Among these may be mentioned the work of Vorce (1880, 1881, 1882), Forbes (1882, 1891), Thomas and Chase (1887), Turner (1892), Woolman (Report of the United States Commissioner of Fisheries for 1897 and 1898), Snow (1904), and Eddy (1927) on the plankton, and the extensive studies on the flora and fauna of Georgian Bay by various investigators from the Georgian Bay biological station of the Biological Board of Canada. Special mention should be made of the reports on the different forms of nitrogen found in the water of Lake Michigan by Domogalla and his associates (1925, 1926). In addition to these studies, more than two dozen publications that deal with certain phases of the limnology of Lake Erie or the ecology of its fauna have appeared from the Lake laboratory and its successor, the Stone laboratory, established by the Ohio State University on Lake Erie.

The most recent series of limnological surveys on the Great Lakes had its inception on Lake Erie in 1926, when "during the month of August the division of fish and game of the State of Ohio undertook to learn how far out from the lake-shore cities sewage pollution may occur in sufficient quantity to affect the life of fishes, either directly or by injuriously modifying feeding or breeding conditions. The evident reduction of the commercial fishing and angling * * * in recent years, * * * the dispute as to whether netting or pollution is the chief factor involved, made such a survey appear an urgent necessity." (Osburn, 1926.) A scientific staff of five was maintained. From the preliminary study of the bottom samples, plankton tows, bacteria, dissolved oxygen, hydrogen-ion concentration, and temperature it was concluded that pollution serious enough to menace fish life was confined to the sewer outlets from cities and to the rivers, the inclosed bays or harbors, and their immediate environs, into which this sewage was dumped. "There was no serious contamination of the open lake in deeper water. or very far from sources of pollution in shallower waters along shore." (Osburn, 1926.)

In cooperation with the United States Bureau of Fisheries, the State of Ohio resumed its limnological investigations of the western end of Lake Erie in the summer of 1927, employing two permanent investigators.

It was not until February, 1928, however, that the most complete and the most extensive limnological survey ever undertaken on the Great Lakes System had its inception, when, at a conference called by the United States Commissioner of Fisheries at Cleveland, Ohio, the various biologists working independently or as members of the staffs of research institutions and universities on Lake Erie formed the Cooperative Fishery Investigations in Lake Erie. In accordance with the plans discussed at this conference the survey was carried on by two parties, one at the western and the other at the eastern end of the lake. The work at the western end of the lake was carried on under the auspices of the State of Ohio division of fish and game, with a staff of 5 men stationed at Put in Bay. A staff of 13 men, under the joint auspices of the Province of Ontario, the Buffalo Society of Natural Sciences, the New York Conservation Commission, the health department of the city of Buffalo, and the United States Bureau of Fisheries, covered the eastern end of the lake.

While the two parties worked independently of each other, both attacked the problem with the same objective in view—to learn the physical, chemical, and biological conditions that exist in the lake, with particular reference to their bearing on young fish.

Under the head of physical conditions is considered topography, morphometry, bottom deposits, waves, currents, transparency, and temperatures. These factors are quite different at the two ends of the lake and affect, in important ways, both the chemical and biological conditions. They also necessitated the use of different equipment and methods by the two parties.

One of the main points of contention with regard to the depletion of the Lake Erie fisheries has been the relative importance of pollution and overfishing. As a result, considerable attention was paid to the kinds, extent, and effects of pollution. The investigation showed that there were localized areas where trade and domestic wastes caused considerable contamination of the waters, but in no case did this extend far from the source. This was indicated by chemical and bacteriological tests and by examination of bottom deposits for putrescent organic matter.

Determinations of dissolved oxygen, of free, fixed, and half-bound carbon dioxide, free and albuminoid ammonia, nitrates, and of hydrogen-ion concentrations were made at numerous stations. With the exception of the polluted areas the lake was found to have no chemical conditions considered detrimental to the normal existence of organisms.

A study of the plankton showed an abundance of both plants and animals, which form the ultimate source of food for fishes. Certain plankton collections were made with meter nets, and these were also used for taking young fish, in addition to the trawls used on and near the bottom. In all, several thousand fish fry and fingerlings were collected. Seine hauls were made on the New York and Ohio shores to determine the abundance of the various species of fish in the various kinds of habitats.

In general, the results of these investigations show nothing in the physical, chemical, and biological conditions of Lake Erie to explain the present depleted state of the commercial fisheries.

At the second conference of the Lake Erie investigators called by the United States Comissioner of Fisheries at Columbus, Ohio, on February 3, 1928, it was planned to continue the limnological work in 1929 and to extend it in order to obtain more complete data for the entire lake.

Fishery surveys.—The surveys devoted specifically to the fisheries of the Great Lakes have been numerous; eight of these, excluding the statistical, have been of sufficiently broad scope to warrant consideration here.

The first general survey of the Great Lakes fisheries was made in 1871 and 1872 by James W. Milner, assistant commissioner of the United States Commission of Fish and Fisheries, who visited many fishing localities, gathered testimony of the fishermen as to the condition of the fisheries, its comparison with former years, the kinds of nets in use and their effect on the numbers of the fish, and the opinion of the net owners on the influence of protective legislation. He also acquired information on the modes of fishing, the species captured, some knowledge of their habits, and the general distribution of invertebrate forms in certain areas of the lakes.

Milner's discussion on the causes of decreases of the food fishes is highly illuminating in view of our present investigations of depletion. He believes that overfishing is a secondary factor, but that the capture of immature fishes is, without doubt, the principal cause of decrease. He discusses the various causes cited by the fishermen, such as the destruction of small fish by pound nets, the wasteful method of fishing by gill nets, the dumping of offal on fishing grounds, and pollution—causes still cited by the fishermen of to-day.

Milner's discussion of proposed protective legislation likewise could be bodily incorporated in a 1928 report with slight modifications. For example, whereas we are discussing at the present time the desirability of abolishing the trap nets, Milner did likewise with respect to the pound nets. We are discussing the merits and demerits of the sorting process; so did Milner. We shall recommend a larger mesh for crib nets; Milner did likewise. We can recommend, with Milner, that no gill net mesh of less than 4½ inches should be used for whitefish. Again, we believe, with Milner, that "a law restricting the number of pound nets to the mile along the shores of the lakes would be a favorable regulation."

I have stressed Milner's admirable report of 1874 to impress you with the fact that even some of the simplest problems that confronted the fishing industry more than 50 years ago have been allowed to pass unsolved and still face the fishing industry to-day. Milner expressed little confidence in the adequacy of protective legislation but believed that artificial propagation is the only certain salvation of the fisheries. The author's notes on the natural history of the important commercial fishes are unusually complete, certain data, as, for example, those on growth rates, being even now the best available.

The most extensive and most complete survey of the Great Lakes fisheries was that conducted in 1893–1896 by Rathbun and Wakeham, appointed as a joint commission by Great Britain and the United States to study the fisheries in waters contiguous to both countries and to consider and report on the regulations, practices, and restrictions proper to be adopted in concert on the (1) limitation or prevention of exhaustive or destructive methods of taking fish, (2) the prevention of pollution or the obstructing of waters to the detriment of the fisheries, (3) the adoption of uniform close seasons, and (4) the adoption of practical methods of restocking and replenishing the waters with fish.

In their excellent report the authors discuss, for each body of water, the statistics, history of the fishing methods, and extent and causes of decrease, and present excellent notes on the distribution, movements, size, and spawning of the important market species in each lake.

Another refreshing feature of this report is the very specific recommendations given for each lake. In many reports recommendations are stated in such general terms that the investigations carried on to arrive at them hardly seem to have been warranted. The specific recommendations proposed by this commission, though excellent conservation measures, were highly restrictive and consequently were not and some have never been adopted by the States. Two of the four general recommendations are highly interesting in view of the present widespread discussions on the Great Lakes concerning the administration of the fisheries and uniform laws. The authors write:

Our observations, moreover, have clearly demonstrated the inexpediency of attempting to regulate the fisheries herein discussed by a rigid code of enactments, owing to their constantly changing character and conditions, and we would therefore urge, in the event of joint action by the two Governments, that a permanent joint commission, to be composed of competent experts, be provided for, which shall be charged with the direct supervision of these fisheries and shall be empowered to conduct the necessary investigations and to institute such modifications in the regulations as the circumstances may call for from time to time.

That a uniform system of regulations common to the entire extent of each body of water along the boundary line is required to insure the protection of its resources is fully shown by the conditions which we have found to exist in nearly all of them, whether bordered on the side of the United States by a single State or by several States. The failure to secure adequate results in that direction has naturally been due to the diversity of legislation, but it has resulted in large part from the general lack of accurate information regarding the habits of the several fishes to serve as a basis for intelligent action. While we have been able to establish some important facts respecting the natural history of the commoner market species, much more remains to be accomplished in that regard, and the subject should be given due prominence in the future.

The next Great Lakes survey of interest to us is that conducted by the International Fisheries Commission in 1908 under the direction of Doctor Jordan. This survey was instituted primarily to acquire data for the preparation of a code of international fishery statutes to supplant those of the Canadian Provinces and of the various States. I have been informed that many data on the Great Lakes fisheries have been accumulated by this commission, but that no report on these has appeared in print. The attempt to place the Great Lakes fishery under national or international control again failed.

The survey conducted by the Biological Board of Canada on Lake Erie during 1920 dealt primarily with specific fisheries problems concerning principally the variations in the sizes of the ciscoes in the various sections of the lake. However, as the result of this survey several preliminary papers appeared on the growth of the more valuable market fish, including the ciscoes, whitefish, blue and yellow pike, and the perch.

In 1925 the United States Tariff Commission ordered a survey of the Great Lakes fisheries with a view of acquiring "factual data that may be useful in constructing a tariff schedule for fresh-water fish." Very valuable and new information was gathered on the status and cost of production of the various market fish by various kinds of gear in both Canada and the United States. The production of 1924 served as a basis for discussion. Detailed data are given on the methods and cost of fishing, of boxing and icing fish, of freezing, salting, smoking, filleting, and storing fish, and of transporting fish.

Dr. Walter Koelz (1926) summarizes the most recent knowledge on the fishing conditions of the Great Lakes, or, as he states the purpose of his paper (Bureau of Fisheries, Document No. 1001, p. 554), "to picture, with a historical background, the condition of the fisheries of the Great Lakes as they are today and to call attention to the need of intelligent action to preserve those fisheries." This author has had many years of experience on the Great Lakes, and in view of all this experience it is interesting to note that he finds the Great Lakes situation so complicated that it is impossible for him to state specifically how the production of the Great Lakes fish should be regulated. He writes (p. 613): "What form such legislation should take the writer can not say." Permit me to quote from his paper the last group of recommendations for the Great Lakes fisheries that have appeared in print and that have been based on extensive observations:

1. The needs of the Great Lakes fisheries should be studied, and in the light of the knowledge gained regulations having for their object the conserving of the fisheries should be created. We already have data to show that no single law can be devised to meet the

varying conditions presented by one lake, to say nothing of applying one law to several of the lakes. The application of any laws found advisable must be independent of political boundaries. The present division of authority over the fisheries among several States impedes the enactment and complicates the administration of any legislative provisions, and it is therefore urgently recommended that some definite and responsible organization, international in character, be provided through which a coordinated control of the fisheries may be secured.

2. The closed season to protect spawning fish should be restored wherever practicable, and no spawn should be collected if investigations and experiments fail to establish the desirability and effectiveness of propagation.

3. Investigations to determine the life histories of the important species already begun should be continued; and statistics reflecting the condition of the fisheries should be collected from year to year to supplement these studies. Only by means of such statistics interpreted in the light of life-history facts, can the fishing industry be intelligently controlled.

At the present time a general survey of the fisheries is being conducted on Lake Ontario by the Ontario fisheries research laboratory of the department of biology, University of Toronto, especial emphasis being given to the natural history of the coregonids.

The bureau's Great Lakes program is confined largely to an exhaustive study of the fisheries of Lake Erie After concluding a preliminary survey of the Great Lakes fisheries in 1927, it was realized that although there was urgent need for an investigation on Lakes Michigan and Huron, by far the greatest need existed on Lake Erie, where the cisco, one of the most valuable species of the Great Lakes, is facing commercial extinction. Our Erie survey began in August, 1927, with a staff of three men. In 1928 our personnel was enlarged to five scientific investigators and two assistants in the office—a staff of seven.

In our investigation we started out with a firm determination to ascertain just why, in the face of serious depletion of so many species of fish and the virtual extinction of the ciscoes in Lake Erie, it has been impossible to adopt a few of the excellent recommendations that have been discussed repeatedly in past years. I believe that in this respect our scientific investigation differs from most of the previous scientific surveys. We have attempted from the beginning to ascertain from the fishermen what, in their opinions, were the urgent problems to be solved first, and have shaped our program in part in accordance with their suggestions. We are convinced that it is absolutely essential to consider in our program the views and requests of the practical fishermen, for we believe that it is primarily the dissension among the fishermen that has blocked the passage of many excellent regulatory measures on the Great Lakes. We are convinced that under existing conditions our only hope of securing proper regulations for the fisheries of the Great Lakes lies in an impartial investigation of all the questions of dispute, irrespective of whether or not they have scientific value or fundamental significance.

It is for these reasons that much of our work at the present time deals with experimental fishing gear. The fishermen ascribe the depletion of the fisheries in part to the destructiveness of the various kinds of gear. Our first tasks, then, have been to ascertain the destructiveness of the commercial gill net, the bull net, the trap net, the pound net, and the seine to the various species of fish, at various seasons of the year and in various areas of the lake. In addition, we fished a series of experimental trap nets and gill nets of various sized mesh throughout an entire year in order to determine whether it is possible to fish the present types of gear with less destruction to the immature fish than occurs at the present time. We have not been entirely unmindful, however, of the scientific call within us. We realize that among other things the aim of fishery science is the detection and prevention of overfishing and the detection and prediction of fluctuations in abundance due to natural causes.

The fisheries of the Great Lakes differ in many respects from those of marine waters. They are confined to smaller bodies of water, and the detection of depletion is much more readily accomplished in these waters than in the oceans. Thus, without any critical or exact statistics such as are required for the detection of overfishing in the seas, we can assert positively that the sturgeon of all the Great Lakes, the bluefin of Lake Superior, the blackfin of Lake Michigan, the bloater of Lake Ontario, and more recently the cisco of Lake Erie are virtually commercially extinct. In so far as these fisheries are concerned we need not hesitate to recommend complete protection, although in certain cases it will be difficult of execution.

We believe that the problem of the nature of overfishing is one of the most important on the Great Lakes and that its solution is impossible without adequate statistics. I have stated repeatedly to the fishermen and to conservation officers that adequate statistics is the most important single tool in the hands of a fishery investigator. Without it we can not ascertain the exact condition nor the real trend of a fishery; we can not detect nor follow nor explain the fluctuations in the actual abundance of the fish in the lake; we can not hope to foretell any great fluctuations in future yields nor have any means of checking the effectiveness of any new restrictive regulations that may be imposed on the commercial fisheries of a lake.

We have labored constantly to induce the States that border the Great Lakes to inaugurate a new system of collecting fishery statistics, whereby the biologist shall be enabled to compute the yields per unit of gear or effort and per unit of time. It is gratifying to announce that the new system has been established already in Michigan, New York, Pennsylvania, and Illinois. It is confidently expected that the other States and the Province of Ontario will follow their example.

The problem of fluctuations in natural supply due to natural causes is being attacked by the usual methods familiar to most of you—the analysis of the catch by year-classes, the determination of age and growth rates, the study of migrations, and the study of races. Efforts were made to collect all possible data on the biology and habits of the important commercial species, nine in number.

Fishery regulations.—On the basis of our studies we hope to be able to draw up specific regulations for the Lake Erie fisheries. We believe that these recommendations should not only be made with a view of conserving the fisheries but should be practical, enforceable, and reasonable. Without the latter qualifications they can not pass the legislatures, nor would they prove of any value. These latter qualifications make our task most arduous, for the human element must be considered. Our hope of success lies principally in bringing together the various factions among the fishermen and in cooperating closely with the departments of conservation in the various States.

This cooperation is likewise essential in our efforts to obtain certain uniform regulations, not only for Lake Erie but for each of the Great Lakes. Strenuous efforts have been made during the past two years to have the States and the Canadian Government accept a uniform code of statutes. At a conference called by Gov. Vic Donahey, of Ohio, at Columbus, Ohio, on February 16, 1927, to which were invited representatives from all the governments that border on Lake Erie and from the United States Bureau of Fisheries, there was formed the Lake Erie International Conservation Council, and resolutions were adopted. So far as I know this council and its resolutions died at birth. The International Fisheries Conservation Council of the Great Lakes, called into existence on March 3, 1927, at Lansing, Mich., by Gov. Fred W. Green, of Michigan, fared considerably better. This council met twice after its formation—on February 8, 1928, and again on December 5, 1928. Recommendations were adopted, but whether they will be enacted into laws by the various legislatures that meet this winter remains to be seen. We can at least point to one important concrete result of these conferences—the inauguration of the new system of collecting statistics in New York, Pennsylvania, and Illinois.

With respect to agreement on uniform fishery laws on the Great Lakes, I feel that history will repeat itself. Permit me to review briefly some of the attempts made to establish uniform fishery regulations on the Great Lakes.

As early as 1879, Jerome, of the Michigan fish department, recommended Federal control of the commercial fisheries of the Great Lakes. Since this time the question of uniform fishery laws has been discussed repeatedly, and several conferences have been called to secure action. In his report of 1890 J. W. Collins, of the United States Fish Commission, called attention to the need for uniform laws on the Great Lakes. His statements, which are to the point and apply with equal force to-day, are as follows (p. 17):

> The marked diversity in the laws regulating the fisheries of the States bordering on the Great Lakes is a matter which appears to deserve consideration. The desirability of having some cooperative action on the part of the various lake States would seem to be apparent, in order that legislative enactments might have an equal bearing and influence upon the fisheries and the fortunes of the fishermen. Much dissatisfaction is often expressed by the latter concerning the inequality of laws governing the fisheries in regions immediately adjacent. It is only natural that the fisherman who finds his work interrupted and his enterprise defeated by restrictive measures should feel discontented when he sees his neighbor just across the State line prosecuting a similar fishery without hindrance. It is also, perhaps, an open question if any permanent benefit can be obtained by the enforcement of prohibitory measures by one State when license is given to fishermen of neighboring States bordering upon the same lake to prosecute their calling without interference.

It is not the purpose of the writer to criticize special restrictions which have been put upon certain methods of fishing, but the object is more to call attention to the seeming inconsistency of attempting to control the fisheriels of a lake by measures so widely at variance as those that are known to exist in the legislation of the different States that are interested in the lake fisheries.

This was written in 1890. Probably the first "International Fish and Game Conference" organized on the Great Lakes to discuss the advisability of procuring uniformity of fish laws was called at New York on October 12, 1891, by Dr. G. A. MacCallum, fish commissioner of Ontario, Canada. Dr. H. M. Smith represented the United States Fish Commission. This conference appointed a committee, which met at Rochester on November 10, 1891. This international conference met again at Hamilton, Ontario, on December 9, 1891, and at the third and last meeting, held at Detroit on December 21 and 22, 1892, adopted a series of resolutions that prohibited the destruction of small fish, provided for closed areas, closed seasons, and size limits.

Another attempt to establish uniform laws was made at a conference held at Chicago in April, 1904. The Hon. C. D. Joslyn writes of this conference as follows:

The result of the meeting was that we did agree upon several recommendations to be made to the respective legislatures of the States represented. But the sad sequel of it all is that not two of the legislatures agreed to nor followed these recommendations. Some States followed some part of them, other States followed some other part, but there was no uniformity and no unanimity. So that we are just where we started—nothing accomplished.

Discussing the question of uniform laws, Mr. Joslyn concludes:

In the circumstances, then, nothing like uniformity can be attained. Still, if the fish of our Great Lakes are not to be entirely destroyed, if they are to be propagated, planted, and protected in these waters so as to produce the best or even beneficial results, it must be done in a uniform manner, under uniform laws, uniformly enforced. It is too plain for argument that this uniformity can only be brought about on our side of the Lakes by our National Government. So forcibly have these things come home to us who live on the Lakes that at the meeting in Chicago, which I have mentioned, it seemed to be the unanimous opinion of those present that the entire matter of propagating, planting, and protecting fish in our inland seas should be put in the hands of the Federal Government. This is certainly and surely the only means of saving the food fishes which naturally thrive in them for those who are to come after us.

I may say that as a result of the Chicago meeting the States of Minnesota and Wisconsin alone lived up to their agreement to pass resolutions ceding their control of the commercial fishery of the Great Lakes to the National Government.

A large portion of the meeting of the American Fisheries Society held at Erie, Pa., July 23–25, 1907, was devoted to a discussion of Federal supervision of commercial fisheries, and several resolutions were passed. So great was the determination at this time to succeed that in several instances bills ceding State rights to the National Government were drawn and actually submitted to the legislatures for enactment, but as usual without avail.

Since 1907 many papers and discussions have been devoted to the subject of uniform laws and Federal control, that finally culminated in another series of international conferences—those referred to above and those held at Columbus, Ohio, and at Lansing, Mich. These efforts to reach agreement on fisheries legislation, in which the bureau always took a very active part, are commendable, but in view of the history of past efforts I hope I may be pardoned for my pessimistic outlook as to their success.

In conclusion permit me to enumerate the salient features of the progress on the Great Lakes during the past two years in which the bureau took an active part:

1. The unification and coordination of the various scientific agencies interested in the study of the limnology of Lake Erie, which led to the most extensive and most complete limnological survey ever undertaken on the Great Lakes.

2. The inauguration of a new system of collecting fishery statistics adequate for use by biologists in studies of depletion.

3. The establishment of a closer contact with fishermen's organizations and State officials than has existed in the past. Instead of simply drawing up a set of general regulations for the Great Lakes and dumping this on the unsuspecting public to have it take its own course, an attempt is being made to bring the various factions together to recommend specific and uniform laws for each lake. We have, for instance, taken a very important part in the codification of the commercial fishing laws of Michigan.

4. The bureau has advanced materially the cause of uniform regulations on the Great Lakes by conducting the international conferences and by drawing up the program and most of the proposed regulations.

5. The bureau has inaugurated a series of studies on the fisheries, entirely new for the Great Lakes: (*a*) A study of effect of gear on the fish population; (*b*) a study of fish populations rather than of individual species; (*c*) a study of fluctuations in the fisheries; and (*d*) a study of the unknown or partly known life histories of nine important market species.

6. Last, but not least, the bureau's Great Lakes scientific staff has grown from two individuals to seven, and its funds have been substantially increased. I believe the bureau may well point with pride to its achievements and progress on the Great Lakes during the past two years.

INVESTIGATION OF WISCONSIN LAKES

Prof. Chancey Juday, *University of Wisconsin*

It gives me great pleasure to have this opportunity of expressing our great appreciation of the kindly and helpful cooperation that we have had from the Bureau of Fisheries for more than 20 years. The assistance that we have received during this time has enabled us to accomplish much more than we otherwise should have been able to do. Thus, the bureau deserves a fair share of credit for whatever success we have attained in our lake investigations.

For convenience of discussion, the Wisconsin lake studies may be separated into three fairly definite periods. The first period includes the work done on the dissolved gases of our lakes between the years 1905 and 1910. This investigation dealt chiefly with quantitative studies of dissolved oxygen and carbon dioxide and their relations to the various biological processes which take place in lakes. This field of research has become so well known in recent years that further discussion of our work need not be given here.

The second period extended from 1911 to 1917. During this interval quantitative and chemical studies of the plankton of the lakes situated in the vicinity of Madison were made. From 1911 to 1914, inclusive, these studies were limited to the net plankton. Various tests showed that large amounts of material were lost through the meshes of the nets, and a method for the recovery of this lost material was finally developed and used from 1915 to 1917. It was found that about 98 per cent of the organisms that were lost through the meshes of the net could be recovered by means of a powerful centrifuge. A machine intended for clarifying oils and varnishes was used for this purpose, and tests showed that it was not only able to remove practically all of the larger organisms, but also from 40 to 75 per cent of the bacteria.

In order to obtain enough material for chemical analyses it was necessary to filter considerable quantities of water (from 3,000 to 15,000 liters, depending upon the size of the crop) in order to obtain enough net plankton. Smaller amounts of water were used for the centrifuge catches—from 1,000 to 2,000 liters.

Most of the observations were made on Lake Mendota, but for purposes of comparison Lakes Monona and Waubesa were included in the investigation. On Lake Mendota catches were made once or twice a week during the open season and about once a month during the winter, so that the observations are numerous enough to give a good picture of the variations in the plankton crop throughout the year. The observations on the other two lakes were made at much less frequent intervals.

One can not determine the annual production of plankton material, because plankton production continues through the year. There is no definite harvest season as on land, so that one has to be content with ascertaining what we have called the "standing crop."

The average standing crop of total plankton in Lake Mendota yielded 214 pounds of dry organic matter per acre, while the live weight of this would be approximately ten times as much, or a little over 1 ton per acre. While it is impossible to estimate the annual turnover in this stock of plankton, it may be pointed out that such large organisms as Daphnias will produce an average of two broods per month from May to September, or ten broods during this time. Most of the other plankton constituents will reproduce much faster, but a tenfold overturn during the year would mean an annual production of 1 ton of dry organic matter per acre in Lake Mendota, or 10 tons of living organic matter per acre.

Observations have been made on lakes ranging in depth from 35 feet to 225 feet, and the total yield of plankton per unit of surface was found to be substantially the same. This seems to show that the production of plankton is independent of the depth within these limits; in other words, it seems to be a function of the area and not of the depth.

The chemical analysis showed that plankton is a very nutritious material, since 44.5 per cent of the dry organic matter consisted of crude protein and 7.5 per cent of fat; that is, these two food substances made up 52 per cent of the dry organic matter.

Plankton is made up of food (phytoplankton) and feeders (zooplankton). Rough determinations showed that the phytoplankton weighed from 12 to 18 times as much as the zooplankton, which ought to insure a sufficient supply of food material for the latter. In spite of the excess of food material, however, it requires a good deal of work on the part of the feeders to obtain a sufficient amount of food. A Daphnia, for example, must strain about 13 cc. of water to obtain her own weight of organic matter from the plankton, which means that she must extract all of the food from 60,000 times her own weight of water in order to secure her own weight of food.

The zooplankton forms constitute the chief connecting links between the phytoplankton and the fish population. While some of the small fish feed directly upon the algae, the great majority take their plankton food in the form of animals that feed more or less extensively upon the phytoplankton.

In addition to the plankton crop, a quantitative survey of the large aquatic plants has been made in two of our lakes, namely, Mendota and Green. In Mendota these large plants extend down to a depth of 23 feet, and over this area the yield averages a little more than 1 ton of dry material per acre. About 75 per cent of the dry weight of these plants consists of organic matter, or approximately 1,500 pounds per acre. The plant zone covers a little less than one-third of the total area of the lake, so that these large aquatics furnish annually about 350 pounds of dry organic matter to the lake as a whole. This quantity is less than twice as large as the average standing crop of plankton—namely, 214 pounds per acre. Since the plankton has an annual turnover estimated at 10 times or more, its contribution of organic matter to the lake will be much greater than that of the large aquatics. The large aquatics also yield a much smaller percentage of crude protein than the plankton.

In Green Lake the yield of large aquatics was only 1,600 pounds per acre in the 0–27 foot zone, or about 300 pounds of organic matter per acre when the area of the entire lake is taken into account.

The bottom fauna is another important source of food for fish, and quantitative studies of this population have been made on both Mendota and Green Lakes. On the basis of dry weight, the 0–1 m. zone in Green Lake yielded only 8 pounds per acre, dry weight, while the 20–40 m. zone gave 30 pounds and the entire lake bottom an average of 20 pounds per acre.

Mendota yielded an average of 53 pounds of dry material in its bottom organisms per acre, or a little more than two and a half times as much as Green Lake.

Alm has given some results that show the relation between the production of bottom animals and the production of fish in a number of lakes in Sweden. The yield of bottom animals in these lakes ranges from a minimum of about 1 pound per acre to a maximum of 215 pounds per acre, while the fish production in these same lakes ranges from about 1 pound to 100 pounds per acre.

Pearse estimated that about half a million perch are caught each year in Mendota. Since most of these perch are rather small in size, their weight may be estimated at 100,000, which would mean a yield of about 10 pounds per acre. This does not include the yield of the other food fish found in the lake.

Lake Nipigon is reported as having yielded an average of 1 pound of fish per acre for a period of 4 years. The yield of Attersee in Austria is reported as a little more than 2 pounds per acre, and the Alpine lakes of Bavaria and Switzerland yield from 7 to 13 pounds of fish per acre, while the lakes of southern Italy are reported as producing from 18 to 27 pounds of fish per acre annually.

The third period extended from 1918 to the present time. The earlier years of this period were used largely for developing apparatus and methods for more extended investigations. The large centrifuge was so valuable in the plankton work that a portable one that could be operated in the field became a necessity. Accordingly our mechanician, Mr. Foerst, took up this problem and soon developed a small, continuous-acting centrifuge, which can readily be taken into the field and operated wherever an electric current is available.

As the work progressed, also, it became desirable to extend the chemical work and take into consideration the problem of the fertility of the aquatic soil. The productivity of a lake is dependent upon the fertility of the water, which constitutes the chief aquatic soil, just as the productivity of the land is dependent upon the fertility of its soil. Aquatic plants, like land plants, are dependent upon the presence in an available form of certain nutritive substances for their growth and reproduction. This is true particularly of the free-floating phytoplankton organisms. In accordance with this plan various chemical and biological studies of the lakes of southeastern Wisconsin were made between 1918 and 1924. These investigations gave a general idea of the chemical and biological conditions that obtain in lakes that possess relatively hard waters. The lakes of northeastern Wisconsin were known to have much softer waters than those of the southeastern part of the State, and a study of the northeastern group of lakes was decided upon after a preliminary survey in 1924.

A temporary laboratory was established at the State forestry headquarters on Trout Lake in 1925, and it has been maintained here each summer since then. Three new buildings were used as laboratories in the summer of 1928, and they will now be occupied solely for this purpose as long as the investigation is continued in that region. The laboratory is situated in the midst of a lake district; something over 300 lakes have been visited so far, and most of them are within 25 or 30 miles of the laboratory. Many more are within easy reach.

These northeastern lakes occupy basins in a glacial outwash plain for the most part, and they differ very greatly in character. There is a wide range in sizes and depths, and a number of them are isolated, possessing neither an inlet nor an outlet. The great majority of them are connected with streams. Most of them are situated in the Wisconsin River Basin, but some of them drain into Lake Superior and others into Lake Michigan.

We may now turn to a brief consideration of some of the chemical and biological results that have thus far been obtained. Most of the chemical work is now done on the fresh samples of waters, but it is impossible to do certain phases of this work in the field. For studies of this character samples of 2½ to 6 liters of water have been evaporated at a temperature of about 70° C. on kerosene stoves, and the residues thus obtained are used for such analyses. The amount of residue obtained in this manner ranges from about 9 mg. per liter in the softest lakes to 107 mg. per liter in the hardest one. Such small samples make it necessary to use microchemical methods for the residue determinations, and such methods have now been worked out for most of these determinations. Samples of 5 to 10 milligrams each are used for most of the analyses.

In the various field observations are included such physical items as temperature, transparency, color, and conductivity of the water, and such chemical items as hydrogen-ion concentration, free and fixed carbon dioxide, dissolved oxygen, free ammonia, nitrite, nitrate, and organic nitrogen, soluble and organic phosphorus, silicia, and chlorides. So far the biological phases of the work have included chemical and quantitative studies of the plankton and quantitative studies of the bottom fauna.

The hydrogen-ion concentration in the various bodies of water varies from pH 5.4 to pH 9.1. The highest acidity has been found in the bog-lake waters, and it is undoubtedly due in part to the presence of organic acids. The most alkaline waters have been obtained from lakes that possess a fair amount of fixed carbon dioxide in solution and where there is a relatively large crop of growing phytoplankton.

In most of these lakes carbon dioxide is present in three different forms, namely, free, half-bound, and fixed. In those that have alkaline waters, or a pH greater than 7, there is little carbon dioxide, because it has been used up by the aquatic plants in their photosynthetic processes. In general, the free carbon dioxide ranged from zero up to 4 or 5 parts per million. The algæ not only make use of the free carbon dioxide in photosynthesis, but they are also able to make use of about three-quarters of the half-bound carbon dioxide; the amount of half-bound carbon dioxide in turn is proportional to the quantity of fixed, so that the total available supply of carbon dioxide is dependent upon the amount of carbonates in solution. In the lakes having the softest water, such as Crystal, for example, there is very little available carbon dioxide, and this seems to set a limit to the production of plankton. These lakes invariably produce smaller crops of plankton than those that have harder waters, though some of the shallow soft-water lakes (those that do not exceed 10 or 15 feet in depth) are able to support large growths. This appears to be due to the fact that the waters of these lakes are kept in circulation at all depths by the wind, so that the water is freely exposed to the air, where a new supply of carbon dioxide may be obtained; and it also comes in contact with the bottom, where decomposition is actively in progress.

The quantitative studies of the various nitrogen compounds show that there is no free ammonia or nitrite nitrogen in the surface waters, or only a trace. The amount of organic nitrogen is dependent upon the quantity of plankton chiefly, and it ranges from 0.18 to 1.36 parts per million. The nitrate nitrogen ranges from 0.008 to 0.050 parts per million, or 8 to 50 milligrams per cubic meter of water. On the whole, it may be said that the supply of nitrogen is abundant enough to supply the demands of the phytoplankton.

In recent papers Atkins has suggested that phosphorus is the limiting factor in the growth of phytoplankton in fresh waters as well as in the ocean. This element is present in relatively small amounts in both fresh and salt water, so that a large growth of phytoplankton will soon exhaust the available supply in the upper water. Furthermore, when these organisms die and sink into the lower water they carry with them this supply of phosphorus, leaving the upper water in a depleted condition. This limits the further growth of the phytoplankton until the circulation of the water brings this phosphorus to the surface once more.

In a few of the northeastern lakes no soluble phosphorus has been found in the surface water at certain times in the summer, but in the vast majority of them the quantity of phosphorus remains fairly uniform throughout the summer. The usual amount of soluble phosphorus ranges from 3 to 6 milligrams per cubic meter of water. In general, therefore, these results do not tend to confirm Atkins's theory. The quantity of organic phosphorus varies from 7 to 85 milligrams per cubic meter, so that the amount is generally from two to several times as large as that of the soluble phosphorus.

A micro-chemical method is now being developed for a quantitative study of the potassium in the samples of residues that have been collected.

In addition to the various mineral substances that are dissolved in the water, there are relatively large amounts of organic matter either in solution in the water or in the form of colloidal particles, which are small enough to pass through the pores of a Berkefeld filter. The amount of this dissolved organic material varies from a minimum of about 3 milligrams to a maximum of 40 milligrams per liter of water. The largest amounts have been found in those lakes that have very high-colored waters. The color of these waters is due to peaty extractives brought in by drainage water from marshes. In general, this dissolved organic matter is six times as large as the organic matter in the plankton. In the case of the colored waters it is still larger.

It has been suggested that this dissolved organic matter may be used as a source of nutriment by aquatic organisms, even by fish, and this question is still being debated. While this material appears to be present in considerable amounts at first thought, yet it represents only 3 to 40 parts of organic matter per million parts of water, so that it constitutes a pretty dilute nutrient solution, to say the least.

As already indicated, the lakes with very soft water usually yielded the smallest amounts of plankton. The amount of dry organic matter in the surface water ranged from a minimum of 0,2 to a maximum of 7 milligrams per liter in the various lakes that have been visited so far.

A quantitative study of the bottom population of these lakes was begun during the summer of 1928, but the results have not been tabulated. The general impression gained from a casual scanning of the records leads me to think that they support a much smaller bottom population than Mendota and Green Lakes.

The diverse chemical and biological characters shown by these lakes naturally raises a question as to their effect on the fish population of these bodies of water. Just how do the variations in the quantity of plankton and of bottom organisms affect the rate of growth of the fish? Does the rate of growth in the very soft-water lakes differ from that of the same species in the lakes that have much harder waters? Are certain species of fish better adapted to certain types of these lakes than to other types? Several questions of this sort may be raised in this connection. Through the cooperation of the Bureau of Fisheries an effort is being made to answer some of these questions. During the past two years several thousand fish have been obtained from different lakes; these specimens have been measured, weighed, and samples of their scales taken for age determinations. Only a small number of these scales have been studied so far, so that no definite answer to any of the above questions has yet been obtained.

SOME FRESH-WATER SPORT-FISHERY PROBLEMS

SETH E. GORDON, *conservation director, Izaak Walton League of America*

It may seem somewhat presumptuous on my part to appear before a conference of scientists and commercial fishermen, but, as the fond parent is supposed to have said to his young heir, "this hurts me more than it does you." However, I am sure that such intermingling of interests will be good for all of us, but I do wish that our national president of the Izaak Walton League, Dr. Henry Baldwin Ward, who is favorably known to many of those present, could be here to help me ward off possible brickbats.

By way of introduction, let me warn you that I was born with a rod and line in my fingers, and as a lad of five was nicknamed after the most inveterate angler in all that section of Pennsylvania. While I have acquired some of his skill as an angler, I must confess that I did not inherit his prowess as a purveyor of choice fishing experiences. Probably, as some would have us believe, you scientists have so stunted the growth of the present-day fishes that none of my catches ever induce descriptive eloquence and fanciful tales.

Seriously speaking, however, allow me to say that I have given fresh-water angling problems considerable study from the standpoint of an angler as well as a Walton League official in an effort to help, as President-elect Hoover so well put it at one of our recent national conventions, "reduce the time between bites." In fact, I have not worried so much about the time between bites as I have about the chances for the man or boy of average means to fish at all. Our best angling, just like our hunting, I regret to say, is rapidly drifting into the hands of wealthy business and professional men of America.

I have had an unusual opportunity during the past two and a half years to learn something about the fresh-water sport-fishery problems of America. As the conservation director of the Izaak Walton League I made many personal contacts, with a few inspections here and there at 3 or 5 dollars each for nonresident angling licenses, in practically every State of the Union. I have had as a fact-finding machine over 3,000 chapters of the Izaak Walton League as well as the aid and cooperation of State and Federal officials. As a result, I feel that I know something of the wishes of the anglers as well as the needs of the fish.

The development of the country, our rapidly increasing population, shortsighted lumbering operations followed by uncontrolled forest fires, drainage of lakes and marshes, good roads and automobiles, and an appalling increase in the number of anglers have decidedly intensified the fresh-water angling problems. But industrial and municipal wastes, commonly referred to as pollution, have done more to destroy many thousands of miles of good angling streams and lakes than all other factors.

There are those who claim that lumbering and forest fires have not materially injured our fishing. Hundreds of specific examples can be cited to prove that denuded hillsides have hastened rapid run-off, thereby inducing erosion and increasing the intensity of floods, filling up the pools and eddies and destroying the sheltering places for the fish, injuring or destroying the aquatic and vegetable life in the streams, and, generally speaking, ruining streams for fishing purposes.

About 80,000,000 acres of former forest lands are now a barren waste. This, added to the 250,000,000 acres that were cleared for farm lands, has naturally made material inroads upon our natural water-storage reservoirs. During the year 1927 the United States suffered a loss of $33,000,000 from 158,000 separate forest fires, which will adversely affect every stream shed touched until a new forest floor and new growth take the place of the materials that furnished food for the flames. Fortunately the people of America, and especially the anglers, are becoming fire wise and are doing more every year to prevent and stop them.

Good forest cover stabilizes the flow of streams and thereby benefits fishing waters. I am much encouraged to find many of the old uneconomic farm lands of the East being abandoned, and especially to note the rapidity with which these lands are being reclaimed by the forest. It was a mistake ever to clear many of these thin-soil farms, and nature is merely reclaiming her own. Fishing streams will benefit thereby.

Drainage of lakes and marshes to increase tillable lands has reduced the fishing waters of America by many thousands of acres. It likewise has seriously affected stream run-off and interfered with nature's scheme of things.

There is no use discussing the good-roads phase of this problem, or the enormous increase in the number of anglers. The only sensible thing to do is to bring back natural conditions so far as possible and increase the natural production, as well as the output of our hatcheries and rearing ponds, to meet the demands.

With reference to the pollution situation as it affects the fresh-water angler, I am sorry to say that in many cases those responsible for the pollution are apathetic, and so long as public opinion does not demand clean streams and lakes we will be compelled to put up with the present unsavory situation. There is no weapon so effective as crystallized public opinion, and there is only one way to get it—by organized effort.

The Izaak Walton League, at the suggestion of the Conference on Outdoor Recreation, undertook the first nation-wide clean-streams campaign. The entire machinery of the league has been used most effectively in the development of a proper program. Other organizations have joined with us, and the progress to date is very encouraging. Unfortunately many of our coworkers imagine that conditions that have developed over a period of 50 or 100 years should be remedied almost overnight. However, as a result of our unceasing campaign we have aroused the American people on this question as they have never before been awakened, with the result that progressive municipalities everywhere are taking steps to clean up their municipal wastes. Likewise many of the large industrial groups are giving serious study to their problems, some of them having employed experts to supervise their activities in that direction.

The one dark blot on the horizon is the stubborn attitude of certain industries; namely, that they have been allowed to build their plants on certain streams, which are now so badly polluted that there is no hope of ever restoring them to their original purity or any semblance of it, so why spend any of their money trying to remove their filth from said waters? The heads of certain industries have repeatedly said that in their opinion certain rivers should forever be left as open sewers to carry away the filth of municipalities and industries. Can you imagine such shortsightedness in progressive America? Especially when we compare conditions here with the far better stream conditions that prevail in many of the older nations of the world? The Izaak Walton League takes the position that no stream or lake should ever be used permanently as a public sewer. We also take the position that industries should help themselves in the elimination of their wastes rather than expect the public to find ways and means for doing so and at the same time pay the bill.

The Walton League's clean-streams campaign has been predicated upon the need for clean streams and lakes to furnish pure waters for both industrial and domestic use and for recreational purposes, thereby safeguarding public health. We believe that if our waters are clean enough to supply these needs the fish life and other aquatic resources of our waters will likewise be safeguarded.

We have noticed that wherever the league has a chapter progress toward clean stream conditions has been much more rapid, and that where a group of chapters join hands to clean up a watershed, or all the waters within a State, still better results are obtained. We propose to keep up our fight unceasingly until the streams and lakes of America are cleansed of these wastes, which we would not think of throwing into our streets or into our neighbors' back lots. The handwriting is on the wall—the American people are demanding pure waters instead of open sewers, and they'll get them if they do their part. This conference very well realizes what this will mean to the fresh-water angler.

There are now approximately 10,000,000 anglers in America. Twenty-five years ago there were scarcely a million of them. In the meantime fishing laws and regulations, licenses, police forces, and other restrictive machinery have been built up and constantly increased, until to-day in many States a disciple of Izaak Walton needs a disciple of Blackstone constantly at his side to keep him out of the toils of the law. This probably explains why there are so many anglers in the ranks of the legal profession—their friends encourage them to go along to do double duty.

Seriously speaking, however, let me say that in most States scores of laws and regulations have been depended upon to perpetuate the fish supply, but in most instances the results hoped for have not been realized, and the only effect has been to confuse the angler who desires to obey the law. What we need in every State is simple, uniform laws, local regulations only where absolutely essential, a discontinuance of unsportsmanlike practices, and ample finances to operate the fisheries activities in a businesslike manner.

Laws alone will never save our fresh-water angling, but we must have such regulations as necessary to prevent overfishing, to stop irresponsible people from taking fish at all seasons of the year, and especially to prevent as much disturbance to the fish as possible during the spawning period. In a number of States I regret to find that the fish laws have been badly neglected. They permit the taking of bass right off the nest, but they would not think of allowing anyone to shoot a wild turkey, or quail, or ruffed grouse while hatching and rearing her young. Probably you scientists can convince the public that fish are not fit for food at that time. People abhor the idea of eating the flesh of a setting hen but keep right on catching spawning fish for both sport and food.

A good way to protect spawning fish is to set aside the general spawning period as a close season and to allow no fishing at all during that time, or by establishing fish refuges, or closing sections of streams as breeding waters. We are establishing refuges for game; why not do so for fish? This might also offer a suggestion to the commercial fishermen present.

The use of all kinds of destructive devices in inland lakes and streams where sport fishing is of prime importance should be discontinued just as quickly as possible. Many of these devices are permitted under the guise of taking food fish for home or local consumption only, whereas the privilege is in reality almost universally abused, and game fish are taken in wholesale quantities. It is hard enough to keep up the supply of fresh-water fishes to meet the demands of the hook-and-line fishermen without catering to pleas made by unreliable commercial fishermen who all too often would gut and loot the waters of every fish they can catch lest some competitor beat them to it.

In many sections this attitude has built up an almost insurmountable barrier between the anglers and the commercial fishermen, even thoug[illegible] leaders on both sides are doing their best to play fair. There [illegible] why common ground, upon which both interests can easily agree be found, but it will take careful handling to avoid still more serious clashes.

One of the species about which there has been considerable controversy is the black bass; another is the steelhead trout, and sometimes the striped bass. But is there any real reason for these misunderstandings? Quite frequently one hears the United States Bureau of Fisheries condemned because it does not take a more agressive stand against the commercial fishermen in the matter of these species. At other times the local State administration is charged with favoring the commercial fishermen, and I suppose there are times when both the United States bureau and the States are criticized by the commercial fishermen for apparently favoring the anglers. And so the battle rages.

Some of the species I have named should be given far more protection than is now given them. The black bass, for example, is worth far more as a sport fish than he can ever be as a market fish. Many of my friends say the same thing about the striped bass and the steelhead. But in view of the enormous demands upon our inland streams and lakes there is certainly no longer any excuse for permitting the sale of black bass over the market stall. They are worth their weight in gold, because any section of the country that can boast good bass fishing will reap a harvest of tourist gold far greater than the dead fish would ever bring.

The commercial fishermen yield to this opinion most stubbornly, and by so doing have made it difficult for themselves as well as for the anglers. In an effort to stop the sale of black bass, Senator Hawes, of Missouri, and the Izaak Walton League succeeded in securing the enactment of an act in 1926 to stop the sale or shipment of black bass. That law, however, is effective only in States that have laws making it illegal to take bass for commercial purposes or to offer or ship them for sale. We have succeeded in scaling down the list to eleven States, and in one of these the State's own bass may not be sold, but those shipped in by her neighbors may be sold. The league is now making a concerted effort to have these remaining 11 States stop the sale of black bass. Let me suggest to the representatives of commercial fishing interests here present that they can win thousands of friends by openly espousing such legislation. The principal offenders are Maryland, Virginia, North Carolina, Florida and Tennessee. Four of these permit commercial fishing for bass in restricted areas only, but so long as there is a legal market anywhere you may bank on it that thousands of pounds of illegally caught bass will be sold. The way to stop it is to close all the markets, then give the United States Bureau of Fisheries some funds for the enforcement of the Hawes bass law. The bureau must take a firm stand and help stop the sale of these gamy denizens of our fresh waters.

In the matter of the steelhead and the striped bass on the west coast, the commercial fishermen would do well to meet the anglers more than half way, because their problems in many instances are mutual and should be fought out together rather than to be fighting each other.

I have pointed out a few of the problems confronting the fresh-water sport fisheries, but the one I have reserved for consideration at the close of my paper is, in my opinion, at the very foundation of the entire problem—an ample staff of scientifically trained men to direct the work and plenty of funds, so that definite long-term programs may be developed. There has been entirely too much groping in the dark, and we are all highly pleased to find the leaders developing more backbone and less wishbone. You scientists here present can well be proud of your profession. You are paving the way and are elevating your work to a standard never before attained. But we need more scientifically trained men in this field. Please do not misunderstand me, as I have nothing but admiration for the dozens of successful men in the field of fish culture who never had an opportunity to secure special training to fit them for this specialized field. In their day it was not to be had, but the boys and girls of to-day can and will get this training if properly encouraged, because more of the institutions of higher learning are offering such courses every year. This augurs well for the future.

There are, however, some disturbing factors, as a recent survey of the fish-cultural work being done by the States developed some rather startling information. I obtained reports from all the States except Maine and Mississippi, and found that the 46 States reporting are operating 414 stations, of which 308 are State-owned, the balance being cooperative projects.

Five of these 46 States have no hatcheries—Arkansas, Georgia, South Carolina, Tennessee, and Virginia. I understand that at least three of these have plants under way. Thirteen of the States have 10 or more stations. California heads the list with 24, Wisconsin 21, Washington 20, New York 19, Michigan 17, Colorado, Montana, Ohio, and Oregon 14 each, Minnesota 13, Maryland 12, and Idaho and Illinois 10 each. There are 16 States with from 5 to 9 stations, among the outstanding ones being Connecticut, Massachusetts, and Pennsylvania. The total investment, exclusive of Connecticut, Missouri, New York, Washington, and West Virginia, is $9,357,000. The grand total is likely around $12,000,000. Pennsylvania heads the list with $1,505,000 invested; Colorado is next with $1,000,000; Ohio, $900,000; Michigan, $625,000; Wisconsin, $550,000; and Minnesota and California, $500,000 each. Of the 41 States with hatcheries, 37 of them spend $1,875,000 annually for operation and salaries, practically all derived from angling licenses, some of it from commercial fishermen. California, New York, Oklahoma, and Oregon failed to give definite figures in response to that question, but I am of the opinion that by adding the amount expended by these four States the total average expenditure for operation of the State hatcheries will be about $2,500,000, or probably slightly more. This, then, gives us a total investment of about $12,000,000 in property by the States and an annual operating cost of about $2,500,000.

The total output is rather difficult to compute because of the fact that quite a number of States still distribute fish in the fry stage in large quantity; but, according to the best figures I was able to compile, the annual distribution figures for 42 States are 84,000,000 trout, 24,000,000 bass, 48,000,000 pike and pickerel, 280,000,000 crappie, bream, blue gills, and perch, and 14,000,000 catfish, sunfish, and other species. Several States also report enormous quantities of commercial species which were not included in the table given.

These figures could easily be broken down to the average cost per fish as well as the average contribution by each of the 10,000,000 anglers, but in view of the large amount expended in law enforcement and various other ways to increase and perpetuate the fish supply for the angler I did not deem it wise to do so. I am sorry to say also that in a number of States the anglers are still parasites; either part or all of the cost of their fish work is paid by the hunters. But this situation is rapidly correcting itself; the fishermen realize as never before that if they want more and bigger fish placed in their streams and lakes they must supply ample funds to do the work. Several States hope to enact fishing-license laws this winter, and a number of others are planning to increase their fees. I have always found the angler willing to pay his full share if he is satisfied that it will be put to good use; he is not a piker.

I hope to obtain figures covering the remaining States as well as like figures covering the work of the Bureau of Fisheries, after which an interesting composite can readily be prepared; but the final point I want to make pertains to personnel, always an interesting study.

The 46 States gave me data on the number of superintendents and other employees, their salaries, perquisites, etc., and I was surprised to learn that in only 9 States are the hatchery employees under civil service. The most astounding development, however, was the amount of the salaries being paid, and the more I studied them the more I became convinced that young men can not be induced to secure special college or university training to make fish-culture and allied subjects their vocation until two outstanding requisites are given attention—namely, the remuneration and the tenure of office.

The 319 superintendents receive salaries running all the way from $1,200 to $3,000 per annum, but in the great majority of States about $1,500 to $1,800 is the top salary. Practically all of these employees are furnished homes, heat, and light, but until the inducements at the top average better than they now do the prospects are not what they should be.

The 171 assistant superintendents receive $840 to $2,000 per annum, but for most of these employees about $1,500 is the top salary. Many of the assistant superintendents as well as some of the other employees are supplied with homes; but the average pay is too low to attract and hold the best men (unless they are just plain cranks, as many of us are) when industries offer much better wages with living conditions more to the liking of an average family.

I admit that I have sketched a pessimistic picture, but I have great hope for the future. With 3,000 chapters of the Izaak Walton League and hundreds of other like organizations scattered throughout America, many of them operating rearing stations, nursery ponds, brood ponds, and some of them hatcheries, we are bringing to your aid an organized support never before possible. I am proud to say that about 250 of these Walton League chapters are spending their time and money helping to rear millions of baby fish to a size that gives them a fighting chance when released in the streams and lakes, and thereafter they take an intense interest in seeing to it that those fish receive the protection they deserve. However, more thorough stream study is necessary before these fish are planted. We expect several hundred additional chapters to take up this rearing work during 1929, but this activity needs the aid of more trained workers.

In conclusion, let me say that every one of the league chapters is 100 per cent behind the Hoover nursery-pond plan, the 5-year program sponsored by Congressman White, the irrigation-ditch screen studies, the effort to bring back the commercial fisheries of the Atlantic, the Pacific, the Gulf, and the Great Lakes, and especially are they anxious to have more technically trained, well-compensated men supplied with ample funds to do the work.

So long as we can keep an ardent angler-conservationist in the White House we should all have ample reason to rejoice. Better days are coming.

PROGRESS IN FISH-CULTURAL INVESTIGATIONS

Dr. H. S. DAVIS, *in charge of aquicultural investigations*

At the present time the investigations dealing with fish-cultural problems center, for the most part, around the activities of the Fairport biological station and the experimental trout hatchery at Pittsford, Vt. This arrangement provides for work with both trout and warm-water fishes, but within rather narrow fields, since only a few species of fish can be handled at either station. Owing to limited facilities, it has been necessary to concentrate on the largemouth bass at Fairport and on brook trout at Pittsford hatchery, although other species have not been neglected entirely.

Probably the most important feature of the work at the Pittsford station during the past two years has been the feeding experiments conducted under the immediate supervision of Mr. Lord. For the first time since these experiments were inaugurated I feel we are in position to discuss with some degree of confidence the relative value of the different foods we have been testing.

Recently we have heard a great deal about an ideal trout food, the idea being that once we can determine the requirements of trout in terms of proteins, carbohydrates, fats, vitamins, salts, and other food accessories we shall be in position to compound a food that will give maximum results. Even were it possible to determine the optimum amounts of these foods, which I seriously doubt, it does not follow that we would then be in position to supply our fish with the ideal food.

It should be remembered that the fish-culturist does not have an unlimited number of foods at his disposal from which he can pick and choose. On the contrary, he is bound hand and foot by considerations of cost and supply. Any food to be used successfully in feeding trout, or other fish for that matter, must be obtainable at a reasonable cost, and there must be an adequate supply available at all times. Of course, I realize there are some exceptions to this statement where certain cheap foods are available locally, but as a general rule the fish-culturist is limited strictly to a few food products that are obtainable in quantity at a low cost.

Available trout foods can be divided readily into two groups. In the first group we have the fresh meats of various kinds, including the liver, heart, and lungs of cattle, sheep, and pigs. Possibly fresh fish of low grade should be included in this group, although this product is not at present universally available. In the other group we have the various dried products, including meat meals, fish meals, clam meal, shrimp meal, dried milk, and cereals.

There is at least one point on which all trout culturists are so well agreed that it may be said to be axiomatic, and that is that trout will not do well for any length of time unless some fresh meat is included in the diet. This fact, which has been demonstrated time and time again, has recently led McCay to postulate a hypothetical factor H which is present in all fresh meats but not in dried products, at least to any extent.

It has been the universal experience of fish-culturists that trout can be reared successfully on a straight meat diet, although there has been much difference of opinion as to which meat gives the best results. Our experiments with both brook and rainbow fingerlings indicates that, in general, a mixed-meat diet is preferable to one composed of only a single meat product. For instance, a mixture of heart and liver will give better results in the long run than either heart or liver alone. Also, our experiments have shown conclusively that the same organ from different animals will often give very different results. Of course this is only what one would naturally expect, and we are not surprised, therefore, that beef liver and beef heart give much better results than do the livers and heart of pigs or sheep. In fact, when using a straight meat diet we have obtained our best results with a mixture composed of equal parts of beef heart and beef liver.

Undoubtedly the results obtained with various meat products are dependent on both their chemical and physical structure, and I am convinced that the latter is not to be ignored by any means. This, I believe, largely explains the superiority of beef heart over beef liver as a food for advanced fry and very young fingerlings. The heart can be ground into very fine particles, which are readily swallowed by the young fish, while the liver forms a thick, mush-like material not so readily separable into discrete particles. Furthermore, a considerable percentage of the ground liver is readily soluble in water, and there is, therefore, a considerable loss in food value from this source.

As the fish increase in size they are able to ingest larger particles, and the food is devoured more quickly. Consequently, there is less loss from solution, and liver now will produce a faster growth than heart, although there is usually a higher mortality. By combining heart and liver to form a mixed diet we find that the growth is practically as great as with liver alone, while the mortality is comparable with that of fish fed on a straight heart diet.

But, unfortunately for the fish-culturists, all fresh meats have advanced in price materially during recent years, and the use of beef liver in promoting growth and combating anemia has placed this product outside the pale of commercial fish culture. Consequently, in our feeding tests during the last year or two we have concentrated on the problem of finding suitable substitutes for part of the fresh meat. These substitutes include various dried products of animal origin, wheat middlings, soybean meal, and Mexican beans. Our experiments indicate that some of these substitutes can be used successfully in combination with fresh meats, but, with one exception, none of these combinations have produced as rapid growth as a suitable combination of fresh meats alone.

As stated above, our experiments for several years consistently show that among the foods ordinarily fed to trout a mixture of beef and beef liver has no superior, and we had begun to believe that this mixture probably represented the best artificial food available. However, we have found during the past season that a mixture of beef liver and so-called "clam heads" is superior to the liver and heart mixture, both in regard to growth and mortality. Not only did the fish thrive better on this diet than on any other, but it was found that "clam heads" in combination with pig liver or sheep plucks gave nearly as good results as with beef liver. Unfortunately, the supply of "clam heads" is limited, but it is hoped that some similar product can be found, which will be available in quantity.

Other animal meals that have given satisfactory results are shrimp meal, haddock meal, cod-liver meal, and dried milk. While these meals did not produce such a rapid growth as "clam heads," the experimental lots showed a fair growth and low mortality.

In connection with the use of animal meals in the diet, the problem arises as to the proper proportions of fresh meat and dried meals. In other words, how much of the fresh meat can be replaced by a substitute without affecting the fish adversely? Of course, from the standpoint of cost alone the smaller the percentage of fresh meat in the diet the better, but, obviously, there are limits to the extent to which meat can be replaced by a cheaper product. Nor is it purely a matter of nutrition, since the physical consistency of the mixture must be taken into consideration. This factor has an important bearing on the readiness with which the food is eaten and also on the amount of nutriment lost in solution.

In preparing the mixtures of fresh meat and meals it has been found best, in most cases, first to mix the dry meal with water to the consistency of a thick mush and then incorporate with the ground meat. When this mush is mixed with an equal quantity of meat it forms a mixture of about the right consistency for feeding to fingerlings. Since most meals absorb from 1½ to 2 times their weight of water, such a mixture contains about 15 to 20 per cent of the substitute, based on the dry weight. It is believed that this is about the maximum percentage of dried products that can be used successfully in the diet of fingering trout, but with yearlings and older fish a considerably larger proportion may be used. In several instances we have obtained excellent results with yearlings in feeding a ration composed of only 33 per cent of fresh meat, and it is not impossible that the percentage could be reduced still further without detriment to the fish. Since most animal meals cost from 3 to 5 cents a pound and fresh meats from 10 to 20 cents it will be seen that the food bill can be more than cut in half by a liberal use of the former.

In continuing the feeding experiments next summer it is planned to devote more attention to the food of fish above fingerling size than has been possible in the past. With the constantly increasing demand for larger fish for planting purposes the problem as to the most economical food for fish 4 inches long and upwards is becoming more acute. We are also planning experimental feeding with brood fish to determine, if possible, whether the food has any influence on the quality of the eggs. In many instances there is a very considerable loss among eggs from hatchery fish, and there is evidence that this may be due, in part at least, to improper food.

Before leaving this subject I should like to digress for a moment to point out that, in my opinion, too much emphasis has been placed on obtaining rapid growth in hatchery fish to the exclusion of other factors. Rapid growth is very desirable, but it should not be procured at the expense of the health and vigor of the fish. The Federal and State hatcheries are raising fish to be liberated in natural waters, and it is very doubtful if the fat, lazy, chunky, pot-bellied trout often seen in hatcheries are as well able to care for themselves, when suddenly thrown upon their own resources, as are fish that have not been forced to the limit. The former are like hothouse plants, and, when suddenly transferred to natural waters, we may expect about the results we obtain when plants are taken from a greenhouse and transplanted into an open field without further attention. For stocking purposes we need fish with some vim and pep, and this fact should be taken into consideration in judging the comparative value of different foods for growing trout.

Another important phase of the work at Pittsford is the experiments in selective breeding. Since there was no stock of fish at the station when it was taken over by the division of inquiry it was impossible to accomplish anything in this direction for the first two or three years, and only now have we reached the point where the work can be taken up seriously. A few fish have been mated during the past two seasons, but these can be considered only in the nature of preliminary experiments. However, this preliminary work has served to emphasize the importance of breeding experiments, and I have no doubt that the results will be of great value to practical fish culture.

With few exceptions very little attention has been paid by trout culturists to the principles of selective breeding. True, a number of growers have taken pride in building up a superior stock of brood fish, but actually the selection has not been carried on systematically for a number of generations, as must be the case if results of permanent value are to be obtained.

The most important work in this field is the experiments of Embody and Hayford at the New Jersey State hatchery. These experiments have been conducted for the purpose of increasing the resistance of fingerlings to disease, and also to develop a stock with a more rapid growth. According to a preliminary account of their work, they have been able in three generations to produce an apparent increase in resistance to disease and also a marked improvement in the rate of growth. In fact, so great was the increase in growth as a result of selection that the average size of the fingerlings on July 1 jumped from 2 to 4 inches in length. I understand that since these results were published they have still further increased that rate of growth among the selected stock.

Our preliminary experiments at Pittsford have shown that the offspring of different parents show marked differences in the rate of growth during the first summer. They have also shown that there is a noticeable tendency for fingerlings from the same parents to grow at a uniform rate, so that there is much less variation among such fish than among fingerlings of mixed parentage.

The results of Embody and Hayford, just mentioned, were obtained by mass selection; and, in fact, this is the only type of selection that has hitherto been practiced by trout-culturists. While we are using mass selection to some extent in our own work, we are laying greatest stress on the selection of individual fish, as it is believed that this method will yield results that will more than compensate for the increased labor and expense.

During the spawning season just closed 34 pairs of brook trout were mated, and the young will be reared separately. In order to follow the parent fish from one year to the next all are tagged, and a complete record is kept of each individual fish.

One of the greatest difficulties in selective breeding is to determine correctly the relative value of fish of different parentage. In order to provide a common basis for comparison as free as possible from error, all fingerlings produced in our breeding experiments will be reared during the first season under as nearly identical conditions as possible. Since it is obvious that two of the most important factors that influence the health and growth of fingerling fish are the food and available space, it is absolutely essential that these be the same in the case of each lot. Otherwise direct comparison of the fish at the end of the season may lead to very erroneous conclusions.

Investigations carried on at the Pittsford hatchery have enabled us to clear up many obscure points in connection with two common trout diseases. These diseases are both caused by bacterial infections, which in one case affect chiefly the gills and in the other the fins.

The gill disease was first recognized at the Pittsford station, where it has annually caused serious losses virtually ever since the station was established. However, the disease is now known to occur at many hatcheries in the East and Middle West, and during the past summer I found it in fingerling salmon from Birdsview (Wash.) hatchery.

This disease is caused by slender rod-shaped bacteria, which are usually joined end to end to form long filaments. The bacteria do not penetrate the tissues but are found attached to the surface of the gills, and in the fry they may also be found on the body and fins.

The gill disease causes very serious losses among fry and fingerlings, and even older trout occasionally die from its effect. During the past summer it was found that fingerling trout may become infected from yearlings and older fish that show no trace of the disease. This indicates that the bacteria may occur in small numbers on perfectly healthy fish for an indefinite time, which, obviously, will make it very difficult if not impossible to eradicate the disease from a hatchery. Fortunately, the disease is easily controlled by the copper-sulphate treatment.

The other disease referred to above is commonly known as "fin rot" or "tail rot." "Fin rot," like most trout diseases, is also widely distributed and has been found in hatcheries from the Atlantic to the Pacific coast. As indicated by the name, the disease is caused by a bacterial infection of the fins, which begins at the outer edge and gradually extends toward the base. The bacteria follow the lymph channels to the base of the fin, whence they may invade the muscular tissues. As a result of the infection the fins may be entirely destroyed. In some cases infection may take place through the skin at some distance from the fins, forming sores filled with a white pus. Later the pus may be washed out, exposing a clean-cut cavity, which often looks as though it had been hollowed out with a knife.

Observations made during the past summer indicate that "fin rot" is much more prevalent in our hatcheries than has been realized. Apparently the organism varies greatly in virulence, and in many cases the disease occurs among fingerling trout as a comparatively mild infection, which causes a small daily mortality without assuming the proportions of an epidemic. In such cases a majority of the fish recover from the disease without suffering any serious injury, and the fins rapidly regenerate the parts that have been destroyed.

"Fin rot" can also be controlled by copper sulphate, but owing to the nature of the infection is not as susceptible to treatment as is the gill disease. Since bacteria that have gained entrance to the tissues can not be reached by the solution, the treatment has little effect on advanced cases. This necessitates several successive treatments at frequent intervals in order to stop infection during the early stages and prevent the disease from spreading to healthy fish.

The investigations in pondfish culture, started three years ago at the Fairport biological station, have been devoted primarily to work with the largemouth black bass. The constantly increasing demand for bass for stocking purposes has emphasized the importance of developing methods of propagation and rearing these fish economically. For various reasons bass culture has lagged behind trout culture until to-day the demand for bass far exceeds the available supply. When we consider that the streams and lakes suitable for bass and other warm-water fishes are many times more extensive than those adapted to trout we begin to realize the magnitude of the problem of keeping these waters properly stocked.

As everyone knows, the methods employed in pondfish culture differ radically from those used in handling trout. Unlike trout and salmon, bass and other warm-water fishes must be allowed to deposit and hatch their eggs under essentially natural conditions. This means that a much smaller number of fish can be reared per unit area of water surface, which, of course, materially increases the overhead. That, however, is offset to a considerable extent by the fact that it is not necessary to feed pondfish regularly, as in the case of trout, and the labor of caring for them is much less. In fact, I doubt if the propagation of bass as compared with trout is such an expensive proposition as many people have been led to believe. Given the proper facilities, I can see no reason why bass may not be propagated and reared both successfully and economically.

The Fairport experiments have demonstrated that bass can be reared successfully in comparatively small ponds; in fact, it is doubtful if it is advisable under ordinary conditions to use ponds over 3 to 4 acres in area. Small ponds have several advantages, not the least of which is the greater ease of control.

The best results in rearing fingerling bass have been obtained in nursery or rearing ponds. The fry as they rise from the nests are caught in a floating trap designed by Mr. Hesen and are then placed in nursery ponds, which previously have been stocked with minnows to serve as forage for the young bass. In this way we have been able to produce as high as 10,000 three-inch fingerlings to the acre without supplying any food other than that produced in the pond. It is interesting to note that in 1926, the first year of experimental work, the average production of bass was 4,400 fingerlings per acre; in 1927 it was 5,300 fingerlings per acre; while in 1928 the average production had risen to 7,100 per acre. These figures include the production in both the spawning and nursery ponds.

At the present time we are using two species of minnows for forage purposes with good results. The larger of these is the golden shiner, *Notemigonus crysoleucas*, which in some respects seems to be the better of the two; but the smaller blackhead minnow, *Pimephales promelas*, is also an excellent forage fish. The superiority of the golden shiner is probably due chiefly to its larger size. Owing to their small size the adult blackheads are readily devoured by fingerling bass before the summer is over, which makes it more difficult to maintain a stock of forage fish in the ponds than in the case of the shiner. It is possible that both species can be used in the same pond to advantage, since the blackhead minnow is primarily a bottom feeder while the golden shiner is not.

The relative value of the two species is indicated by the results of experiments in the E ponds during the past summer. These are small ponds of approximately the same area and situated side by side. Two of these ponds were stocked with golden shiner, the other two with blackhead minnows. Later, 3,900 bass fry were liberated in each pair of ponds. When drawn in the fall there were 1,507 fingerlings in the shiner ponds with a total weight of 220 ounces. On the other hand, the ponds stocked with blackheads yielded only 307 fingerling bass, weighing 116 ounces.

By the use of forage fish in bass ponds we are able to produce not only larger and better fingerlings but the percentage of survival is also much greater. In one instance there was a survival of approximately 56 per cent, and we have several examples of between 40 and 50 per cent survival.

The fertilizer experiments are an important part of the pond work and have yielded some very notable results. In 1926 a mixture of bone meal and dried sheep manure was applied to several ponds at frequent intervals during the spring and early summer, but the results were not conclusive. During the following summer (1927) superphosphate was used instead of bone meal, and in every instance the fertilized ponds showed a much greater production than the unfertilized. In several instances where the results were directly comparable the weight of the bass produced in fertilized ponds was from two to four times that from the unfertilized.

In addition to largemouth bass, several other species have been propagated in the Fairport ponds. Good results have been obtained with bluegill sunfish, black and white crappie, and smallmouth bass. Attempts to propagate the white bass, *Roccus chrysops*, and yellow bass, *Morone interrupta*, have so far been unsuccessful; and it is believed that it will be necessary to obtain more information regarding the spawning habits of these fish before we can hope to make any progress in this direction. We are also attempting to improve the stock of bass and sunfish by keeping the best fingerlings for brood fish and also by obtaining superior strains of wild fish.

In connection with the pond investigations, Mr. Wiebe has been conducting a series of experiments on the influence of various fertilizers on plankton production. These experiments, which have been carried on in small concrete pools, have shown that soybean meal produces more plankton than any of the other fertilizers used. In view of the favorable showing made by this meal it is planned to try it out on a more extensive scale in the bass ponds next season.

During the past season we have been able to extend our investigations on warm-water fishes to the Upper Mississippi River wild-life refuge. Here is presented an excellent opportunity for studies on fish under natural conditions, which will supplement and amplify the work carried on at Fairport.

In order that we may have a comprehensive idea of conditions in the refuge, Mr. Surber has been engaged during the past summer in making an inventory of the ponds and sloughs available for aquicultural investigations. With the aid of a houseboat he has been able to cover the most important parts of the refuge and collect data that will be invaluable in developing a systematic program for future work. Although the survey was necessarily superficial, Mr. Surber has been able to determine the general nature of most of the ponds and sloughs in the area covered and to classify them on the basis of their probable value for fish-cultural work.

In the past there has been considerable discussion regarding the feasibility of increasing the production of desirable fish in natural waters, but so far no one has had the temerity to attempt to do this on any extensive scale. In venturing to apply the principles of practical aquiculture to such an extensive area as the bottom lands of the Upper Mississippi we are embarking on what is virtually an uncharted sea and are subjected to all the perils of an inglorious shipwreck. However, I believe the time has come for action rather than a continuation of theoretical and academic discussions, which get us nowhere in particular.

Mr. Surber's survey has shown that certain sloughs appear to offer a much more favorable opportunity for experimental work than others, and it is on this type of slough that we purpose to concentrate for the present. If we are able to make progress and solve some of the problems presented by such ponds we shall then be in position to extend our operations to more difficult fields.

While the bottom lands of the Upper Mississippi River wild-life refuge afford, in the aggregate, a large number of sloughs and ponds under Federal control, and to that extent provide exceptionally favorable conditions for such a program as we have in mind, we are, nevertheless, laboring under a very severe handicap. The periodical floods, which may occur at almost any time, present an obstacle that in many cases it will probably be impossible to overcome. Only overflowed lands are included in the refuge, and in order to obtain ponds that are not subject to occasional floods it will be necessary to go outside the limits of the reservation. However, in spite of these difficulties we are optimistic regarding the future and believe that much can be accomplished that will be of permanent value to aquiculture.

BIOLOGY AND CULTIVATION OF SHELLFISH

Dr. Paul S. Galtsoff, *In charge of oyster investigations*

Of the numerous marine organisms inhabiting the inshore waters, the oyster occupies a unique place; it grows in great abundance in nearly every harbor along the Atlantic coast and Gulf of Mexico and plays, therefore, an important rôle in the biological and chemical changes that occur in the inshore waters. To understand the rôle of the organism in the cycle of changes that take place in the sea and to discover the factors that control its propagation and growth are the aims of our investigation. From the scientific point of view it is unimportant what organism we are dealing with; it may be mollusk, sponge, or fish, but fortunately the study of the biology of the oyster opens remarkable possibilities. Working on the oyster we are dealing not only with an animal that is widely distributed and important from an economic point of view, but we have an organism that easily yields to experimental treatment, both in the laboratory and in its natural habitat. This makes it possible to apply the results of laboratory work to the field experiments and carry them out on a large scale.

For many years the method applied in the study of life in the ocean consisted in descriptions of the organisms—grouping them in so-called ecological communities and giving rather incomplete records of the physical and chemical conditions and changes that take place in the sea water. This purely descriptive method affords very little opportunity for analysis of the controlling factors operating in any body of water and is inadequate for the understanding of the complexity of interrelated events that determine the propagation, growth, and distribution of living matter in the ocean. In order to understand any biological phenomenon in the ocean we must possess better knowledge of the functions and requirements of a given organism and understand the operation of the limiting factors that govern its life in the sea. This requires long-continued experimental study and implies the introduction of experimental investigations into the field of oceanic biology, which up to the present time was based on descriptive method. The procedure is more difficult than the old scheme of collecting the organisms and attempting to correlate the biological data with the few physical and chemical observations that form a traditional program of oceanographical observations, but it opens a new and promising field of research. On these general ideas we have attempted to develop the program of oyster investigation.

The first phase in our study deals with the propagation of the organism. Several ecological papers on the biology of the oyster describe rather vaguely the spawning of the oyster; they state that the discharge of sex products takes place when the temperature of the water reaches 68° or 72° F. Vivid descriptions of the spawning of oysters in tanks or floats are given by Brooks, Stafford, and Nelson. It has been known from these papers that the discharge of gonads is accompanied by the contraction of the adductor muscle and clapping of the shells. This information gives, however, little help in understanding either the mechanism of the reaction or the conditions under which it takes place. The organisms kept in natural environment are under the influence of a number of variable chemical and physical factors that can not be controlled and can easily escape our attention. The reaction should be studied in the laboratory under as far as possible controllable conditions. Three years ago I began the experiments on spawning in the laboratory at Woods Hole. The method used in this study consisted in immobilizing the oyster and connecting one of its shells to a "heart lever," which records the motion of the shell on the slow-moving kymograph. The oyster is placed in a 30-liter glass tank filled with sea water; the temperature, oxygen content, and pH are kept constant.

There is a distinct difference between the spawning of the female and male oysters. In the female the reaction consists in rhythmical contractions of the adductor muscle and discharge of the eggs, while in the male the discharge of sperm is not accompanied by any muscular activity, and consequently the spawning of the male can not be recorded with any self-registering device.

Both males and females can be induced to spawn by placing them in warm water; in the males the reaction takes place easier than in the females, and exposure of an hour or two at the temperature 5° or 7° C. higher than the original causes a discharge of eggs. It is more difficult to induce spawning in the female; out of many experiments I succeeded only once, when the female was kept for five hours at a temperature of 26.5° C. As a result of many experiments it has been found that in both females and males the spawning reaction can be provoked by the addition to the surrounding water of small amounts of eggs or sperm.

There is, however, a distinct difference in the reactions of the two sexes. We shall consider first the reaction of the female. When sperm is added to the water in which the female is kept there occurs a latent period, which varies from seven minutes to half an hour; then the adductor muscle begins to contract rhythmically, each contraction being followed by a brief period of relaxation. The kymograph records show the difference in the ordinary contraction of the muscle and those occurring during spawning. The reaction lasts from 15 to 40 minutes and varies considerably in intensity and number of contractions. The contraction may be accompanied by the discharge of eggs, but in many instances the muscular activity caused by the sperm is not followed by the shedding of the sex products; apparently the two phenomena are independent of each other. When there is a discharge of eggs the reaction is more complex. When the female is ready to spawn it opens its shell wide; then the edges of the mantle on each side of the organism come in contact with each other, nearly shutting off the pallial cavity from the outside, except one small opening where the edges of the mantle are slightly gaping. When the mantle contracts the eggs are ejected through the opening; then the edges of the mantle come apart, the pallial cavity opens, and in a few seconds begins to close again, the process repeating itself until the spawning is over. When there is no discharge of eggs the mantle cavity remains open all the time.

One of the typical features of the reaction is the rhythmical contraction of the adductor muscle, which makes it possible to detect it on the kymograph record even when there is no discharge of eggs. The intensity and duration of the reaction, as well as the duration of the latent period, are independent of the amount of sperm. The reaction complies well to a "none or all" principle—the sperm or the active principle of the sperm is the agent that releases the mechanism, but it exerts no effect on the intensity of the reaction. There is a certain minimum dose of sperm capable of producing the reaction. In our experiments it was determined as being equal to 0.03 c. c. of sperm suspension made of 1 gr. of gonad tissue in 100 c. c. of sea water and added to the 30 liters of sea water.

After the reaction is over the oyster fails to respond to subsequent additions of sperm and for 3 or 4 days remains unaffected by it. The period of insusceptibility presents considerable complication in the experimental study and requires numerous additional experiments. It certainly should be considered very carefully in interpreting the negative results of the experiments.

There is some evidence in my experiments that the female oyster can be rendered insusceptible toward sperm by adding several small doses, each of which is too small to cause the reaction. Although the total amount of sperm is larger than the minimum effective dose, the organism does not react.

The response of the male to the addition of eggs is quite different. When the male is ripe the addition of eggs to the water causes an immediate discharge of sperm, which is carried off with the outgoing current. There is no increase in muscular activity. The reaction can be repeated many times, until the oyster has discharged all its sperm.

In both males and females temperature is one of the important factors. After a number of experiments convincing evidence has been obtained showing that the spawning reaction in the female does not occur at a temperature below 20° C. The most conclusive proof was obtained last summer with one oyster that, being subjected to temperatures of 16° and 18° C., failed to spawn but reacted two hours later when the temperature of the water was raised to 20.6°. In these experiments the same suspension of sperm was used. The spawning of the male oyster was observed only at a temperature of 22° C. or above.

On the basis of these experiments it is possible to visualize how spawning takes place in nature. It is very probable that when the temperature reaches 22° (or above) some of the males discharge sperm, which induces the spawning reaction in the females. The eggs discharged by the female instantly cause the ejection of sperm by other males and the process spreads all over the bed. If the gonad development is very light, and consequently the concentration of sperm in the water is low, the females may become unsusceptible and spawning will be delayed for at least four days. One of the practical deductions than can be made is that successful spawning should be expected only on densely populated oyster beds. It also seems possible, when the temperature of the water is 22° C. or higher, to start spawning of oysters in the shallow harbor by opening a few of them and pumping the suspension of sperm or eggs over the bed. Experimental evidence also shows that oysters may spawn several times during the 4 or 6 weeks of the spawning season. One oyster has spawned in laboratory tanks five times, each time discharging a certain amount of eggs.

Study of the spawning reaction shows that in addition to temperature the discharge of sex products is controlled also by a chemical agent discharged with them. It is very interesting to determine the nature of it, but unfortunately the problem is not an easy one. It has been found that the active principle is very unstable, being destroyed by heating for 5 minutes at 44° C.; its action is specific, the sperm of foreign species having no effect on the organism. Ultrafiltration experiments made last summer convinced me that the active principle is not soluble in sea water and does not pass through collodion membranes. It is interesting to note that the presence in sea water of these substances, which can not be detected by ordinary methods of analysis, plays an important rôle in the propagation of marine organisms and controls their spawning. It is very likely that what has been found for the oyster is true also for other forms.

Next to spawning the question of feeding and respiration is one of great importance in understanding the requirements of the organism. During the past year the study of the mechanical activity of the oyster gills has been finished and published. This work was undertaken in order to solve certain problems that arose in connection with sanitary control. It was of particular interest to find out how temperature affects the activity of the gills; it has been found that the majority of oysters cease feeding at 7° C. No oysters were found that were able to feed at a temperature of 5° C. or below. This fact was taken into consideration by the committee on sanitary control of oyster beds, which regarded that the slowing down of the activity of the oyster at this temperature affords an additional factor of safety. It was, therefore, possible to permit, during the cold weather, the marketing of oysters taken from bottoms that were slightly and indirectly affected by pollution. The introduction of this clause in the resolution of the committee probably saved many thousands of acres of oyster bottoms to the oyster industry.

The method of study of the functions of the gills was fully described in my paper. It suffices to mention here that it consists in collecting and measuring the amount of water passed through the gills or in determining the rate of flow of water in the cylindrical tubing that was introduced and made fast in the gill cavity. The results of these experiments give us the exact filtering capacity of the average oyster and throw some light on the conditions under which the oyster lives in nature.

Knowing the average rate of flow of water for an adult oyster at a given temperature, it was possible to estimate the amount of water used by the oysters on a crowded reef. In certain shallow bays in Texas, where the number of oysters on the reef is known, there is not water enough to supply the demand, and the same water is filtered several times by the oysters growing on the reef. This is apparently one of the direct causes of the very poor quality of their meats.

The development of the gonads and the quantity of spawn in the ripe oyster apparently depend on the food consumed. It has been noticed that when the first half of the summer is cold the gonad development in oysters on Long Island Sound is light. Suppose that for a certain summer the average temperature for May and June was, for instance, 5° below normal. Knowing the average rate of flow at a given range of temperature and the average duration of feeding, we can compute the deficiency in the amount of water filtered. Prytherch applied this method to his work and found, under these conditions, that the "average" oyster in Long Island Sound would have filtered about 200 liters less than it would at the normal temperature for these months. These examples show us that it is possible to develop this method further and obtain reliable data regarding the feeding of oysters under different conditions and to apply them to an analysis of the ecological conditions in a given body of water.

Other physiological work on oysters consisted in a study of the rate of oxygen consumption, which, as it has been determined, varies in proportion to oxygen tension. It has been found, also, that the ciliary activity is not affected by the changes in O_2 tension, and that there was no difference in the rate of metabolism in green and normal oysters.

The study of greening of the oyster has been continued. Experimental evidence so far obtained tends to show that the accumulation of copper in the tissues of the oyster is not due to the direct absorption of copper but is probably caused by changes in catalytic reactions, resulting in the accumulation of copper normally present in sea water. Our present work consists in the analysis of conditions responsible for the production of greening in the oyster.

Other psysiological work on chemical sensitivity and factors controlling the activity of the adductor muscle were carried on by Doctor Hopkins. The study of the biology of the oyster larvæ was continued chiefly by Mr. Prytherch, who paid particular attention to the factors controlling the setting of the larvæ. As a result of this investigation he was able to work out a method of prediction of spawning and setting. I wish to mention that his estimations for Connecticut waters issued one month in advance proved correct.

It has been noticed in our previous work that the appearance and distribution of oyster larvæ has some relation to tidal movements of the water. In certain localities it was very difficult to obtain the larvæ, although later the setting was very heavy. There arises a question whether the behavior of the larvæ is influenced by the movement of water, and this problem was taken up by Doctor Luce, who carried out a number of experiments at Milford. Owing to certain technical difficulties no definite results were obtained, but it is expected to carry out these experiments and find out how the velocity of tidal currents affects the behavior of the larvæ. We found that in tidal rivers it is impossible to obtain oyster larvæ at the high flood tide, while at low slack water they might be abundant. The study of the biology of the larvæ is essential for the development of a better method of catching spat and for the increase in the production of seed oysters.

In New England waters the industry is handicapped by the fluctuations and inconstancy in seed production, and it is our belief that this can be overcome by adoption of a better method of spat collection. The development of an efficient method of spat collection was one of the principal problems in which several investigators were engaged during the last three years. The experiments were carried out at Onset, Wareham, Milford, and Great South Bay, and always with successful results. We are in position now to recommend this method to the industry. It consists in using 3 feet by 1 foot wire bags of 1½-inch mesh filled with oyster shells. The bags are placed on the bottom and, if necessary, can be stacked in various ways. Three years of experimenting with various collectors proved that wire bags are superior and that by using this method the production of seed oysters per given area can be increased from 8 to 40 times. The increase is due, first, to the fact that three dimensions of the setting zone are utilized instead of only two, as in the ordinary method. Second, after they have caught some spat the bags can be removed and new ones placed instead. In this manner the concentration of spat on the shells can be regulated. Third, the bags can be placed on bottoms unsuitable for ordinary planting. As an example I want to mention the results of last year's experiments in Onset, in which a few bags were placed in Sunset Bay. This bay is regarded by the oystermen who tried to plant shells there as absolutely unsuitable for catching seed and was left unutilized. We succeeded in obtaining in this location around 5,000 spat to a bushel, which should be regarded as a fair commercial set. Local oystermen are becoming more interested in this method, and last year they planted several thousand bags and obtained good results.

For a successful application of the method it is necessary to know the prevailing currents in the bay, to determine the level of the setting zone, and to know the distribution and number of spawners. The determination of the setting zone can be made by examining the piles, rocks, or other objects within the tidal zone or on the bottom. The necessity of having a large number of spawners in the immediate vicinity of the planted bottoms is frequently overlooked by the oystermen, who waste their money in planting shells with no assurance of heavy spawning in the bay.

Experiments in oyster culture were extended to Georgia, and last summer Doctor Weatherby made a great many observations at the temporary laboratory at Doboy Island. Oyster beds in Georgia suffer from both depletion and overcrowding. Because of the heavy setting in the tidal zone the reefs produce poor coon oysters, while the few good reefs with single oysters are almost completely depleted. As an illustration of the wasteful methods employed in this State I want to mention the following observations. Cluster oysters taken from the reefs and brought to the shucking houses always contain a considerable percentage of small oysters. At one of the houses last spring I found that the oysters delivered to the shuckers were unusually poor, and the clusters were formed by very small oysters; counting their number in clusters I found that to one adult oyster, the meat of which was taken by the shucker, 44 were destroyed and wasted because they were too small to be opened. This represents not only waste of the oyster but a tremendous waste of labor and expense in carrying, steaming, and disposing of shells. An interesting fact observed by Weatherby is that setting around Doboy Island takes place on the bottom of the tidal river. This fact is of importance because it opens better possibilities for oyster culture in Georgia waters.

Surveys of oyster bottoms were carried out in North Carolina by Seiwell, in the Potomac River by Doctor Luce, and on the Pacific coast by myself and McMillin. From a biological point of view the situation on the Pacific coast is of great interest.

There are three species of oysters found on the Pacific coast—the native Olympia oyster, the imported Japanese, and the eastern oyster. The purpose of the survey was to determine what species of oyster affords the best opportunities to the industry. We begin our discussion with Olympian oysters. This small oyster is being cultivated in various bays in the southern end of Puget Sound; Olympia can be regarded as the center of the industry. The oyster is cultivated on tidal flats that are exposed at low water. Owing to the very high range of tide, varying from 12 to 30 feet, a large area of the tidal flats become exposed at each low water. In order to make cultivation possible, there has been developed an elaborate system of dike construction at different levels of the tidal slope. In some of the bays there are four or five levels of diked areas. The shape and size of each area varies, depending on local conditions, but usually each dike surrounds about one acre of bottom. The dikes are built of concrete and are from 3 to 7 feet high and about 1 foot wide. The bottom inside the dike is graded and reinforced with gravel. Improved first-class oyster bottom represents an investment of $2,000 or $3,000. The dikes require constant attention. The greatest trouble is caused by the decapod crustacean Hypogebia, which bores under the dike and causes a wash out and leakage under it. To protect the dikes the oystermen built a wall around it, using 6-foot boards of creosoted lumber.

It is amazing that while so much effort and money are spent on the improvement of bottom very little attention is paid to the oyster itself, and virtually nothing is known regarding the exact time of its ripening, spawning, and setting. The latter, as a rule, is very light, three or five spat to a shell being regarded as a good catch. We know that the Olympian oyster is hermaphroditic and that it grows very slowly. From a commercial point of view it is a valuable oyster, and the demand for it is greater than the supply. It is cultivated on privately owned farms, which, in spite of great expense in building the dikes and high taxation, bring a good return. According to the information I received during my trip, a small farm of 24 acres brings a gross income of about $5,000 a year. Oyster farming in these waters can be extended considerably without any danger of overproduction, and I believe that a biological study of the Olympian oyster will be of great help to the industry.

Attempts to import the eastern oyster have been made many times, and although we found a few young eastern oysters in Willapa and other harbors in the State of Washington, it is generally believed that this species can not be propagated on a commercial scale.

The importation of the Japanese oyster presents an interesting problem. Several thousand bushels of Japanese seed oysters are imported annually and are planted in Samish Bay. The oyster grows fast but does not spawn. Scattered Japanese oysters can be found in other sections of Puget Sound, and a few young Japanese oysters were obtained in Nasel River. Oysters in Samish Bay were examined in October; they were full of spawn but apparently were unable to discharge their sex products. It appears feasible, by studying the spawning reaction of this oyster, to find a method whereby they can be induced to spawn, and it is planned to carry out these experiments in the near future.

The importation of Japanese seed is undesirable because of the danger of introducing the Japanese drill, which might destroy valuable Olympian grounds. From a commercial point of view the Japanese oyster is inferior to the native oyster, which should be protected from enemies. Dealing with this problem our efforts should be applied in two directions—first, in outlining practical measures of control and the inspection of imported seed with the view to prevent the admission of drills and other enemies, and second, in studying the conditions under which the Japanese oyster can be propagated in Puget Sound. Examinations of bottoms in Puget Sound, Gray's Harbor, and Willapa Bay show that all three oysters may spawn and set in these waters. It is a problem of biological research to find a method for their propagation and cultivation than can be applicable to commercial oyster farming in a given locality. I believe that the solution lies in a study of local conditions and in the intelligent application of the results obtained with eastern oysters on the Atlantic coast

ARTIFICIAL CULTURE OF GLOCHIDIA OF FRESH-WATER MUSSELS

DR. M. M. ELLIS, *professor of physiology, University of Missouri*

The experiments that have led to the working out of an artificial nutrient solution in which to rear the glochidia of certain of the fresh-water mussels have been very largely physiological in character. In these experiments mussel larvæ have been carried through their parasitic stage, thus replacing the developmental period ordinarily passed in cysts on the gills of fishes by one in glass vessels under controlled laboratory conditions. It has been established for many years that cells and bits of tissue can be made to grow outside of the body of the animal from which they were taken if kept in fluids in which the proper chemical balance of salts and nutrient substances is maintained. The development of a method for the handling of the glochidia (which, after all, are little more than bits of embryonic tissue) has therefore been a study of the conditions under which the glochidia live while parasitic on the fish by tissue-culture methods.

The first problem to which a definite answer was obtained was that concerning the status of the glochidium while encysted on the fish gill. It has been stated by some observers that the glochidium during its parasitic stage received little or no food from the host fish, but that the fish acted merely as a carrier, providing at once both a distributional agent by means of which the juvenile mussels were scattered upstream as well as downstream, thus assuring the mussel species a safe distribution against the river current, and a safe place for metamorphosis from larval glochidium to juvenile mussel. That is, the relation between the fish and the glochidium was a sort of passive parasitism. From analyses of fish blood and sera, salt solutions having the proper osmotic pressure, hydrogen-ion concentration, and salt balance were prepared; and in these solutions glochidia of various species of mussels were carried under suitable conditions of oxygenation. The glochidia lived well in these solutions, although the solutions themselves had no nutritive value for periods longer than those required for transformation had these same glochidia been encysted on fish gills. There was, however, little or no development in these salt solutions, and the glochidia always died after a longer or shorter time following the disintegration of the large muscle that holds the two valves together.

Solutions of balanced salts, to which dextrose was added in amounts comparable to those found in fish blood and sera, were next tried. Glochidia lived in these solutions even longer than in the solutions containing salts only; but the final result was always the same, namely, little development and finally death after the disintegration of the muscle.

As it is well known that the glochidia when closing on the gills of fishes include small bits of the host tissue between the valves of the glochidial shells, and that these bits of tissue subsequently disappear, it was thought that the glochidia might require the initial stimulus of some protein or enzyme from the fish, and that, once started, the development of the glochidium might continue in the salt solutions; that is, that, after all, the glochidia might carry sufficient food material in themselves for metamorphosis if properly stimulated at the start. Accordingly, glochidia were closed on bits of fish gill, liver, muscle, and blood clots and then transferred to the salt solutions described above. The glochidia in these series showed fine starts toward development but soon failed and then died, just as those carried in the salt solutions alone had done. From these experiments it was evident that the glochidia do not carry sufficient food material in themselves to complete metamorphosis, and that the fish does supply some substance or substances which are essential for more than mere starting stimulation. No matter how valuable to the mussel species the protection and distribution factors are, the fish host adds some other required part in the successful life cycle of these mussel species.

As the result of tests and analyses of the protein constituents of the fish blood and sera, it seemed likely that the substance or substances lacking in the salt-dextrose mixtures were to be found in the protein portion of the serum from the host fish. New series of solutions were compounded, and when the proper amounts of amino-acid mixtures were added to the salt-dextrose preparations, solutions were perfected in which the glochidia made complete development and transformation into juvenile mussels without any contact whatever with the host fish. The juvenile mussels reared in this way were found to be active and vigorous and, in fact, were subject to a lower mortality than juveniles raised on the fish.

The experiments that were successful demonstrated that the mussel glochidia are true parasites, obtaining a definite nitrogenous food supply from their hosts; and also proved that the artificial media that supplied these needed substances were just as successful as the fish as far as the development of the glochidia was concerned. The next problem, then, was to devise means to supply these nutrient fluids to large enough numbers of the glochidia to make the method commercially profitable. As soon as large numbers of glochidia were taken, however, additional problems were encountered. First there were bacteria, for these nutrient solutions were found to be excellent media for the bacteria that the glochidia carried with them from the river water; in fact, the bacteria rapidly overwhelmed the glochidia in such cultures. Then there were protozoans to be killed. It is well known that the glochidia, before leaving the marsupia of the mother clam, are attacked by several species of Protozoa, and one of these was found to thrive in the nutrient solutions. Besides, there were still other problems concerning the viability of the glochidia themselves and the condition of the glochidia at different seasons of the year. A method has been perfected which meets these various difficulties and admits of the handling of large numbers of glochidia, but the work is being continued with a view of simplifying and perfecting this method still further so that increasingly larger numbers of glochidia can be handled successfully.

DESTRUCTION OF OYSTER BOTTOMS IN MOBILE BAY BY THE FLOOD OF 1929[1]

By Paul S. Galtsoff, Ph. D., *in charge of oyster-fishery investigations, U. S. Bureau of Fisheries*

CONTENTS

INTRODUCTION

Oyster-producing bottoms of the State of Alabama are confined to the eastern part of Mississippi Sound and to the lower section of Mobile Bay. A chain of islands and sand bars extending along the mainland protects this shallow area from the rough waters of the Gulf and prevents the free access of sea water, which can enter the sound and the bay only through several shallow cuts between the bars and through the channel between Dauphin Island and Mobile Point. The inshore region receives a considerable amount of fresh water from Mobile River, emptying into Mobile Bay, and from Pascagoula River, which discharges its waters into Mississippi Sound 20 miles west from the Alabama-Mississippi State line. Many small rivers and creeks draining the surrounding territory also contribute a considerable amount of fresh water, which enters the bay. Consequently, the concentration of salt in the waters of Mobile Bay and Mississippi Sound is subject to wide fluctuations, depending on the amount of local precipitation and on the stages of the rivers.

Although the oyster is very tolerant to changes in the salinity of the water, and by shutting its valves and keeping them tightly closed can survive even in a very low concentration of salts, yet the condition may occur when the dilution of the sea water is too great or the exposure to fresh water lasts longer than the organism is able to endure. Every spring a great number of oysters inhabiting the estuaries near the mouths of large rivers are killed by freshets, but it happens very rarely that the whole oyster population of an area of several hundred square miles is nearly completely wiped out by fresh water. This happened, however, to the oyster bottoms of Mobile Bay in the spring of 1929.

[1] Appendix XI to the Report of the U. S. Commissioner of Fisheries for 1929. B. F. Doc. 1069. Submitted for publication June 17, 1929.

In April, 1929, at the request of the Alabama conservation commissioner and certain of the State's delegation in Congress, the author was directed by the United States Commissioner of Fisheries to proceed to Mobile Bay to make a survey of the oyster bottoms, with the view to determining the extent of the damage and finding out a method of rehabilitating the destroyed bottoms. The State conservation department cooperated in this work by providing a suitable boat with equipment and by supplying the necessary labor. The party, consisting of the author and Dr. R. H. Luce of the Bureau of Fisheries, State Deputy E. Ackridge, and several members of the Sea Food Emergency Committee of the Mobile Chamber of Commerce, visited all the principal public reefs in Alabama waters and determined the percentage of oysters killed by the flood. The destruction of oysters was found to be so extensive that the necessity for the immediate rehabilitation of the reefs was self-evident.

It is the purpose of this paper to give an analysis of the condition of the oyster reefs in Alabama waters and to outline a method for their rehabilitation and maintenance. The success of such an enterprise depends chiefly on knowledge of the biology of the oyster and on an understanding of local conditions affecting its growth and propagation. Fortunately, the oyster bottoms in Alabama were studied for the bureau by H. R. Ritter in 1894–95, by H. F. Moore in 1910, and by the author in 1927. These investigations give valuable information regarding the type of bottoms, changes in the salinity of the water, and growth and propagation of the oysters, and supply a sound basis for a practical solution of the problem of how to restore the destroyed bottoms and to insure in the future a sufficient supply of oysters to the industry.

TABLE 1.—*Public oyster reefs in Alabama waters (according to surveys of Ritter and Moore)*

Reef	Acres	Reef	Acres
MOBILE BAY		MISSISSIPPI SOUND	
Western shore:			
Fowl River	100	Dauphin Island Bay	756
White House	881	Sprinkels Bay	133
Kings Bayou	82	Collier Bay	18
Birmingham	267	East base	3
Cedar Point	201	*Half Moon Patches*	14
Pass des Huitres	285	Heron Bay, east side	102
Dutch Gully	58	Heron Bay, west side	54
Dutch Island	87	Northwest arm of Heron Bay	58
Big Gully	65	Middle Ground	52
Peter Billys Gully	81	Grassy Island	4
Grants Pass	127	Goose Bayou	12
Pass aux Herons	292	Southwest Signal	1
Red Fish Gully	220	East of Marsh Island	2
Black Lumps	139	Portersville planted	8
West side Little Dauphin Island	165	North end Portersville	2
Mussel Gully	43	West side Coffee Island	27
Sand Reef	655		
Total	3,748	Total	1,241
		Grand total	5,419
Eastern shore:			
Great Point Clear	53		
Fish River	83		
Bayou Coqr Reef	68		
Bon Secours	38		
Shell bank	188		
Total	430		

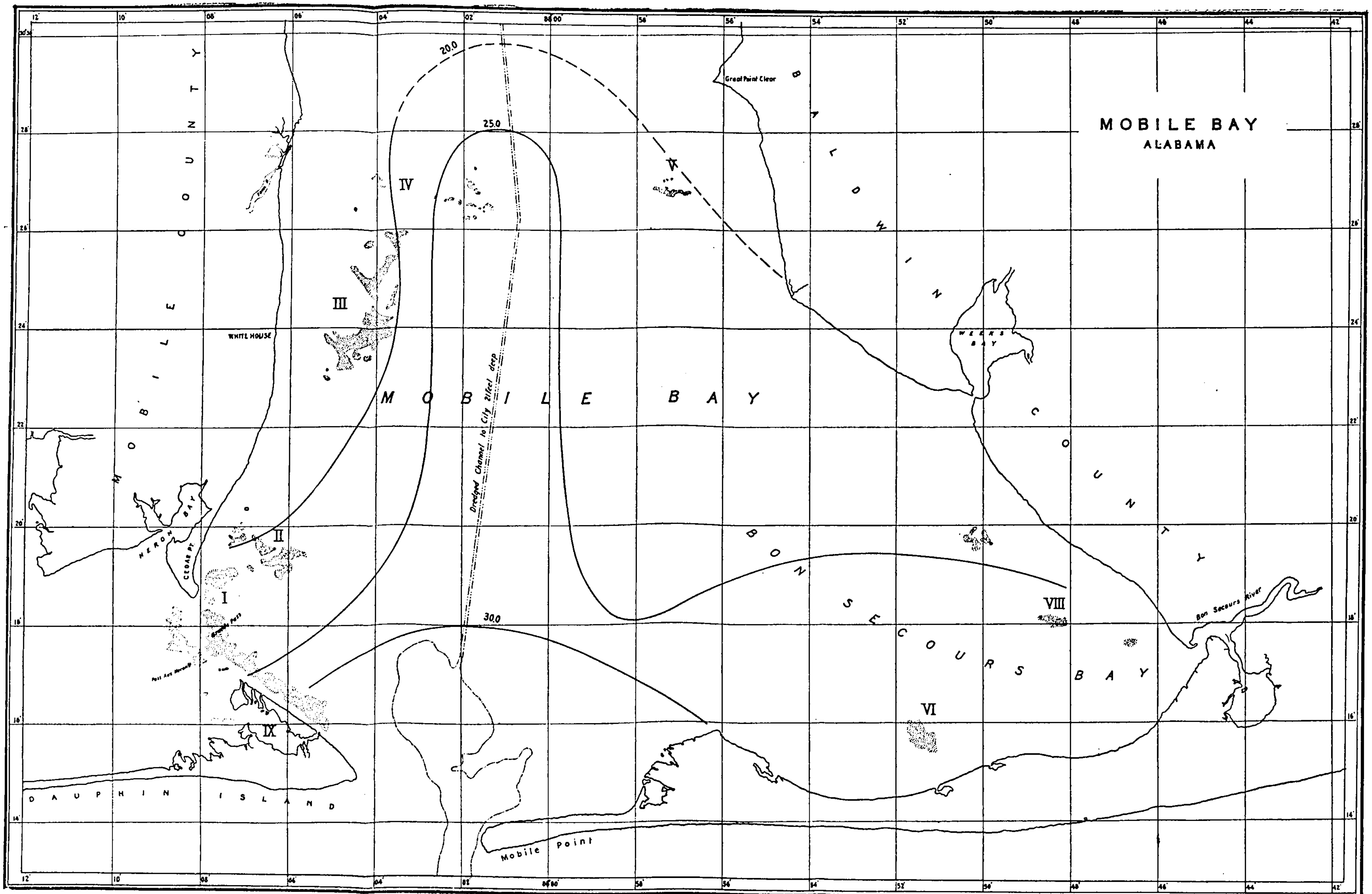


FIGURE 1.—Oyster reefs and distribution of salinity in Mobile Bay in December, 1894 (computed from the data of H. R. Ritter). Stippled areas indicate oyster reefs; heavy lines indicate salinities in parts per thousand; roman figures refer to the various reefs listed in Table 1 and pages 744-745. Scale: 1 5/16 inch = 2 statute miles.

OYSTER BOTTOMS IN ALABAMA WATERS

The total area of oyster-producing public bottoms in the State of Alabama comprises, according to the surveys of Ritter (1894) and Moore (1910), 5,419 acres, of which 4,178 acres are located in Mobile Bay and in the junction of the bay with Mississippi Sound, and 1,241 acres are confined to the eastern section of the sound. The whole oyster-producing area embraces the natural beds of different qualities, both with regard to the density of the oyster population and the quality of the oysters.

Continuous fishing on more accessible reefs, coupled with the failure to return the shells to the bottoms from which oysters were taken, has resulted in depletion of a number of reefs, which became unproductive and were abandoned. Moore estimated that in 1910 only 37 per cent of the oyster bottoms in the Alabama section of Mississippi Sound had dense growths of oysters (over 150 bushels per acre), 25 per cent were listed as having "scattering growths" (between 25 and 150 bushels per acre), and 38 per cent were depleted (less than 25 bushels per acre). During the last three years the commercial fishery has been confined to the reefs in the lower part of Mobile Bay and to those located at the junction of the bay and the sound. Bon Secours Bay (eastern section of Mobile Bay) supplied "select" oysters of very high quality, but the amount of them was insignificant. Altogether, the area of oyster-producing public bottoms used for commercial fishing just before the flood was probably not over 1,500 acres (part of White House Reef, Birmingham Reef, Grants Pass, and Bon Secours Bay).

From an ecological point of view the conditions existing in Mobile Bay are different from those in Mississippi Sound. It is desirable, therefore, to discuss them separately.

MOBILE BAY

Mobile Bay is a large and shallow body of water that lies 90 miles northeastward of the South Pass of the Mississippi River. The entrance to the bay, between Mobile Point on the east and Dauphin Island on the west, has a width of 2¾ miles but is largely obstructed by shoals extending several miles offshore. The bay is about 28 miles long and 10 miles wide, forming in the lower part a large indentation extending 14 miles eastward from the Mobile Point and known as Bon Secours Bay. Outside of the 30-foot-deep ship channel, the depth of the bay does not exceed 16 feet, the greater part having a depth of about 10 feet. The bottom is generally soft mud, with a few patches of hard or sticky ground and oyster reefs. The latter are located in the lower half of the bay south of a line connecting the Great Point Clear on the east and the mouth of Fowl River on the west. Examining the chart (fig. 1), one notices that the middle of the bay is completely devoid of any reefs; they occur only along the shores or at the comparatively narrow junction of the bay and Mississippi Sound.

The oyster-bearing bottoms in Mobile Bay can be grouped in two distinct classes. The first class comprises the reefs located along the western shore of the bay; they extend from Fowl River to Grants Pass, a distance of 12 miles, and for 4 miles more in a southeasterly direction and parallel to the northern shore of Little Dauphin Island. The reefs are almost entirely confined to the area lying between the 3-foot and the 12-foot curves. The surrounding bottom is soft mud on the eastern side of the reefs and sand between the shore line and the western edges of the reefs. The area between the 6-foot and 12-foot curves from Fowl River to the eastern end of Little Dauphin Island comprises about 20,000 acres, but the actual extent of the natural beds amounts to 3,748 acres. The oyster growth on these reefs may be characterized as dense. In many instances the reefs of this group produce only "coon" oysters of inferior quality. This fact is due exclusively to the extreme abundance of set, which covers the adult oysters and causes the formation of clusters of oysters, preventing their normal development and growth.

Observations made by the author in April, 1927, show that there existed a distinct difference in the quality of the oysters on different reefs. It is therefore desirable to give here a brief résumé of this investigation.

The first reefs one meets going south from Mobile are located between the mouth of Fowl River and Mobile Light. (Fig. 1, IV.) On this area of several square miles there are a number of scattered small reefs separated in some instances by a considerable distance and covering altogether not more than 100 acres. The specimens obtained from these reefs were mostly mud-covered cluster oysters and old shells. The reefs were of little commercial importance.

The next is the White House reef (fig. 1, III), which lies at a depth of from 7 to 12 feet between Mobile Bay Lighthouse and Point Juliet. It is 3 miles long, varying in width from a few to 1,300 yards. The total area of the reef, according to Ritter, was 881 acres. The reef produces oysters of good shape and flavor. In April, 1927, the eastern section of the reef was found to be overcrowded with large cluster oysters, to which a considerable number of small ones was attached. The central part of the reef, which was dredged by the State conservation department, was in better condition; there was a larger proportion of single oysters of good shape, and the young oysters were numerous. At the southern end of the reef only shells were found; the oysters were said to have been killed by the storm of November, 1926.

Birmingham Reef (fig. 1, II) lies about 2 miles east by north of Cedar Point at a depth of 5 to 6 feet. It consists of a group of small oyster beds covering altogether 267 acres. The slopes at the edges of the reef are quite abrupt, indicating that the reef had raised itself several feet above the surrounding soft bottom. The reef produces good-sized oysters growing in clusters. In April, 1927, there was a considerable number of young oysters on the reef.

Cedar Point Reef (fig. 1, I) embraces an area of 174 acres of good oyster bottoms located in shallow water from 4 to 6 feet deep around the point. In April, 1927, the reef had an abundant supply of both marketable and young oysters. Because of its convenient location and the shallowness of the water the reef is worked extensively by the tongers and is regarded as one of the most important in the bay.

Between Cedar Point and Pass Drury there is a chain of reefs that begins at the southern end of Cedar Point and extends for a distance of about 4 miles in a southwestern direction across the junction of Mississippi Sound and the bay and along the northeastern shore of Dauphin Island. It consists of a series of oyster beds (fig. 1, I) from one-third to one-half mile wide lying mostly at a depth from 2 to 6 feet.

The bottom is generally hard and shelly in the northern section of the group and sandy toward its southeastern end. The sections of this group known as Pass des Huitres, Grants Pass, Little Dauphin Island, and other shallow and well-protected parts of it, supplied the greatest portion of market oysters to the local canneries and were the scene of most active tonging. In April, 1927, the oyster growth was rather dense in the northern section of the group and very scattered at its southeastern end along the shores of Dauphin Island. The latter part of the group is of no commercial value. Oysters taken from this reef were in large clusters consisting of a great number of small, elongated "coon" oysters. Young oysters were also abundant.

It can be noticed from the description of the reefs that all of them except those of the Fowl River group supported large oyster colonies, which in many instances were overcrowded. Those sections of the reefs that were dredged by the State produced oysters of much better quality. This fact indicates that the removal of a certain portion of the oyster population was beneficial and improved the quality of those oysters that were left. The abundance of small young oysters of various sizes was a sign that setting occurred regularly and that the propagation of the oysters was going on successfully. The reefs along the western shores of Mobile Bay were not sufficiently worked and hence were overcrowded, for tonging at a depth of 9 to 12 feet is possible only on perfectly calm days.

The second group of oyster bottoms comprises the grounds along the eastern shore in Bon Secours Bay. The reefs are few in number, covering about 430 acres, with sparse growth but producing single oysters of good quality. The depth of water over the beds varies from 6 to 8 feet, and the beds are surrounded by soft mud. Between the 6-foot curve and the shore there is an area of hard sandy bottom, the larger part of which may be regarded as suitable for oyster culture; while the bottom of the bay, although generally soft, contains large areas of sticky mud, likewise suitable for oyster planting. All the reefs in Bon Secours Bay (fig. 1, V, VI, VIII) were examined by the author in April, 1927. With the exception of the Great Point Clear Reef, where no live oysters were found, the oysters on all of the reefs were of large size and good shape. Bon Secours oysters have a well-established reputation on the local market and are sold for $5 a barrel, while the oysters from the western shore bring only $1.50 a barrel. The high quality of Bon Secours oysters is undoubtedly due to the fact that they are not overcrowded and have plenty of room to grow. The number of young oysters was very small, indicating that setting in this section of the bay occurs very rarely; but Bon Secours Bay has great possibilities for oyster cultivation, for it can be utilized for growing "select" oysters. At present the greater portion of oysters produced in Alabama waters goes to the canneries, which use only cheap oysters. The local market for select oysters is very small.

MISSISSIPPI SOUND

The natural oyster beds in the Alabama section of Mississippi Sound, excluding the reefs lying in the contiguous parts of the sound and in Mobile Bay, which have been already described above, embrace 1,241 acres scattered over a large area. Most of them are of very little economic value. The largest oyster bed of this section, having an area of 756 acres, is located in Dauphin Island Bay (fig. 1, IX), the entire bottom of which is sparsely covered with oysters of very poor quality. The majority of them are under 3 inches and are classed as "coon" oysters. It is said that every winter a considerable portion of them is killed by frost. The bed does not yield any market but can be regarded as a valuable natural setting area, from which a large supply of seed oysters can be obtained.

In the eastern section of the sound there are large areas of barren bottoms, especially in Grand Bay, Portersville Bay, and around Coffee Island, suitable for oyster planting. Hard bottom is found also in the middle of the sound and along the northern shore of Dauphin Island.

Since 1925 the State conservation department has planted in Portersville Bay a considerable number of seed oysters, which were growing very satisfactorily. The State oyster inspector has estimated that at the beginning of 1929 there were not less than 150,000 bushels of marketable oysters on State planted beds, which, as will be shown later, were destroyed by the flood.

EXPLOITATION AND MAINTENANCE OF PUBLIC OYSTER REEFS

The oyster industry of the State of Alabama is based on the exploitation of public reefs. According to section 1, Act No. 107, "all the beds and bottoms of the rivers, bayous, lagoons, lakes, bays, sounds, and inlets * * * are declared to be the property of the State." Although the owners of land fronting waters where oysters may be grown have the right to plant and gather them to the distance of 600 yards from the shore, riparian rights do not extend to any part of the natural and public reef. As in the other States where the industry is dependent on the supply of oysters from public reefs, the strict adherence to the idea of public oyster bottoms constitutes a considerable obstacle in the development of oyster culture and creates conditions that prevent the development and full exploitation of the natural oyster resources. Under present legal conditions the productivity of the public reefs, which are the main source supplying the industry, is dependent on the activity of the State conservation commissioner, who, according to sections 12 and 18, Act No. 259, has discretionary power "to adopt such means as are wise and practicable for the development of the public oyster reefs * * * and the protection and fostering of the oyster industry, and * * * to make such regulations and rules * * * that the oysters of the State may be adequately protected and the industry encouraged."

The greatest encouragement to the industry consists in insuring a continuous supply of good oysters. This can only be attained by the introduction of modern oyster farming carried out by private citizens who are willing to invest their money and labor. It appears to be a duty of the State government to encourage private initiative by giving protection to privately owned or leased grounds and by demonstrating the best methods of farming. Unfortunately, under present conditions the cultivation of oysters in Alabama waters has very little chance for development. Although the law permits the cultivation of oysters within 600 yards from shore line, there are considerable difficulties in exercising these rights. Section 20, Act No. 107, defines a natural oyster reef as "not less than one acre of continuous area of any bottoms of any bay, sound, bayou, creek, inlet, or any other body of salt or brackish water on which oysters grow naturally or have grown naturally in quantity sufficient to warrant fishing for them with hand tongs as a means of livelihood within a period of five years preceding the time at which said matter may be presented for consideration and determination by the inspector. The inspector shall be in all cases the judge as to the facts in the declaring or determining what is a natural bed or reef." Section 7, Act 504 (1923), forbids the leasing of the State's public oyster bottoms to persons, firms, and corporations and repeals all previous laws relating to the leasing of oyster bottoms.

It is obvious that the definition of natural reefs and the provisions of Act No. 504 made the development of oyster culture in Alabama waters nearly impossible. The same act (secs. 1, 1½, 2, and 3) authorizes the State conservation commissioner to "plant seed oysters and other shells and to enlarge and improve the oyster bottoms." In other words, the maintenance of the reefs is placed in the hands of the commissioner, who has the difficult task of protecting and propagating the oysters on the reefs that are open to the public for fishing.

Examinations made by the United States Bureau of Fisheries in 1894, 1910, and 1927 show that the reefs exposed to the rough sea and having a depth from 8 to 12 feet were overcrowded, while those located in shallow and protected waters were in various stages of depletion. In order to protect the public reefs from depletion the State law forbids dredging and permits the taking of oysters only by hand tongs. The result is that tongers concentrate their activity on a comparatively small area and do not take oysters from deep and exposed reefs. It was the author's opinion that restricted dredging carried out under the supervision of a competent inspector should be permitted on the reefs along the western shore of Mobile Bay, and that such operations would help to improve the quality of the oysters.

Examinations made by the author in 1927 and 1929 disclose that the majority of the bottoms (Grants Pass, Cedar Point, mouth of Heron Bay, and White House) had but very little cultch, hence the young oysters had no other place of attachment than the shells of the adults. It was learned from the office of the State conservation department that during the last 10 years no shells have been planted on the public reefs. The failure to supply a sufficient amount of clean cultch is one of the main causes of overcrowding. For the maintenance of the reefs in good condition the planting of shells is more important than the planting of seed. The present area of the oyster-producing bottoms can be increased by distributing a sufficient amount of shells, an abundant supply of which can be obtained from local canneries. It is the author's opinion that by the proper use of the natural setting ground for collecting seed oysters and by transplanting and growing them in the waters of Bon Secour Bay the annual oyster crop can be increased, so that not only will the local factories have an ample supply but considerable quantities of oysters will be left for export.

Since 1880 the annual crop of oysters in Alabama waters has varied from 76,125 to 590,000 bushels. In 1928, according to the information received from local packers, the crop was not more than 75,000 bushels. (Fig. 2.) The amount of oysters taken annually from Alabama waters depends not only on their abundance but is indirectly dependent on the run of shrimp. When shrimp are abundant the tongers quit oystering and engage in the more profitable shrimp fishing. Besides economic conditions, the annual yield of oysters is undoubtedly influenced by the natural causes that affect their growth and propagation. It is known that in the warm inshore waters of the Gulf of Mexico oysters grow fast, reaching marketable size in two

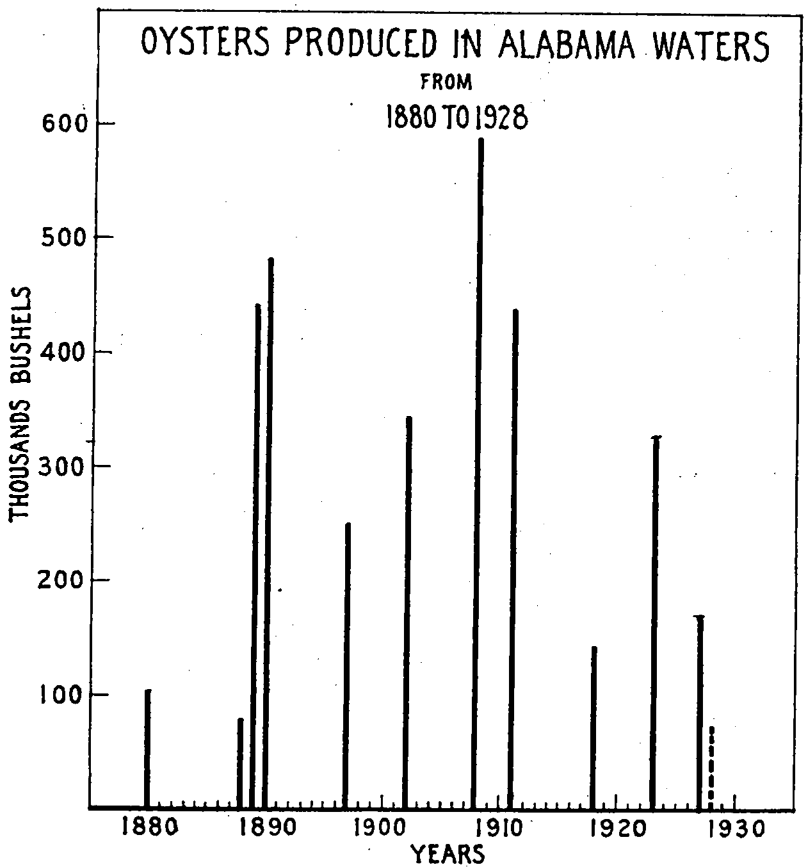


FIGURE 2.

years. Their growth may be affected, however, by adverse meteorological conditions. Excessive rainfall or severe storms are often held responsible for the great mortality of oysters or for their failure to spawn and set. The greatest danger, however, to oyster bottoms close to the mouths of large rivers is an excess of fresh water, which may reduce the concentration of salt to a dangerous point. An understanding of the seasonal fluctuation and distribution of the salinity in Mobile Bay is, therefore, essential for the intelligent management and utilization of the oyster bottoms.

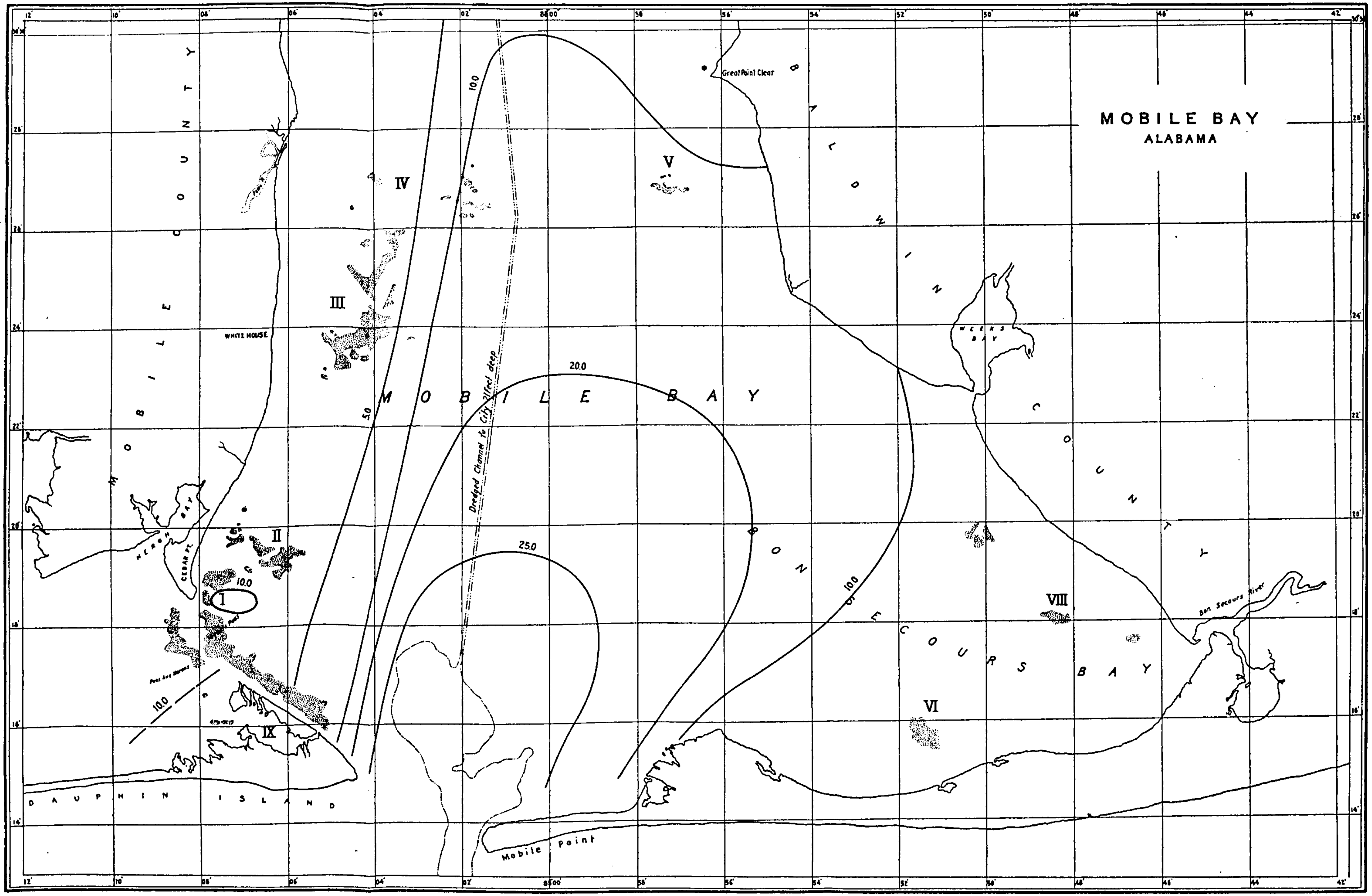


FIGURE 3.—Oyster reefs and distribution of salinity in Mobile Bay in February-March, 1894 (computed from the data of H. R. Ritter). Stippled areas represent oyster reefs; heavy lines indicate salinities in parts per thousand; roman figures refer to the various reefs listed in Table 1 and pages 744-745. Scale: 1⁵⁄₁₆ inch=2 statute miles

SALINITY OF WATER

Although no systematic study of the changes in the salinity of the water of Mobile Bay has been carried out, yet a number of observations made in the years 1894–95, 1910, and 1927 shows that in spring the salinity decreases and the water in the upper part of the bay often becomes fresh. The oystermen state that every spring the water in the bay remains fresh for a period of from two to five weeks. An examination of Figures 1 and 3 gives one a general idea of the distribution and changes in the salinity at the end of a dry season (December; fig. 1) and during the freshets (March and April; fig. 3). The charts were prepared by computing the salinities (concentration of salts in parts per thousand) from density readings and drawing the lines between the points of equal salinities. (The computation of salinity from density readings was made by applying a correction for the change of the base of the hydrometer and using Knudsen's tables.) The following important facts can be noticed by examining the charts: By the end of the "dry" season the salinity in the lower part of Mobile Bay varies from 15 to 30 parts per thousand, and that the fresh water discharged by the rivers at the head of the bay has a tendency to follow the western shore of the bay, where the principal reefs are located.

TABLE 2.—*Salinity (in parts per thousand) of the surface water in Mobile Bay and Mississippi Sound in April, 1927, and May, 1929*

Location	Salinity	
	April, 1927	May, 1929
Mississippi Sound:		
Isles aux Herles	6.96	
Marsh Island	6.96	6.40
South of Marsh Island	4.83	
Mouth of Heron Bay	Fresh.	5.41
Heron Bay, mid bay		5.25
Heron Bay, near out		5.01
Bayou Labatre		3.10
Dauphin Island Bay		12.25
Mobile Bay:		
Fowl River Reef	Fresh.	
Channel at Mobile Bay Light—		
Surface	Fresh.	
Bottom	23.02	
Great Point Clear	Fresh.	
White House Reef	Fresh.	Fresh.
Kings Bayou Reef	Fresh.	Fresh.
Cedar Point Reef	Fresh.	Fresh.
Grants Pass Reef	Fresh.	4.42
Bon Secours Bay:		
South of Fish River point	Fresh.	
Bon Secours Reef	Fresh.	
Shell Bank	3.57	4.49
Navy Cove	Fresh.	

In February–March (fig. 3) the salinity at the bottom of the bay varied from 0 to 25.0, and all the reefs along the western shore were covered with nearly fresh water (Knudsen's tables do not permit the computation of salinities below 1.8 parts per thousand). The salinity over the bottom of Bon Secours Bay was between 5 and 10 parts per thousand. In April, 1927 (Table 2), fresh water prevailed all over the reefs, including those of Bon Secours Bay. Sea water of the salinity 23.0 was confined to the bottom of the ship channel. In May, 1929 (Table 2), at the end of the flood, conditions were similar to those observed in April, 1927—the water was fresh on the reefs along the western shore of Mobile Bay, while the salinity of the water in the other sections of the bay was around 5.0.

The salinity of the water of the Mississippi Sound is always higher than that of the Mobile Bay. In May, 1929, a salinity of 6.4 was recorded at Marsh Island and 12.25 at Dauphin Island Bay. The salinity in Heron Bay was 5.0.

There is no doubt that freshets constitute the greatest danger to the oyster reefs in Mobile Bay. Oysters can sustain a salinity of 5 parts per thousand and less for a limited period of time, which probably depends to a great extent on the temperature and alkalinity of the water and on the condition of the organisms themselves. Unfortunately, because of the lack of experimental data it is impossible to state definitely how long and under what conditions the oyster will survive in fresh water. Apparently the flood of 1929 lasted long enough to kill the majority of the oysters. An analysis of the meteorological and hydrographical conditions that caused the flood will help us in understanding the factors that caused the destruction of the oyster bottoms, but before discussing them it is necessary to give a brief account of the extent of the damage caused by fresh water during the spring of 1929.

OYSTER POPULATION ON REEFS OF MOBILE BAY IN MAY, 1929

The method of surveying the oyster bottoms in May, 1929, consisted in dredging with a 36-inch dredge and counting the number of live oysters, those recently killed, and the single old shells. When dredging, the boat made about 3 knots, and the dredge was usually hauled after two or three minutes of dragging. The results of the survey are presented in Table 3. They show that the oysters on State bedding ground at Portersville Harbor, on Cedar Point Reef, and in Bon Secours Bay were nearly destroyed completely. At the mouth of Heron Bay and at White House Reef the per cent of survivors was from 4.6 to 6.6, respectively. At Grants Pass 15.1 per cent of oysters survived. In small inclosed bays, like Heron Bay, the per cent of survivors was considerably larger (7.8 and 14.9) than in the adjacent waters of the sound. The highest per cent of live oysters was found at the head of Heron Bay; the smallest close to its entrance. It is interesting to note that small oysters of less than 2 inches in length survived in Heron Bay better than the larger ones; out of 37 and 73 live oysters obtained at two stations in Heron Bay, there were 25 and 59 small ones. The greater number of survivors in Heron Bay is apparently due to the fact that because of the high stage of water in Mobile Bay and lack of circulation the sea water was held in check in the small bays and was displaced by fresh water very slowly.[2]

[2] The range of tide in Mobile Bay varies from 1 to 1.5 feet.

TABLE 3.—*Oyster population on the reefs in May, 1929*

Location	Depth, in feet	Time of dredging, in minutes	Number of oysters in the dredge			Per cent of survivors
			Recently killed	Alive	Old single shells	
State Ground, Marsh Island	4.5	5	131	0	126	0
		6	345	0	320	
Mouth of Heron Bay	4	3	237	19	225	4.6
			153	0	217	
Heron Bay, near entrance	3–4	1.5	30	2	208	7.8
		2	0	0	0	
		2	359	31	70	
Heron Bay, near cut	3–4	2	417	73	102	14.9
Cedar Point Reef	4–5	2	109	1	54	.7
		1	328	2	112	
White House Reef	12–14	1	100	2	75	6.6
		2	355	30	89	
Bon Secours Bay, Shell Bank	8–9	2	81	0	63	.8
		5	163	2	75	
Grants Pass	5–6	2	275	49	49	15.1
Pass aux Heron	16–18	1.5	114	96	73	45.7
Dauphin Island Bay	0–3	[1]	------	200	[2]	100
Bayou Labatre, 1 mile from entrance	5	2	88	37	[2]	28.8
	5	2	54	18		
	16	2	16	9		

[1] Sample taken by tongs. [2] Not counted.

NOTE.—The per cent of survivors was computed for the total number of oysters dredged at each station. Old single shells were not taken into consideration.

All the oysters in Mobile and Bon Secours Bays that survived the flood were in very good condition. They were fat and had well-developed crystalline styles, the presence of the latter indicating that the oysters were feeding actively.

There were very few adult oysters left in Mobile Bay and in the eastern section of Mississippi Sound. The largest number of survivors was found in the deep water (18 feet) north of beacon No. 4 at Pass aux Heron, where 45.7 per cent of the adult oysters were alive. Unfortunately, this area is only about 2,500 by 500 yards and has a very scattering growth of oysters. Small numbers of large oysters were found also in the channel of Bayou Labatre, where 25.5 per cent of them survived.

Bottoms along the southern shore of Mississippi Sound were apparently less affected by the flood, but they are of no commercial importance. The oysters in Dauphin Island Bay did not suffer from the fresh water at all.

As can be noticed from this review, the oysters on the principal reefs in Alabama waters (White House, Cedar Point, Grants Pass) were either completely destroyed or their number was so reduced that the reefs could not become productive unless they were rehabilitated by planting of a new stock. The question arises whether it is wise, in view of the danger of floods, to replant the reefs. An answer to this question can be found in the analysis of the conditions that caused the flood of 1929.

CONDITIONS THAT CAUSED THE FLOOD OF 1929

Fresh water discharged into Mobile Bay comes from two main sources—from Mobile River, which empties into the northern part of the bay, and from a number of small rivers and creeks that drain the surrounding territory. While the discharge of Mobile River is dependent on its stages, the drainage from the surrounding country is influenced directly by local precipitation. Mobile River is only 45 miles long; it is formed by the confluence of the Tombigbee and Alabama Rivers, both of which are navigable for a distance of over 300 miles. The nearest river stations where daily observations of the stage of the water are carried out by the United States Weather Bureau are located at Demopolis, on the Tombigbee River, 185 miles from its mouth, and at Selma, on the Alabama River, 211 miles above the mouth. The drainage area of Tombigbee River above Demopolis is 15,280 square miles and that of the Alabama River above Selma is 15,400 square miles.

Some idea of the fluctuations of the river discharge can be obtained by studying the occurrence and duration of flood stages. The river stages given by the United States Weather Bureau are the arbitrary figures denoting the vertical heights of water, in feet, with reference to the zero of the graduated gage; the zeros are generally placed at the bottom of the flowing water at a given station. The flood stage is the height of water at a given place when the river begins to overflow its banks. The flood stage for Tombigbee River at Demopolis is 39 feet and for the Alabama River at Selma is 35 feet. An examination of the river stages gives us only relative figures indicating the decrease or increase in the amount of water discharged into the bay. For the purpose of the present work the absolute figures of river discharge are unnecessary, because an analysis of the conditions that caused the destruction of the oyster bottoms in Mobile Bay can be made without determining the actual amount of fresh water discharged by the rivers.

The daily data of the stages of the Tombigbee and Alabama Rivers are available for the last 36 years. They show that the period of February–April is the time when the flood stages occur more frequently, and that in August–October the rivers rarely reach the flood stage. This can be easily noticed from an examination of Table 4, which shows for the 36-year period the total number of days of each month when these rivers were at flood stages. For both rivers the maximum number of flood days occurs in March and the minimum in September.

TABLE 4.—*Occurrence of floods on the Tombigbee and Alabama Rivers for each month during the 36-year period 1893–1928*

Month	Tombigbee River at Demopolis (number of days)	Alabama River at Selma (number of days)	Month	Tombigbee River at Demopolis (number of days)	Alabama River at Selma (number of days)
January	226	42	July	40	20
February	303	104	August	2	0
March	429	173	September	0	0
April	278	88	October	10	0
May	150	1	November	30	3
June	75	4	December	96	23

From a biological point of view both the height of the flood and its duration are of equal importance. Flood with a very high crest but of a brief duration may, under certain conditions, be less destructive than the smaller but long-continued flood. The extent of variations in the heights of water and in the duration of March floods of the Tombigbee and Alabama Rivers are shown in Table 5. The most dangerous floods occur when both rivers rise to flood stages simultaneously. One can notice from Table 5 that during the 36-year period there were 16 years when both rivers were at flood stage in March, and that the floods of the Tombigbee River occurred more often and were higher than those of the Alabama River. In March, 1929, both rivers attained the highest stages recorded for this month (65.4 feet at Demopolis and 56.2 feet at Selma), and for the first time in 37 years both of them were at flood stage during the whole month. There is no doubt that the combined effect of very high stages of the two rivers and the unusual duration of the flood were responsible for the destruction of the oyster bottoms.

TABLE 5.—*March floods at Demopolis (Tombigbee River) and Selma (Alabama River)*

Year	Height of flood, in feet		Duration of flood, in days		Year	Height of flood, in feet		Duration of flood, in days	
	Demopolis	Selma	Demopolis	Selma		Demopolis	Selma	Demopolis	Selma
1893	49.1	0	8	0	1912	55.3	46.2	31	16
1894	41.8	0	10	0	1913	53.9	48.9	31	13
1895	48.7	42.6	14	9	1914	0	0	0	0
1896	0	0	0	0	1915	0	0	0	0
1897	53.0	41.5	20	19	1916	0	0	0	0
1898	0	0	0	0	1917	54.6	50.1	28	15
1899	59.3	38.8	20	5	1918	0	0	0	0
1900	51.8	0	10	0	1919	53.0	48.0	31	14
1901	0	0	0	0	1920	56.4	44.9	15	8
1902	55.6	48.9	4	13	1921	43.5	0	8	0
1903	54.1	42.8	26	7	1922	56.5	49.6	25	17
1904	0	0	0	0	1923	51.4	0	9	0
1905	49.2	0	5	0	1924	52.8	0	22	0
1906	52.7	50.2	12	11	1925	47.0	0	7	0
1907	47.3	37.2	12	4	1926	43.9	0	8	0
1908	50.1	39.4	10	4	1927	51.8	0	18	0
1909	60.9	52.9	31	18	1928	49.4	0	14	0
1910	0	0	0	0	1929	65.4	56.2	31	31
1911	0	0	0	0					

It is of interest to analyze the conditions of other floods when the stage of the Tombigbee River was above the 60-foot mark. These data, presented in Table 6, show that since 1886 only three times was the Tombigbee River at a stage higher than that attained in March, 1929: In April, 1900 (72.9 feet); March, 1902 (68.7 feet); and July, 1916 (66.2 feet). The flood of February–March, 1903, was of longest duration (49 days) and was but slightly lower than the flood of March, 1929. The stage of the Alabama River in March, 1929, was only 0.8 of a foot lower than the maximum height (57 feet) recorded in 1886. Although in March, 1929, neither the Tombigbee nor the Alabama have reached their respective maximum stages, yet the effect of the flood apparently was more disastrous than in any previous years. This was due to the fact that the combined duration of flood stages of both rivers (41 days in Tombigbee and 32 days in the Alabama) was longer than in any previous year.

TABLE 6.—*Highest floods at Demopolis (Tombigbee River) and Selma (Alabama River)*

Date	Demopolis		Selma		Precipitation at Mobile during the months of floods	
	Maximum stage, in feet	Duration of flood, in days	Maximum stage, in feet	Duration of flood, in days	Inches	Month
1886, April			57	(?)	7.17	April.
1900, April-May	72.9	24	41	6	2.07	March.
1902, March-April	68.7	24	50.7	11	8.83	February.
1903, February-March	64.9	49	50.6	16	2.39	February.
1909, February-March	61.5	45	52.9	18	20.50	July.
1916, July-August	66.2	26	53.9	20	.79	January.
1927, January	65.3	21	0	0	.91	April.
1928, April-May	60.9	26	48.8	8	20.23	March.
1929, February-April	65.4	41	56.2	32		

There was another contributing factor that aggravated the disaster. According to the United States Weather Bureau, the March mean monthly precipitation at Mobile is 6.27 inches. The rainfall in March, 1929, was 20.23 inches and established a record precipitation for this month since 1871. The 20-inch mark of monthly rainfall in Mobile was reached only twice before: In June, 1900 (26.67 inches), and in July, 1916 (20.50 inches). The highest rainfall in March recorded before this year was 14.62 inches in 1886. There is no doubt that the drainage of rain water from the surrounding country contributed a large amount of fresh water and aggravated the conditions caused by the flood stage of the Alabama River.

It is known that in previous years the floods were responsible for the destruction of a considerable number of oysters. Thus, the flood of July, 1916, destroyed approximately 50 per cent of oysters on the reefs of Mobile Bay. This flood was caused by very high stages of both rivers (Table 6) but was of shorter duration; it was also accompanied by a very high local precipitation (20.50 inches). It is possible that the dilution of sea water in July, 1916, did not reach the dangerous degree it attained in 1929 because the initial salinity of the water just before the flood in July was higher than it was in March. It is known that during the spring the salinity of the sea water in Mobile is always lower than it is in summer, when the prevailing southerly winds drive the Gulf water into the bay. These facts support the conclusion that the greatest danger to the oyster reefs should be expected with the spring floods.

The question arises: What is the probability of a recurrence of conditions that caused the flood of 1929? It has been shown that two factors controlling the discharge of the Alabama River are of greatest importance: (*a*) The duration of the flood stages in the Tombigbee and Alabama Rivers and (*b*) their simultaneous occurrence. The effect of local rainfall is of lesser importance, since there were a number of floods when local precipitation was less than normal for the month. (Table 6.) If we assume that dangerous conditions in March develop when the crest of the Tombigbee River at Demopolis is 50 feet or over and when the flood stage lasts for 31 days, the probability of the occurrence of this condition is five thirty-sevenths. (Table 5.) The probability that flood stages in the Alabama River will last also for 31 days is one thirty-seventh. Since the probability that both of two independent events will happen together is the product of their separate probabilities, the probability of the occurrence in March of flood similar to that of 1929 is $5/37 \times 1/37 = 1/273.8$, or one in 274 years. This figure can not be regarded as accurate, because the flood stages of both rivers are not entirely independent from each other; as the table shows, every considerable flood of the Tombigbee River was accompanied by flood stage of the Alabama River, yet the probability of the concurrence of highest crests in both rivers and the duration of flood in both of them over 31 days is very remote. The analysis of the river stages and precipitation in March, 1929, shows clearly that the flood that destroyed the oyster bottoms in the bay was due to the very rare combination of three factors—simultaneous high stages in the Tombigbee and Alabama Rivers, unusual duration of flood stage in both of them, and extremely high local precipitation.

REHABILITATION OF OYSTER BOTTOMS

It has been shown by the present survey that all commercially important oyster bottoms in Mobile Bay were destroyed. The percentage of oysters that survived the flood is so small that the reefs can be rehabilitated only by planting oysters brought from the other sections of the coast. The best method of restocking the reefs consists in establishing the spawning grounds. For that purpose an area of about 5 acres should be set aside at each of the following localities: Portersville Harbor, mouth of Heron Bay, Cedar Point Reef, Birmingham Reef, and White House Reef. From 750 to 1,000 bushels of adult oysters (spawners) should be planted on each acre of these grounds.

Adult oysters can be obtained from deep water at Pass aux Herons, from the channel of Bayou Labatre, and probably from Grants Pass. If the local supply of spawners is not sufficient, adult oysters should be brought in from Mississippi or Florida. Great care should be exercised in transporting and re-laying the oysters. The operation should be carried out as quickly as possible, and the oysters should not be left exposed to the direct sunlight. It is impossible, however, to state whether the transplanted oysters would spawn this summer or not. Adult oysters taken from various parts of Mobile Bay and Mississippi Sound and examined in May, 1929, were in good condition and contained a fair quantity of spawn. Very probably they will spawn some time in July or August. It is doubtful, however, if oysters brought from Mississippi or Florida will spawn during this season.

If planting operations are carried out successfully, shells should be planted in the immediate vicinity of the spawning beds when the oysters are ready to spawn. From 750 to 1,000 bushels of shells should be distributed over each acre of setting area, the total amount of shells depending on the number of spawners and their condition (the latter can be determined by an examination of the oysters at regular intervals).

To expedite the process of rehabilitation seed oysters can be planted in the following localities:

	Acres		Acres
White House Reef	881	Grants Pass	127
Kings Bayou	82	Bon Secours Reef	38
Birmingham Reef	267	Shellbaun Reef	188
Cedar Point Reef	201		
Pass aux Herons Reef	292	Total	2,025

About 500 bushels of seed oysters (not exceeding 2 inches in length) can be planted to each acre of bottom. Thus, the total amount required for the restocking of the principal reefs with seed oysters would be over 1,000,000 bushels. It is doubtful, however, that the State of Alabama will be able to carry out these operations on such a large scale. The only supply of seed oysters available in Alabama waters is found in Dauphin Island Bay. It is estimated that at present there are about 150,000 bushels of oysters in the bay and that about half of this amount, 75,000 bushels, can be taken and transplanted on the destroyed reefs. This amount will be sufficient for restocking about 150 acres only and should be distributed on the following reefs: Birmingham Reef, Cedar Point, and Portersville Harbor. It is not expected that coon oysters from Dauphin Island Bay will produce large numbers of spat, for in May, 1929, some of them had already spawned out, while others had very slight gonad development; but if the transplanted coon oysters grow satisfactorily some of them can be marketed in the winter of 1930.

During the rehabilitation period the reefs should be closed to all oyster fishing and efficiently patrolled. Special care should be exercised in protecting the spawning beds, which may attract unscrupulous fisherman, for they can be easily destroyed by illegal fishing. It is believed that by carrying out the outlined program of rehabilitation the reefs of Mobile Bay can be restored to their former level of productiveness.

It has been mentioned already that the present methods of exploitation and maintenance of the reefs do not permit their full utilization, but a greatly increased production and an improvement in quality of the product can be obtained by introducing modern methods of oyster farming. Natural conditions in Alabama waters are favorable for the cultivation of oysters. There are large areas at Grants Pass Reef, Cedar Point, and Dauphin Island Bay where an abundant supply of seed oysters can be obtained. On the other hand, the bottoms at 10 to 12 feet deep in Mobile Bay and those of Bon Secours Bay afford good conditions for growing oysters and can be used for planting of seed. To facilitate and control the production of seed oysters the new method of spat collecting by means of the wire-bag collector, developed by the United States Bureau of Fisheries, can be used. By adopting this method Dauphin Island Bay alone can supply all the seed oysters required for planting Bon Secours Bay and the deep reefs in Mobile Bay. The temperature of the water in Mobile Bay does not drop below the point (7° C.) where oysters cease feeding and begin to hibernate. Consequently, their growth is not interrupted and they reach marketable size in two years. It is a conservative estimate that 800 bushels of oysters can be grown on 1 acre of good oyster bottoms; hence, with the turnover every other year, the annual productivity should be about 400 bushels. If only 2,000 out of 5,419 acres of oyster bottoms are properly cultivated the annual productivity will be not less than 800,000 bushels. Under present archaic methods of exploitation the annual crop is less than one-tenth of that figure.

Oyster farming appears to be the only efficient method whereby the oyster industry of the State can be revived. Present laws regulating the oyster fishery neither give adequate protection to the reefs nor encourage the development of the natural resources.

Unless they are changed so as to permit and encourage private initiative to engage in the oyster culture there is little hope that the industry will prosper.

SUMMARY

1. Public oyster reefs in Alabama waters embrace 5,419 acres in Mobile Bay and the eastern section of Mississippi Sound. The reefs are confined to the area lying between the 3-foot and 12-foot curves. The surrounding bottom is mostly soft mud. Continuous fishing on more accessible reefs and failure to return the shells to the bottoms from which oysters were taken have resulted in the depletion of a number of reefs, which have become unproductive and have been abandoned. During the last three years the commercial fishery was confined to the reefs in the lower part of Mobile Bay (White House, Birmingham, and Cedar Point) and to those located at the junction of the bay and the sound (Grants Pass, Pass aux Herons, and others).

In the spring of 1929 the oyster population on the reefs in Mobile Bay was almost completely destroyed by the flood. A survey made in May, 1929, showed that the percentage of survivors on the reefs of Mobile Bay varied from 0 to 6.6; 15 per cent of oysters survived at Grants Pass. Oysters along the southern shore of Mississippi Sound were not affected by the flood. The oysters on the principal reefs in Alabama waters (White House, Cedar Point, and Grants Pass) were either completely destroyed or their number was so reduced that the reefs can not again become productive unless they are rehabilitated by the planting of new stock.

2. Fresh water entering Mobile Bay comes from the Tombigbee and Alabama Rivers, which empty into the northern part of the bay, and from the drainage of rain water from the surrounding country. The flood that destroyed the oysters in 1929 was due to the unfortunate coincidence, for the first time in 37 years, of high stages of water in both rivers and heavy local rainfall. The probability of a recurrence of this rare combination of circumstances is very slight.

3. The laws of the State of Alabama forbid the leasing of public oyster bottoms to private interests and place the development and protection of these under the jurisdiction of the State conservation commissioner, whose duty is "to plant seed oysters and other shells and to enlarge and improve the oyster bottoms" and "to adopt such means as are wise and practicable for the protection and fostering of the oyster industry." Hence, under present conditions the rehabilitation of the destroyed oyster bottoms by the State commissioner can only be accomplished by adopting the following plan of action:

1. Establish spawning beds.
2. Plant cultch (shells) in the immediate vicinity of the spawning beds.
3. Restock the reefs with seed oysters.

It is recommended that there be set aside as spawning grounds 5 acres at each of the following localities: Portersville Harbor, mouth of Heron Bay, Cedar Point Reef, Birmingham Reef, and White House Reef, where from 750 to 1,000 bushels of spawners should be planted on each acre of ground. Small numbers of adult oysters are available from Pass Aux Herons and Bayou Labatre; the rest should be brought in from Mississippi or Florida.

When the oysters are ready to spawn, about 1,000 bushels of shells should be planted on each acre of ground in the immediate vicinity of the spawning beds, the total amount of shells depending on the number of the spawners and their condition.

To expedite the restocking of reefs, seed oysters can be planted on the following reefs: White House, Kings Bayou, Birmingham, Cedar Point, Pass aux Herons, Grants Pass, Bon Secours, and Shellbank. About 500 bushels of seed not exceeding 2 inches in length can be distributed over each acre of bottom. The total amount of seed oysters and shells required for the restocking of the reefs is over 1,000,000 bushels. Probably 75,000 bushels of small oysters can be transported from Dauphin Island Bay; the rest should be imported either from Mississippi or Florida. It is estimated that the rehabilitation of the reefs will cost $150,000.

During the rehabilitation period the reefs should be closed to all oyster fishing and efficiently patrolled.

4. Natural conditions in Alabama waters are favorable for the development of private oyster farming. There exist, both in Mississippi Sound and in Mobile Bay, natural setting grounds, which, if properly developed, will produce an ample supply of seed oysters. The latter can be transplanted on growing and maturing grounds in Bon Secours Bay and in the deeper water of Mobile Bay, where they will reach marketable size in two years. Oyster farming appears to be the best method of increasing the productivity of the oyster bottoms and would put the industry on a more stable basis than under the present system. It is estimated that by proper cultivation oyster bottoms in Mobile Bay and the adjacent part of the Mississippi Sound can produce more than 800,000 bushels annually.

Under present State laws for regulating the oyster fishery the development of oyster farming is impossible. Unless they are revised to permit the leasing of oyster bottoms by private citizens and to remove limitations in marketing the product there is little hope that the industry will prosper. The present crisis caused by the destruction of public reefs, is an opportune time for a revision of the old laws and for the introduction of a new policy of leasing the oyster bottoms to private citizens. There is no doubt that the development of oyster farming on privately leased oyster bottoms will increase their productivity, supply a sufficient amount of oysters to the industry, give steady employment to tongers, and increase the revenue to the State.

PROPAGATION AND DISTRIBUTION OF FOOD FISHES, FISCAL YEAR 1929[1]

By Glen C. Leach, *Assistant in Charge, Division of Fish Culture*

CONTENTS

[1] Appendix XII to the Report of the U. S. Commissioner of Fisheries for 1929. B. F. Doc. No. 1070.

Part 2.—Distribution of Fish and Fish Eggs

INTRODUCTION

In submitting a summary of the operations of the division of fish culture for the fiscal year 1929 it is fully realized that the figures showing the numerical output of fish and fish eggs represent merely a criterion for judging the efficiency with which facilities and funds utilized for fish-cultural operations have been administered. The actual basis for judging the effectiveness of the division's efforts rests in the catch of food and game fish from waters benefiting from these activities.

The production of a record output, over 30,000,000 in excess of that for any previous year, may, therefore, be cited as evidence that every possible opportunity has been utilized to exact the maximum return from each unit of equipment and from each dollar expended. Variations of several millions in the production of eggs and fry of the marine species, of carp, and of similar nongame types are significant only in connection with the maintenance of a proportional increase in the production of the more desirable food and game species.

No valid data may be cited to show the actual results of this and previous seasons' operations in terms of actual take of fish per fisherman. Highly satisfactory records of the catch of Pacific salmon may be cited, or, conversely, a continuing decline in the catch of Great Lakes coregonids; but a number of factors other than numerical replenishment from hatcheries must be taken into consideration, and the relationships are too obscure to permit a rational evaluation of the weight of any one factor.

However, the case for artificial propagation and the continuation of fish hatcheries rests upon a very simple theorem, namely, that the planting of one or a thousand fry or fingerling fish in a body of water offers more prospect of making that area productive of fish than if no planting whatever had been done. This is particularly true in the instance where the spawn for such plantings is derived from fish caught for maket, as is the case with the shad, cod, haddock, etc. The hatchery is thereby serving as a plant for the recovery of a by-product as truly as is the establishment devoted to preparation of a marketable product from fish offal. The ensuing detailed reports are therefore designed to illustrate the efforts to make the hatchery production of real economic value as much as to show the merely technical details of hatchery operation.

Part 1.—FISH PRODUCTION: PROPAGATION AND RESCUE WORK

SPECIES HANDLED

The species appearing on the distribution records constitute a summary of the most important food and game fishes of the interior and coastal waters of the United States. The list includes 45 different varieties.

CATFISHES (SILURIDÆ):
- Catfishes (Leptops sp.).
- Horned pout (*Ameiurus nebulosus*).

SUCKERS (CATOSTOMIDÆ): Buffalo fish (Ictiobus sp.) and suckers (Catostomus sp.).

CARP (CYPRINIDÆ):
- Common carp (*Cyprinus carpio*).
- Goldfish (*Carassius auratus*).

SHAD AND HERRING (CLUPEIDÆ):
- Shad (*Alosa sapidissima*).
- Glut herring (*Pomolobus æstivalis*).

SALMONS, TROUTS, AND WHITEFISHES (SALMONIDÆ):
- Common whitefish (Coregonus sp.).
- Cisco (*Argyrosomus artedi*).
- Chinook, king, or quinnat salmon (*Oncorhynchus tschawytscha*).
- Chum salmon (*Oncorhynchus keta*).
- Humpback salmon, pink salmon (*Oncorhynchus gorbuscha*).
- Silver salmon, coho salmon (*Oncorhynchus kisutch*).
- Sockeye, blueback, or red salmon (*Oncorhynchus nerka*).
- Steelhead salmon (*Salmo gairdneri*).
- Atlantic salmon (*Salmo salar*).
- Landlocked salmon (*Salmo sebago*).
- Rainbow trout (*Salmo shasta*).
- Golden trout (*Salmo roosevelti*).
- Black-spotted trout, redthroat trout (*Salmo lewisi*).
- Loch Leven trout (*Salmo levenensis*).
- Lake trout, Mackinaw trout (*Christovomer namaycush*).
- Brook trout (*Salvelinus fontinalis*).

GRAYLINGS (THYMALLIDÆ): Montana grayling (*Thymallus montanus*).

PIKES (ESOCIDÆ): Common pickerel (*Esox lucius*).

SUNFISHES, BLACK BASSES, AND CRAPPIES (CENTRARCHIDÆ):
- Crappie (*Pomoxis annularis* and *P. sparoides*).
- Largemouth black bass (*Micropterus salmoides*).
- Smallmouth black bass (*Micropterus dolomieu*).
- Rock bass (*Ambloplites rupestris*).
- Warmouth bass, goggle-eye (*Chænobryttus gulosus*).
- Green sunfish (*Apomotis cyanellus*).
- Bluegill sunfish (*Lepomis incisor*).
- Common sunfish (*Eupomotis gibbosus*).

PERCHES (PERCIDÆ):
- Pike perch (*Stizostedion vitreum*).
- Yellow perch, ringed perch (*Perca flavescens*).

STRIPED BASSES (SERRANIDÆ):
- Striped bass (*Roccus lineatus*).
- White perch (*Morone americana*).
- White bass (*Roccus chrysops*).

DRUMS (SCIAENIDÆ): Fresh-water drum, lake sheepshead (*Aplodinotus grunniens*.)

CODS (GADIDÆ):
- Cod (*Gadus callarias*).
- Haddock (*Melanogrammus æglifinus*).
- Pollock (*Pollachius virens*).

FLOUNDERS (PLEURONECTIDÆ): Winter flounder, American flatfish (*Pseudopleuronectes americanus*).

MACKEREL (SCOMBRIDÆ): Common mackerel (*Scomber scombrus*).

COOPERATIVE ACTIVITIES

The bureau's contact with the majority of public and private agencies interested in the conservation of fishery resources has been the means of establishing and maintaining profitable cooperative relationships. The well-established practice of supplying surplus trout eggs, either as outright donations or on an exchange basis, to many of the States has been followed to the greatest possible extent. The bureau's egg collections, particularly in the West, have therefore been an important item in assuring a supply of trout eggs at low cost to several of the States. The bureau has also benefited by reciprocal action of a similar nature on the part of the State authorities. Acquisition of early black-spotted trout eggs from Nevada has accelerated distribution of this species in the Rocky Mountain section, and the State of Montana has furnished grayling, otherwise unavailable, in return for Loch Leven eggs, of which the bureau has an ample supply. The bureau has also acted as a clearing house through which the Eastern States, in particular, have been able to secure eggs of species unavailable from usual commercial sources. The steelhead, as well as other Pacific salmons, the lake trout, the Loch Leven, and the western strain of rainbow trout have thus been disseminated. The assignments listed below represent both the outright donations on the part of the bureau and the exchanges whereby the bureau may have received a return of equivalent value.

Cooperation has been practiced in ways other than the physical transfer of eggs and fish. The bureau has, as usual, incubated trout eggs for the State of West Virginia and lent a distribution car for transporting the resulting fish. The pike-perch hatchery on Lake Champlain, a joint project of the bureau and the States of Vermont and Pennsylvania, was operated as heretofore. The bureau has detailed employees to carry on the propagation of spiny lobsters for the State of Florida and to supervise construction of a large bass hatchery for Arkansas. A limited distribution of bass was secured from the pond at Miles City, Mont., constructed by the State on Government-owned land and stocked and operated by the bureau. Virginia is developing a fish-cultural program with the assistance of the bureau in the matter of supplying fish and the necessary technical supervision. There appears elsewhere in this report a summary of the fish-cultural activities of the various States in so far as current data could be secured. A feature of the year's work has been the strengthening of cooperative relationships with other Federal agencies, particularly the Forest Service and the National Park Service. The bureau has to the fullest possible extent honored the requisitions for fish for the national forests. One of the bureau's employees was detailed to investigate the stocking possibilities in one of the national-forest areas in Alabama.

With regard to developments in the national parks the year has shown material progress. A large new hatchery building of rustic log construction has been virtually completed, and the work of constructing living quarters is proceeding with the view of ultimately providing one of the finest trout hatcheries in the country. The plant will be in operation during the spring of 1930. In addition, there have been constructed at Mammoth Hot Springs ten 60-foot rearing pools, which will be used in retaining fish from the lake hatchery and from outside stations until October. A series of rearing pools has also been constructed at Glacier Park and the hatchery capacity enlarged, following a rearrangement of the water supply. Egg-taking operations were initiated during the spring with a collection of over 100,000 black-spotted trout eggs. Further developments in this field have been planned to compensate for the drain arising from the opening of a new road through the park within a short time. Arrangements have been completed for the appointment of a bureau employee to act as contact officer with the park service in all matters pertaining to fish culture and to map out in detail the fish-cultural possibilities in the various parks. The bureau has assumed these various obligations in addition to its primary duty of filling individual applications of private citizens for fish.

Assignments of fish eggs to State and Territorial fish commissions, fiscal year 1929

State and species	Number	State and species	Number
California: Atlantic salmon	25,000	New Mexico: Loch Leven trout	1,035,000
Colorado:		New York:	
Chinook salmon	501,000	Lake trout	500,000
Lake trout	30,000	Landlocked salmon	35,000
Loch Leven trout	500,000	Steelhead salmon	100,000
Rainbow trout	100,000	North Carolina: Rainbow trout	400,000
Connecticut:		Oregon:	
Brook trout	50,000	Chinook salmon	11,885,000
Lake trout	60,000	Silver salmon	755,000
Loch Leven trout	100,000	Sockeye salmon	4,266,000
Georgia: Rainbow trout	141,000	Steelhead salmon	1,408,000
Hawaii:		Pennsylvania:	
Chinook salmon	18,000	Atlantic salmon	20,000
Steelhead salmon	40,000	Common sucker	1,800,000
Idaho:		Cisco	8,000,000
Landlocked salmon	50,000	Pike perch	28,600,000
Rainbow trout	100,000	Utah: Brook trout	52,000
Iowa: Rainbow trout	171,000	Vermont:	
Maine:		Loch Leven trout	150,000
Atlantic salmon	300,000	Landlocked salmon	25,000
Lake trout	300,000	Washington:	
Maryland:		Brook trout	500,000
Loch Leven trout	200,000	Humpback salmon	1,852,000
Rainbow trout	50,000	Lock Leven trout	500,000
Michigan: Lake trout	240,000	Silver salmon	1,901,000
Minnesota: Lake trout	592,000	Sockeye salmon	314,000
Montana:		Wyoming:	
Chinook salmon	500,000	Brook trout	100,000
Loch Leven trout	2,348,000	Loch Leven trout	1,250,000
Rainbow trout	500,000	Rainbow trout	500,000
Nebraska: Loch Leven trout	200,000		
Nevada: Rainbow trout	1,246,000	Total	74,410,000
New Hampshire: Lake trout	100,000		

FISH NURSERIES

The practice of retaining hatchery fish in rearing pools conducted and maintained by groups of sportsmen for several months before releasing them in the streams has been expanded further. A review of the accompanying table will show that the number of units operated has increased materially, with a corresponding increase in the number of fish supplied. The Windber (Pa.) and Harrisburg (Pa.) hatcheries received over 500,000 eggs, which brought the assignments to a number almost twice that of previous years. The Windber organization has constructed a splendid new hatchery building with a capacity of several million eggs.

Experience has shown that one of the most prolific sources of trouble at the nurseries has been the tendency to overstock them.

Some assignments therefore have been reduced, and there has been considerable improvement in the quantity and quality of fish produced. In addition to the Pennsylvania establishments cited above, one other hatchery, located at Barneveld, N. Y., is equipped to handle eggs, and a brood stock of trout capable of supplying limited quantities of eggs has been built up. There are now three of these projects owned by groups of sportsmen and operated as hatcheries by the bureau's employees. Such plants have actually served as substations to the bureau's main stations.

Observations appearing in the report for 1928 to the effect that the nurseries were developing in groups too closely bunched and that a special personnel will be necessary properly to care for the expansion deserve repetition. It may also be repeated that bass nurseries are needed to a greater extent than those for trout, but that prevailing conditions have made it much more difficult to develop such projects.

In addition to the fish assigned to the nurseries listed herein, many of the trout consigned upon regular applications are placed in rearing ponds that are not conducted under the auspices of the bureau. This is particularly the case in the Western States, where large nursery-pond projects have been conducted independently or under the supervision of the States. A number of the States have been active in developing the rearing-pool plan, and the impetus given by the bureau's earlier work has brought about an expansion far beyond the facilities of any single agency.

It would appear desirable to emphasize again the facts experience has shown to be essential for success in conducting the work of private fish nurseries. Any site should be inspected by an experienced fish-culturist prior to development and should not be developed at all if the investigation does not show that the proper conditions exist. Construction and development should be strictly in accord with the recommendations of the bureau or the State supervising the work, and the recommendations with regard to the operation of the plant, including the number of fish to be stocked, feeding, etc., should be followed explicitly. Above all, a conscientious caretaker should be on hand to give frequent or constant attention to the fish. A stock of small trout can not be placed in the average nursery and neglected without heavy losses ensuing.

Cooperative nurseries and rearing ponds supervised by the bureau in 1929

Locality	Number of fish supplied	Kind
Massachusetts:		
Fitchburg	400	Brook trout.
Lenox	25,000	Do.
Pittsfield	9,000	Do.
Westfield	3,500	Do.
Michigan:		
Rogers City	800,000	Lake trout.
Turtle Lake	200,000	Brook trout.
Minnesota:		
Anoka	3,000	Do.
Kimball	6,500	Do.
Lake City	20,000	Do.
Lewiston	10,000	Rainbow trout.
Mora	5,000	Brook trout.
Red Wing	10,400	Do.
Do	18,850	Rainbow trout.

Cooperative nurseries and rearing ponds supervised by the bureau in 1929—Contd.

Locality	Number of fish supplied	Kind
Minnesota—Continued.		
Rochester—Altura	60,320	Loch Leven trout.
Rochester	8,000	Brook trout.
Rushford (2 nurseries)	16,500	Loch Leven trout.
Rushford	11,050	Rainbow trout.
St. Charles	15,080	Loch Leven trout.
Wadena	5,000	Brook trout.
Winona	50,000	Rainbow trout.
Do	40,000	Brook trout.
New Hampshire:		
Merrimack	20,000	Do.
Greenville	20,000	Do.
Wilton	20,000	Do.
Lebanon	25,000	Do.
Peterboro	20,200	Do.
New Jersey: Paterson	10,000	Do.
New York:		
Watertown	658,715	Do.
Malone	40,000	Loch Leven trout.
Do	40,000	Brook trout.
Adams	25,000	Do.
Oneonta	60,000	Do.
Arena	5,000	Loch Leven trout.
Austerlitz	4,000	Brook trout.
Barneveld	238,455	Brook-trout eggs.
Do	113,398	Rainbow-trout eggs.
Clyde	14,000	Black bass.
Pennsylvania:		
Windber	267,000	Brook-trout eggs.
Harrisburg	317,000	Do.
Do	33,360	Brook trout.
Chester	10,000	Loch Leven trout.
Meyersdale	25,000	Brook trout.
Meadeville	48	Black bass.
Renovo	40,000	Brook trout.
Ridgway	15,000	Rainbow trout.
Belleville	20,000	Brook trout.
Carrollton	10,000	Do.
Clearfield	20,000	Do.
Muncy (2 nurseries)	55,000	Do.
Muncy	20,000	Loch Leven trout.
Williamsport	10,000	Do.
Williamsport (4 nurseries)	115,000	Brook trout.
Ebensburg	10,000	Do.
Altoona	5,000	Loch Leven trout.
Do	10,000	Brook trout.
Do	10,000	Rainbow trout.
Johnstown	10,000	Brook trout.
Do	10,000	Rainbow trout.
Galeton	20,000	Brook trout.
Hazleton	20,000	Do.
Scranton	50,000	Do.
Pittston	10,000	Do.
Do	5,000	Loch Leven trout.
Bloomsburg	20,000	Brook trout.
St. Marys	10,000	Do.
Sharon	4,000	Do.
Somerset	25,000	Do.
Do	15,000	Rainbow trout.
Chambersburg	8,175	Brook trout.
Do	6,000	Rainbow trout.
Jennerstown	5,000	Brook trout.
Ligonier	15,000	Do.
Do	25,000	Rainbow trout.
Vermont:		
Bennington	75,000	Brook trout.
Averill	75,000	Do.
Do	60,000	Lake trout.
Virginia:		
Shawsville	15,000	Rainbow trout.
Smythe County	75,000	Do.
Do	75,000	Brook trout.
Wise County	7,000	Rainbow trout.
Craig County	80,000	Do.
Do	60,000	Brook trout.
Bath County	30,000	Do.
Do	20,000	Rainbow trout.
Nelson County	17,000	Brook trout.
West Virginia:		
Durbin	25,000	Do.
Do	3,000	Rainbow trout.

Cooperative nurseries and rearing ponds supervised by the bureau in 1929—Contd

Locality	Number of fish supplied	Kind
Wisconsin:		
Altoona	3,000	Rainbow trout.
Arcadia	15,000	Brook trout.
Athelstane	25,000	Do.
Boscobel	15,000	Do.
Do	5,000	Rainbow trout.
Clear Lake	8,000	Brook trout.
Darlington	5,000	Rainbow trout.
Eau Claire	2,500	Brook trout.
Eau Claire (2 nurseries)	42,500	Rainbow trout.
Elroy	9,000	Brook trout.
Ellsworth	40,000	Rainbow trout.
Do	5,000	Brook trout.
Elmwood (2 nurseries)	6,000	Rainbow trout.
Galesville	10,000	Brook trout.
Gilmanton	3,000	Do.
Glenwood City	4,750	Do.
Hatley	9,000	Do.
Hazel Green	15,000	Do.
Holmen	13,000	Do.
Independence	15,000	Do.
La Crosse	20,000	Rainbow trout.
Do	5,000	Brook trout.
Laona	17,670	Do.
Manitowoc	5,000	Rainbow trout.
Marathon	10,000	Brook trout.
Medford	3,000	Do.
Merrill	20,000	Do.
Nekoosa	10,000	Do.
Osseo	10,000	Do.
Plum City	8,000	Do.
Port Edwards	10,000	Rainbow trout.
Prescott	5,000	Brook trout.
Rothschilds	8,000	Do.
Schofield	3,000	Do.
Shullsburg	5,000	Rainbow trout.
Sparta	3,000	Brook trout.
Stanley	14,250	Do.
Stevens Point	20,000	Rainbow trout.
Do	9,500	Brook trout.
Tomah	15,000	Do.
Tomahawk	15,000	Do.
Tunnel City	10,000	Do.
Viroqua	6,000	Rainbow trout.
Wausau	12,000	Brook trout.
Westby	12,000	Rainbow trout.
Wisconsin Rapids	5,000	Do.
Total	5,006,121	

STATE FISH-CULTURAL ACTIVITIES

The propagation and distribution of fish by the States is a factor of great importance in maintaining the supply of food and game species. While a few States operate no hatcheries, State activities in others overshadow those of the Bureau of Fisheries. As a means of comparative illustration of the facilities for fish culture and the results accruing therefrom, questionnaires were sent to the States, and the information so secured is tabulated below. In interpreting these data it should be remembered that direct comparison on the basis of actual numerical output is erroneous, since several States in the East distribute their game fish at a legal size only, with the consequent reduction in numbers. Other States, particularly in the West, are still distributing small fingerlings. The smaller number of fish may therefore have a greater stocking value than the numerically greater output of other States. The information in the table is supplied by the States themselves or taken from the printed reports and covers the latest complete year upon which data could be obtained.

The totals will therefore fail to represent an aggregate country-wide distribution for any one year but are rather indicative of a normal annual output.

State fish-cultural activities

State	Distribution of—				Total
	Trout	Pondfish	Other game fish	Food fish	
Alabama		299,435			299,435
Arizona	2,480,000	40,000			2,520,000
Arkansas		1,000		8,392,000	8,393,000
California	20,202,000			4,260,000	24,462,000
Colorado	27,000,000	1,000,000			28,000,000
Connecticut	396,031	321,751	35,650,000	132,251,566	168,619,348
Florida		1,887,500		[1] 38,800,000	40,687,500
Georgia	250,000				250,000
Idaho	10,000,000				10,000,000
Illinois		1,240,000			1,240,000
Indiana		898,855	10,259,000		11,157,855
Iowa	316,240	445,042	15,880		777,162
Kansas		300,000	700,000		1,000,000
Kentucky		98,318			98,318
Louisiana		2,622,260		8,067,810	10,690,070
Maine	2,752,800		1,077,004		3,829,804
Maryland	800,000	200,000		621,990,000	622,990,000
Michigan	18,193,026	1,724,350	16,884,109	98,228,147	135,029,632
Massachusetts	446,880	747,652	45,121	3,915	1,243,568
Minnesota	4,436,000	1,527,500	595,800,000	91,029,000	692,792,500
Missouri	444,270	390,709	1,300		836,279
Montana	45,634,318	315,000		2,791,400	48,740,718
Nebraska	728,305	5,717,707			6,446,012
Nevada	3,884,248				3,884,248
New Hampshire	12,012,737	1,430	822,600	16,803,334	29,640,101
New Mexico	4,516,000				4,516,000
New Jersey	637,522	856,500	78	98,120,000	99,614,100
New York	9,622,899	528,139	147,991,500	800,417,450	958,559,988
North Carolina	3,133,000	552,812	261,435	7,000,000	10,947,247
North Dakota			64,000,000		64,000,000
Ohio		3,912,781			3,912,781
Oklahoma		966,974			966,974
Oregon	20,346,278	3,461,323		71,000,000	94,807,601
Pennsylvania	794,312	1,359,550	239,327,200	115,187,800	356,668,862
Rhode Island	41,030	600	500	[1] 1,200,000	1,242,130
South Dakota	249,115	4,554,115			4,803,230
Texas		400,000			400,000
Utah	8,018,700	2,331,870			10,350,570
Vermont	1,107,624	40,000	38,264,514		39,412,138
Washington [2]	34,111,152		25,667,150	98,567,098	158,345,400
West Virginia	1,152,000	30,100			1,182,100
Wisconsin	11.344,125	4,615,339	215,749,000	42,772,600	274,481,064
Wyoming	10,000,000				10,000,000
Total	255,050,612	43,388,612	1,392,516,391	2,256,882,120	3,947,837,735

State	Number of hatcheries	Number of employees	Expenditures	Investment
Alabama	1	2	$1,480.54	$15,000.00
Arizona	3	5	18,000.00	20,000.00
Arkansas	[3] 1	2		65,000.00
California	20			
Colorado	15	25	100,000.00	750,000.00
Connecticut	6	12	44,135.14	150,000.00
Florida	6	11	77,963.14	137,759.73
Georgia	[3] 1	2	6,000.00	
Idaho	11	20	48,000.00	82,000.00
Illinois	9	20	35,000.00	250,000.00
Indiana	5	15	49,573.00	225,000.00
Iowa	4	8	57,000.00	75,000.00
Kansas	5	11	30,500.00	80,000.00
Kentucky	2	3		80,000.00
Louisiana	3	4	5,687.48	100,000.00
Maine	12	30	71,688.82	75,000.00
Maryland	8	11	22,500.00	10,000.00
Michigan	17	75	273,896.00	642,758.37
Massachusetts	7	10	60,267.42	122,368.00
Minnesota	13	33	106,530.55	375,000.00
Missouri	7	16	53,500.91	79,650.00

[1] Lobsters. [2] Does not include figures for county hatcheries. [3] New.

State fish-cultural activities—Continued

State	Number of hatcheries	Number of employees	Expenditures	Investment
Montana	14	83	$85, 240. 80	------------
Nevada	1	--------	------------	------------
New Hampshire	6	21	86, 055. 51	$350, 000. 00
New Mexico	6	9	44, 000. 00	69, 251. 00
New Jersey	2	12	68, 400. 42	------------
New York	11	60	250, 000. 00	------------
North Carolina	6	17	45, 000. 00	170, 581. 34
North Dakota	1	2	5, 000. 00	15, 000. 00
Ohio	11	17	------------	------------
Oklahoma	4	30	82, 778. 00	800, 000. 00
Oregon	50	--------	226, 739. 06	------------
Pennsylvania	6	30	229, 116. 40	1, 505, 230. 00
Rhode Island	1	--------	------------	------------
South Dakota	6	8	34, 504. 49	165, 000. 00
Texas	5	15	25, 000. 00	250, 000. 00
Utah	8	11	42, 000. 00	250, 000. 00
Vermont	5	10	32, 588. 79	77, 200. 00
Washington [3]	25	73	164, 340. 82	500, 000. 00
West Virginia	[4] 4	4	12, 500. 00	10, 000. 00
Wisconsin	23	31	112, 568. 50	421, 379. 80
Wyoming	8	14	42, 500. 00	160, 000. 00
Total	859	712	2, 645, 056. 29	7, 868, 178. 24

[3] Does not include figures for county hatcheries. [4] Nurseries.

OUTPUT

The aggregate output of 7,060,369,500 eggs, fry, and fingerling fish represents a new high total for the fish-cultural work of the bureau. Analysis of the figures for the various groups in succeeding sections will give a clearer picture of the significance of the year's operations, however. A material increase in the total arising from a heavy output of some varieties, such as carp, with a decrease in the production of Pacific salmons or trout would really constitute a retrogression from the standpoint of economic utility. Fortunately, the 1929 percentage distribution of the various groups within the total is substantially the same as in previous years, and the 30,000,000 increase represents an actual gain. The comparison of this season's output with the 5-year average will give a clearer conception of the trend of development.

Game fishes comprised only about 1 per cent of the total output, in comparison with 2.7 per cent for 1928. The decline was due entirely to the failure of the rescue work on the Mississippi River, which normally supplies well over 51 per cent of the total production of game fishes. The proportion of Pacific salmons dropped from 2.9 to about 2.2 per cent. The output of marine species (eggs and fry) was increased from 82 to 86.9 per cent, while the commercial anadromous forms as a whole receded from 4.1 to 3.5 per cent. The commercial species of the interior waters, mainly the Great Lakes, are represented by a percentage of 7.9, in comparison with 8.3 for the previous year. These slight percentage changes leave the actual numerical output for the various groups virtually the same as last year, with the total increase being carried by the marine commercial species.

The production of fingerlings dropped from 261,634,200 to 136,185,500, a decrease of 47.9 per cent. This was entirely accounted for by the failure of the rescue work, which normally supplies between 140,000,000 and 150,000,000 fish, all fingerlings. Deducting the rescued fish from the fingerling totals for 1928 and 1929, it appears that there was an actual increase of 27,762,140 fish, or 26.9 per cent in the number of fingerlings actually produced and distributed from the bureau's stations in 1929.

Summary, by species, of the output of fish and fish eggs during the fiscal year ended June 30, 1929

Species	Eggs	Fry	Fingerlings	Total
Catfish			888, 100	888, 100
Buffalo fish	49, 369, 000		34, 700	49, 403, 700
Common sucker	1, 800, 000			1, 800, 000
Carp	24, 300, 000	2, 500, 000	31, 000	26, 831, 000
Shad		71, 351, 000		71, 351, 000
Glut herring		11, 500, 000		11, 500, 000
Whitefish	3, 000, 000	94, 295, 000		97, 295, 000
Cisco	9, 200, 000	123, 000, 000		132, 200, 000
Chinook salmon	14, 419, 000	925, 000	39, 049, 400	54, 393, 400
Chum salmon	765, 000	19, 153, 000	49, 000	19, 967, 000
Silver salmon	2, 101, 000	6, 049, 000	1, 398, 300	9, 548, 300
Sockeye salmon	6, 432, 000	2, 640, 000	54, 176, 900	63, 248, 900
Humpback salmon	1, 852, 000			1, 852, 000
Steelhead salmon	1, 979, 000	112, 000	1, 428, 500	3, 519, 500
Atlantic salmon	345, 000		572, 200	917, 200
Landlocked salmon	110, 000	15, 000	543, 700	668, 700
Rainbow trout	4, 685, 000	635, 000	7, 399, 200	12, 719, 200
Golden trout			9, 000	9, 000
Black-spotted trout	11, 842, 000		7, 242, 000	19, 084, 000
Loch Leven trout	7, 713, 000	5, 000	1, 496, 700	9, 214, 700
Lake trout	2, 184, 000	26, 100, 000	2, 051, 000	30, 335, 000
Brook trout	1, 542, 000	2, 407, 000	12, 906, 200	16, 855, 200
Grayling		1, 765, 000		1, 765, 000
Pike and pickerel			34, 800	34, 800
Mackerel		2, 778, 000		2, 778, 000
Crappie			1, 898, 900	1, 898, 900
Largemouth black bass		696, 000	1, 728, 900	2, 424, 900
Smallmouth black bass		664, 000	155, 000	819, 000
Rock bass			79, 000	79, 000
Warmouth bass			6, 700	6, 700
Sunfish			2, 154, 000	2, 154, 000
Pike perch	28, 600, 000	52, 150, 000	400	80, 750, 400
Yellow perch		192, 923, 000	188, 500	193, 111, 500
Striped bass		9, 661, 000		9, 661, 000
White perch			250	250
White bass			300	300
Fresh-water drum			2, 850	2, 850
Cod	2, 228, 122, 000	274, 033, 000		2, 502, 155, 000
Haddock	351, 442, 000			351, 442, 000
Pollock		358, 442, 000		358, 442, 000
Winter flounder	109, 434, 000	2, 809, 149, 000		2, 918, 583, 000
Miscellaneous fishes			660, 000	660, 000
Total	2, 861, 236, 000	4, 062, 948, 000	136, 185, 500	7, 060, 369, 500

The following table indicates the actual numerical output of the strictly game fishes, the anadromous species (which includes the shad, glut herring, salmons, etc.), the commercial species of interior waters (including the whitefish, cisco, lake trout, and pike perch), and also the marine species. Yellow perch are included with the game species, although in many sections they are also an important commercial fish. On the other hand, the pike perch has been listed as a commercial fish, although it is eagerly sought by sportsmen. A comparison of the limited number of game fish with the other varieties would indicate reasons for the bureau's difficulty in giving early and immediate attention to applications for these forms.

Game species	260, 845, 150
Anadromous species	245, 958, 300
Commercial species (Great Lakes and interior waters)	367, 411, 400
Marine species	6, 133, 400, 000
Miscellaneous species	52, 754, 650
Total	7, 060, 369, 500

EGG COLLECTIONS

While the general public is most familiar with the hatcheries, with their equipment for incubating eggs and rearing fish, the success of hatchery operations sometimes depends upon the work of the egg-collecting stations. The taking of eggs is frequently attended by hardship and sometimes hazard. It is often necessary to penetrate to remote locations to secure trout eggs in the face of adverse weather conditions in the late fall or early spring in mountainous sections in the Western States, or to go out in small boats in storms to secure cod eggs or the eggs of the Great Lakes species. In many instances the location represents the point from which eggs are shipped to the hatcheries, the bureau having no property or equipment in use. It will be noted that the total egg collections, aggregating 7,870,015,000, were smaller than those of last year, although the output of fish was greater. This was due to the high quality of the eggs, the increased percentage of hatch, and the fact that the distribution included a large number of fingerlings reserved from the previous year's hatch. The figures covering striped-bass operations represent cooperative activities with the State of North Carolina. The taking of mackerel eggs is a minor development in connection with the propagation of other marine species at the Woods Hole (Mass.) station.

The most unfavorable aspect of this phase of the work lies in the continued decline of the whitefish-egg collections. Some of the stations, particularly that at Put in Bay, Ohio, are able to obtain sufficient eggs for only a third or a half of the jar capacity, and it is necessary to handle more abundant and less desirable forms in order to utilize the equipment. With the exception of several hundred thousand brook-trout eggs purchased for stocking cooperative hatcheries, the bureau was relieved of the necessity of buying any trout eggs during the year. Field collections and the take from station brood stocks furnished sufficient rainbow, Loch Leven, and black-spotted trout eggs for exchange to fill other requirements and shortages. Requirements for all species of eggs for the coming year will probably be met without the necessity of making any purchases whatever from commercial hatcheries.

Comparison of egg collections, fiscal years 1929 and 1928

Species	1929	1928	Species	1929	1928
Buffalo fish	49,396,000	10,200,000	Black-spotted trout	16,202,200	23,115,000
White sucker	1,800,000		Loch Leven trout	15,048,100	15,767,800
Carp	28,050,000	7,500,000	Lake trout	65,354,400	85,911,340
Shad	83,806,000	51,473,000	Brook trout	16,686,110	18,509,290
Glut herring	37,740,000	223,444,000	Mackerel	3,482,000	6,237,000
Whitefish	149,712,000	198,709,500	Pike perch	228,303,000	729,610,000
Cisco	241,901,250	172,822,500	Yellow perch	214,835,000	184,890,000
Chinook salmon	49,830,200	58,792,800	Striped bass	13,780,000	9,415,000
Chum salmon	23,467,000	25,247,000	Cod	2,244,467,000	2,373,459,000
Humpback salmon	4,428,800	2,625,000	Haddock	475,737,000	331,417,000
Silver salmon	9,104,300	15,462,000	Pollock	596,132,000	213,867,000
Sockeye salmon	51,038,120	44,495,000	Winter flounder	3,219,880,000	3,054,153,000
Steelhead salmon	9,293,300	4,729,500			
Landlocked salmon	1,157,880	767,950	Total	7,870,015,000	7,882,070,100
Rainbow trout	19,377,340	21,060,480			

Egg-collecting stations

Station	Period of operation	Species handled
Baker Lake, Wash.: Brinnon, Wash	Nov. 24-Jan. 15	Chum salmon (late run).
Boothbay Harbor, Me.:		
Ebenecook Harbor, Me	Mar. 5-Apr. 15	Winter flounder.
Fisherman Island Passage, Me	Apr. 22-June 1	Cod and haddock.
Johns Bay, Me	Mar. 5-Apr. 23	Winter flounder.
	Apr. 30-June 1	Cod and haddock.
Linekins Bay, Me	Mar. 12-June 1	Winter flounder, cod, and haddock.
Little River, Me	Mar. 23-Apr. 30	Winter flounder.
Muscungus Bay, Me	Apr. 30-June 1	Cod and haddock.
Robin Hoods Cove, Me	Mar. 15-Apr. 17	Winter flounder.
Sheepscott Bay, Me	Apr. 1-June 11	Cod.
Sheepscott River, Me	Mar. 5-June 11	Winter flounder and cod.
Cape Vincent, N. Y.:		
Bowmanville, Ontario	Nov. 1-Nov. 15	Whitefish.
Brighton, Ontario	do	Do.
Charity Shoals, N. Y	Oct. 20-Nov. 5	Lake trout.
Chaumont Bay, N. Y	Nov. 6-Dec. 3	Whitefish and cisco.
Consecon, Ontario	Oct. 28-Nov. 24	Lake trout, whitefish, and cisco.
Fairhaven, N. Y	Nov. 17-Nov. 30	Cisco.
Gardenville, N. Y	Nov. 12-Nov. 24	Do.
Indian Point, Ontario	Oct. 28-Nov. 30	Lake trout, whitefish, and cisco.
Irondequoit Bay, N. Y	Dec. 6	Cisco.
Long Point, Ontario	Oct. 30-Nov. 18	Lake trout and whitefish.
Pigeon Island, Ontario	Oct. 17-Nov. 10	Lake trout.
Simcoe Island, Ontario	Oct. 25-Nov. 16	Lake trout and whitefish.
Sodus Point, N. Y	Nov. 17-Dec. 1	Cisco.
Stoney Island, N. Y	Oct. 20-Nov. 5	Lake trout.
Clackamas, Oreg.:		
Lemhi River, Idaho	Aug. 16-Sept. 3	Chinook salmon.
Upper Clackamas, Oreg	Aug. 31-Sept. 24	Do.
Williams Lake, Idaho	Apr. 30-June 10	Rainbow trout.
Craig Brook, Me.: Green Lake, Me	July 1-Nov. 22	Landlocked salmon.
Duluth, Minn.:		
Au Train, Mich	Oct. 15-Oct. 30	Lake trout.
Bemidji, Minn	Apr. 16-Apr. 30	Pike perch.
Big Traverse Bay, Mich	Oct. 15-Oct. 30	Lake trout.
Copper Harbor, Mich	Oct. 1-Oct. 12	Do.
Gay, Mich	Oct. 15-Oct. 30	Do.
Grand Marais, Mich	Oct. 18-Nov. 7	Do.
Huron Island, Mich	Oct. 15-Nov. 1	Do.
Isle Royale ports, Mich	Sept. 28-Nov. 20	Lake trout and whitefish.
Manitou Island, Mich	Oct. 13-Oct. 27	Lake trout.
Marquette, Mich	Oct. 17-Nov. 1	Do.
Munising, Mich	Oct. 20-Oct. 30	Do.
Portage Entry, Mich	Oct. 13-Nov. 2	Do.
Portage Lake Canal, Mich	Oct. 10-Nov. 2	Do.
Gloucester, Mass.:		
Boars Head, N. H	Feb. 2-May 25	Cod.
Marblehead, Mass	Feb. 25-Mar. 10	Do.
Plymouth, Mass	Nov. 1-Feb. 28	Cod and pollock.
Rockport, Mass	Nov. 1-May 25	Pollock, cod, and haddock.
Leadville, Colo.:		
Mount Massive Club Lakes, Colo	Oct. 22-Dec. 6	Brook trout.
Mount Princeton Lake, Colo	Nov. 14-Nov. 24	Do.
Turquoise Lake, Colo	Oct. 20-Dec. 5	Brook and Loch Leven trout.
Wurts Lakes, Colo	Sept. 24-Nov. 3	Brook trout.
Nashua, N. H.: Lebanon, N. H	Apr. 10-May 6	Rainbow trout.
Northville, Mich.:		
Beaver Island, Mich	Nov. 3-Nov. 30	Lake trout and whitefish.
Black River, Mich	Oct. 30-Oct. 31	Lake trout.
Cheboygan, Mich	Oct. 22-Nov. 7	Do.
	Nov. 23	Whitefish.
Cross Village, Mich	Nov. 19-Nov. 20	Do.
Epoufette, Mich	Nov. 7-Nov. 20	Do.
Frankfort, Mich	Nov. 17-Nov. 30	Lake trout.
Leland, Mich	Nov. 15-Nov. 30	Do.
Middle Island, Mich	Nov. 3	Do.
Naubinway, Mich	Nov. 17-Nov. 30	Do.
Northport, Mich	Nov. 15-Nov. 30	Do.
Oscoda, Mich	Oct. 27-Nov. 23	Lake trout and whitefish.
Presque Isle, Mich	Nov. 6	Lake trout.
St. Ignace, Mich	Oct. 22-Nov. 30	Lake trout and whitefish.
Sturgeon Bay, Mich	Nov. 17	Whitefish.
Put in Bay, Ohio:		
Catawba Island, Ohio	Nov. 9-Dec. 1	Do.
Middle Bass, Ohio	Nov. 9-Nov. 29	Do.
North Bass, Ohio	Nov. 9-Dec. 1	Do.
Port Clinton, Ohio	Nov. 9-Dec. 4	Do.
	Apr. 17-May 2	Pike perch and yellow perch.
	June 3-June 22	Carp.
Toledo, Ohio	Nov. 9-Dec. 2	Whitefish.
	Apr. 7-Apr. 30	Pike perch.

Egg-collecting stations—Continued

Station	Period of operation	Species handled
Saratoga, Wyo.:		
Big Creek Lakes, Colo	Sept. 4–Nov. 1	Brook trout.
Lost Creek, Wyo	Mar. 26–June 26	Rainbow trout.
Springville, Utah: Fish Lake, Utah	Oct. 6–Dec. 4	Brook trout.
	Apr. 1–May 31	Rainbow trout.
Woods Hole, Mass.:		
Groton, Conn	March to April	Cod and haddock.
Waquoit, Mass	January to April	Winter flounder.

SALVAGE OF FISH

The uncertainty attending the practice of rescuing fish from overflow areas, as of the upper Mississippi River, is well illustrated by the fact that the total collections for the year slightly exceeded 5,000,000, whereas under normal conditions 150,000,000 or more fish may be handled. Adequate rainfall throughout the summer permitted the river to recede slowly, allowing most of the fish to escape and rendering it unnecessary and impracticable to put the usual seine crews in the field. Such conditions occur at sufficiently frequent intervals to assure frequent restocking of the upper Mississippi with the entire output of these spawning areas and to replenish the drain occasioned by the extremely limited withdrawal of fish shipped to other waters by the bureau. The survey of the fish-cultural possibilities of the upper Mississippi River wild life and fish refuge was continued with the object of propagating warm-water fishes artificially and discontinuing the use of rescued fishes for general distribution.

Many organizations, being advised of the tremendous number of fish handled during a normal season of rescue work, have requested the delivery to other waters of bass and other species in carload lots. It has been necessary to refuse these requests in order to keep the withdrawals within reasonable limits. Further embarrassment has arisen from the fact that the public is unaware of the fluctuations in this source of supply and has assumed that it could be drawn upon at all times.

Number and disposition of fish rescued, fiscal year 1929

Locality and species	Delivered to applicants	Restored to original waters	Total number of fish rescued
All stations:			
Buffalo fish		34,705	34,705
Carp		31,255	31,255
Catfish	1,020	834,822	835,342
Crappie	48,600	1,804,822	1,853,422
Fresh-water drum		2,850	2,850
Largemouth black bass	1,445	4,357	5,802
Pike and pickerel		34,775	34,775
Pike perch		393	393
Sunfish	14,479	1,611,600	1,626,079
White bass		332	332
Yellow perch	6,650	110,648	117,298
Miscellaneous		660,000	660,000
Total	72,194	5,130,059	5,202,253
Summary, by stations:			
Fairport, Iowa		233,833	233,833
Homer, Minn	28,300	3,403,565	3,431,865
Lake Worth, Tex	25,000		25,000
Marquette, Iowa	18,894	1,492,661	1,511,555
Total	72,194	5,130,059	5,202,253

SHIPMENTS TO FOREIGN COUNTRIES

Shipments of eggs or fish to foreign countries during the year were somewhat below the number usually furnished. While the normal number of tentative inquiries relative to the possibility of acclimatizing American forms were received, they resulted in only the limited number of shipments appearing below. The bureau cooperated in handling some shad fry furnished by the State of Oregon for shipment to Japan. It is interesting to note that a consignment of smallmouth black bass fingerlings was successfully transported to Sweden. Certain shipments of eggs to Canada are not included, as these were involved in exchanges whereby the bureau received an equivalent number of salmon eggs.

Shipments of fish and fish eggs to foreign countries, fiscal year 1929

Country and species	Eggs	Fish	Country and species	Eggs	Fish
Canada: Rainbow trout	40,000		Sweden: Smallmouth black bass		250
Cuba: Rainbow trout	50,000		Switzerland: Lake trout	50,000	
Japan: Whitefish	3,000,000				
Peru: Rainbow trout	150,000		Total	3,290,000	250

PRODUCTION BY INDIVIDUAL STATIONS

The nature and magnitude of the activities at the various stations and substations is indicated in the ensuing table. The substations, which are not necessarily within the same territory as the main stations, occasionally being located in different States, are so designated for administrative reasons or on account of activity allied to that of the headquarters station. The number of main stations operated totals 37, while 40 substations were on an active basis.

Stations and substations operated and output of each, fiscal year 1929

[Asterisk (*) denotes transfer of eggs. See table, p. 779]

Stations, substations, and species	Eggs	Fry	Fingerlings, yearlings, and adults	Total [1]
Afognak, Alaska:				
Humpback salmon	1,851,550			1,851,550
Sockeye salmon			18,700,000	18,700,000
Baird, Calif.: Chinook salmon			711,000	711,000
Battle Creek, Calif.: Chinook salmon			2,189,000	2,189,000
Mill Creek, Calif.: Chinook salmon	*1,000,000		500,000	1,500,000
Baker Lake, Wash.: Sockeye salmon	(*)		63,500	63,500
Birdsview, Wash.—				
Brook trout			1,000	1,000
Chinook salmon		670,000	2,218,200	2,888,200
Silver salmon		1,875,400	268,890	2,144,290
Sockeye salmon			72,000	72,000
Steelhead salmon	90,000		760,000	850,000
Duckabush, Wash.—				
Chinook salmon			750,000	750,000
Chum salmon		11,541,000		11,541,000
Silver salmon		886,000	153,300	1,039,300
Quilcene, Wash.—				
Chinook salmon		50,000	693,000	743,000
Chum salmon		7,612,000		7,612,000
Silver salmon		1,420,540	148,000	1,568,540
Steelhead salmon			540,000	540,000
Sultan, Wash.—				
Chinook salmon		200,700	43,800	244,500
Silver salmon		1,362,100	50,000	1,412,100
Steelhead salmon		111,500	136,000	247,500

[1] Lost in transit, 30,780.

Stations and substations operated and output of each, fiscal year 1929—Continued

Asterisk (*) denotes transfer of eggs. See table, p. 779]

Stations, substations, and species	Eggs	Fry	Fingerlings, yearlings, and adults	Total
Berkshire trout hatchery, Mass.:				
Brook trout			256,030	256,030
Catfish			7,060	7,060
Boothbay Harbor, Me.:				
Cod	1,068,142,000			1,068,142,000
Haddock	133,577,000			133,577,000
Winter flounder		2,025,822,000		2,025,822,000
Bozeman, Mont.:				
Black-spotted trout			905,180	905,180
Brook trout			253,930	253,930
Golden trout			9,000	9,000
Loch Leven trout	*2,775,000		295,480	3,070,480
Rainbow trout			916,290	916,290
Glacier Park, Mont.—				
Grayling		15,000		15,000
Rainbow trout	100,200		375,000	475,200
Meadow Creek, Mont.—				
Black-spotted trout	140,000			140,000
Grayling	(*)	1,750,000		1,750,000
Loch Leven trout	*4,847,700		120,000	4,967,700
Rainbow trout	*575,400		110,000	685,400
Cape Vincent, N. Y.:				
Brook trout		321,000	199,500	520,500
Catfish			300	300
Cisco	*9,200,000	116,000,000		125,200,000
Lake trout	357,000	2,431,490		2,788,490
Loch Leven trout		5,000		5,000
Rainbow trout			74,080	74,080
Whitefish		22,705,000		22,705,000
Swanton, Vt.—				
Common sucker	1,800,000			1,800,000
Pike perch	28,600,000	16,390,000		44,990,000
Yellow perch		7,700,000		7,700,000
Watertown, N. Y.—				
Brook trout			427,850	427,850
Rainbow trout			95,150	95,150
Central Station, Washington, D. C.:				
Largemouth black bass			2,100	2,100
Brook trout			2,400	2,400
Chinook salmon		4,000		4,000
Cisco		1,000,000		1,000,000
Rainbow trout		20,000	16,150	36,150
Sunfish			300	300
Fort Humphreys, Va.—				
Shad		64,851,000		64,851,000
Yellow perch		166,023,000		166,023,000
Lakeland, Md.—				
Largemouth black bass			13,570	13,570
Crappie			8,400	8,400
Sunfish			40,150	40,150
Clackamas, Oreg.:				
Black-spotted trout			20,000	20,000
Brook trout			69,100	69,100
Chinook salmon			4,285,000	4,285,000
Rainbow trout	15,000		80,400	95,400
Silver salmon	505,000			505,000
Steelhead salmon			32,500	32,500
Applegate, Oreg.—				
Chinook salmon			514,600	514,600
Silver salmon			778,400	778,400
Steelhead salmon	*1,989,000			1,989,000
Big White Salmon, Wash.—				
Black-spotted trout			8,000	8,000
Brook trout			254,000	254,000
Chinook salmon	5,636,000		7,987,500	13,623,500
Little White Salmon, Wash.—				
Chinook salmon	6,883,000		9,940,000	16,823,000
Chum salmon	765,000		49,000	814,000
Rogue River, Oreg.—				
Chinook salmon	1,000,000		2,740,000	3,740,000
Sockeye salmon			[1] 68,000	68,000
Salmon, Idaho—				
Chinook salmon			6,477,500	6,477,500
Rainbow trout			875,500	875,500
Cold Springs, Ga.:				
Largemouth black bass		103,150	234,700	337,850
Catfish			5,900	5,900
Sunfish			87,800	87,800

[1] In addition to 25,000 fingerling sockeye salmon turned over to the State of Oregon in cooperative work.

Stations and substations operated and output of each, fiscal year 1929—Continued

[Asterisk (*) denotes transfer of eggs. See table, p. 779]

Stations, substations, and species	Eggs	Fry	Fingerlings, yearlings, and adults	Total
Craig Brook, Me.:				
Atlantic salmon	345,000		572,200	917,200
Brook trout	(*)		1,542,500	1,542,500
Landlocked salmon	*110,000		311,470	421,470
Grand Lake Stream, Me.—				
Brook trout			199,150	199,150
Landlocked salmon			220,000	220,000
Green Lake, Me.: Landlocked salmon	(*)			
Duluth, Minn.:				
Brook trout			183,700	183,700
Cisco		6,000,000		6,000,000
Lake trout	197,000	13,001,000	[1] 775,000	13,973,000
Pike perch		12,760,000		12,760,000
Whitefish		1,300,000		1,300,000
Edenton, N. C.:				
Largemouth black bass		6,000	12,100	18,100
Crapple			460	460
Glut herring		11,500,000		11,500,000
Shad		6,500,000		6,500,000
Sunfish			40,250	40,250
Yellow perch		1,200,000	550	1,200,550
Weldon, N. C.: Striped bass (in cooperation with State)		9,661,000		9,661,000
Erwin, Tenn.:				
Largemouth black bass		30,500	3,800	34,300
Brook trout			332,400	332,400
Loch Leven trout			158,750	158,750
Rainbow trout	75,000		243,550	318,550
Rock bass			20,980	20,980
Sunfish			6,600	6,600
Fairport, Iowa:				
Largemouth black bass		11,700	47,200	58,900
Buffalo fish			28,300	28,300
Carp			23,750	23,750
Catfish			88,290	88,290
Crapple			73,200	73,200
Pike perch			400	400
Smallmouth black bass			4,200	4,200
Sunfish			40,300	40,300
Yellow perch			550	550
Gloucester, Mass.:				
Cod	1,159,980,000	274,033,000		1,434,013,000
Haddock	217,865,000			217,865,000
Pollock		358,442,000		358,442,000
Winter flounder		161,166,000		161,166,000
La Crosse, Wis.:				
Largemouth black bass			550	550
Brook trout	50,000		493,300	543,300
Catfish			160	160
Crappie			460	460
Loch Leven trout			168,100	168,100
Rainbow trout			318,600	318,600
Sunfish			2,800	2,800
Yellow perch			360	360
Bellevue, Iowa—				
Buffalo fish	44,100,000			44,100,000
Carp	24,300,000			24,300,000
Guttenberg, Iowa: Buffalo fish	5,296,000			5,296,000
Homer, Minn.—				
Largemouth black bass			2,900	2,900
Carp			1,000	1,000
Catfish			419,230	419,230
Crappie			842,000	842,000
Fresh-water drum			850	850
Pike and pickerel			12,480	12,480
Sheepshead			2,000	2,000
Sunfish			1,371,300	1,371,300
Yellow perch			108,500	108,500
Miscellaneous			660,000	660,000
Lynxville, Wis.—				
Largemouth black bass			680	680
Brook trout			9,600	9,600
Crappie			700	700
Sunfish			600	600
Marquette, Iowa—				
Largemouth black bass			1,300	1,300
Buffalo fish			6,450	6,450
Carp			6,500	6,500
Catfish			327,700	327,700

[1] In addition to 18,000 fingerling lake trout turned over to the State of Minnesota in cooperative work.

Stations and substations operated and output of each, fiscal year 1929—Continued

[Asterisk (*) denotes transfer of eggs. See table, p. 779]

Stations, substations, and species	Eggs	Fry	Fingerlings, yearlings, and adults	Total
La Crosse, Wis.—Continued.				
Marquette, Iowa—Continued.				
Crappie			922,000	922,000
Pike and pickerel			22,300	22,300
Sunfish			221,600	221,600
White bass			300	300
Yellow perch			3,400	3,400
Yellowstone, Wyo.—				
Black-spotted trout	*10,402,000		5,898,000	16,300,000
Leadville, Colo.:				
Largemouth black bass			2,700	2,700
Black-spotted trout			172,500	172,500
Brook trout	*850,200		3,635,850	4,486,050
Loch Leven trout			173,000	173,000
Rainbow trout			207,000	207,000
Creede, Colo.: Rainbow trout			158,000	158,000
Louisville, Ky.:				
Largemouth black bass			2,700	2,700
Rock bass			1,530	1,530
Smallmouth black bass		531,000	11,060	542,060
Sunfish			2,130	2,130
Mammoth Spring, Ark.:				
Largemouth black bass			144,800	144,800
Rock bass			15,370	15,370
Smallmouth black bass			116,000	116,000
Sunfish			31,300	31,300
Lonoke, Ark.: Largemouth black bass (in cooperation with State)			411,000	411,000
Manchester, Iowa:				
Largemouth black bass			1,380	1,380
Brook trout			568,900	568,900
Rainbow trout	*313,300		224,300	537,600
Smallmouth black bass			3,330	3,330
Nashua, N. H.:				
Brook trout	10,000	15,000	276,300	301,300
Catfish			250	250
Landlocked salmon			9,600	9,600
Rainbow trout	10,000		14,100	24,100
Smallmouth black bass		40,000		40,000
Neosho, Mo.:				
Largemouth black bass		32,200	11,850	44,050
Crappie			5,930	5,930
Rainbow trout	*304,000		218,200	522,200
Rock bass			11,800	11,800
Sunfish			6,900	6,900
Bourbon, Mo.: Rainbow trout	*1,725,000			1,725,000
Langdon, Kans.—				
Largemouth black bass			110,100	110,000
Carp			250	250
Catfish			33,400	33,400
Crappie			7,300	7,300
Rock bass			2,900	2,900
Sunfish			55,000	55,000
Yellow perch			5,100	5,100
Northville, Mich.:				
Brook trout			598,100	598,100
Landlocked salmon			2,400	2,400
Rainbow trout			252,380	252,380
Smallmouth black bass		72,000	20,100	92,100
Alpena, Mich.—				
Lake trout	200,000	[4] 618,000	1,276,000	2,094,000
Whitefish	3,000,000	9,700,000		12,700,000
Charlevoix, Mich.—				
Lake trout	1,430,000	10,049,000		11,479,000
Whitefish		14,608,800		14,608,800
Orangeburg, S. C.:				
Largemouth black bass		129,300	247,400	376,700
Catfish			1,600	1,600
Crappie			1,400	1,400
Sunfish			27,760	27,760
Warmouth bass			6,470	6,470
Put in Bay, Ohio:				
Carp		2,500,000		2,500,000
Pike perch		23,000,000		23,000,000
Whitefish		45,981,000		45,981,000
Yellow perch		18,000,000		18,000,000
Quinault, Wash.:				
Brook trout			1,860	1,860
Chinook salmon	(*)			
Silver salmon	*2,100,900			2,100,900
Sockeye salmon	*50,200	2,640,000	988,700	3,678,900

[4] In addition to 240,000 lake-trout fry turned over to the State of Michigan in cooperative work.

Stations and substations operated and output of each, fiscal year 1929—Continued

[Asterisk (*) denotes transfer of eggs. See table, p. 779]

Stations, substations, and species	Eggs	Fry	Fingerlings, yearlings, and adults	Total
St. Johnsbury, Vt.:				
Brook trout	(*)	1,353,000		1,353,000
Landlocked salmon		14,500	260	14,760
Loch Leven trout			680	680
Steelhead salmon			1,030	1,030
Pittsford, Vt.—				
Brook trout			82,750	82,750
Rainbow trout			6,030	6,030
York Pond, N. H.: Brook trout	25,000	206,800	45,050	276,850
San Marcos, Tex.:				
Largemouth black bass			147,500	147,500
Crappie			12,040	12,040
Rock bass			2,330	2,330
Sunfish			46,000	46,000
Warmouth bass			250	250
Lake Worth, Tex.: Crappie			25,000	25,000
Medina Lake, Tex.—				
Largemouth black bass			25,740	25,740
Rainbow trout			20,060	20,060
Sunfish			700	700
New Braunfels, Tex.—				
Largemouth black bass			16,300	16,300
Sunfish			53,100	53,100
Saratoga, Wyo.:				
Black-spotted trout			238,310	238,310
Brook trout	*400,000	[5] 460,000	577,600	1,437,600
Loch Leven trout			119,000	119,000
Rainbow trout	(*)		335,250	335,250
Lost Creek, Wyo.: Rainbow trout	*700,000	605,000		1,305,000
Spearfish, S. Dak.:				
Brook trout	(*)		419,340	419,340
Loch Leven trout			217,100	217,100
Rainbow trout	(*)		211,500	211,500
Crawford, Nebr.—				
Largemouth black bass			500	500
Catfish			1,950	1,950
Sunfish			450	450
Springville, Utah:				
Brook trout	246,400		[6] 439,000	685,400
Rainbow trout	100,000		1,442,800	1,542,800
Tupelo, Miss.:				
Largemouth black bass		377,000	234,160	611,160
Catfish			1,880	1,880
Sunfish			110,560	110,560
Aliceville, Ala.—				
Largemouth black bass			19,350	19,350
Sunfish			14,200	14,200
White Sulphur Springs, W. Va.:				
Largemouth black bass			25,600	25,600
Brook trout	10,300		[7] 1,822,530	1,832,830
Loch Leven trout			[8] 244,570	244,570
Rainbow trout	777,200		[9] 979,810	1,757,010
Rock bass			6,600	6,600
Sunfish			16,200	16,200
Woods Hole, Mass.:				
Mackerel		2,778,000		2,778,000
White perch			250	250
Winter flounder	109,434,000	622,161,000		731,595,000
Wytheville, Va.:				
Largemouth black bass		6,000	8,990	14,990
Brook trout			[10] 214,500	214,500
Catfish			420	420
Rainbow trout			[11] 243,060	243,060
Rock bass			17,680	17,680
Smallmouth black bass		21,000	300	21,300
Yes Bay, Alaska: Sockeye salmon	4,530,000		34,284,720	38,814,720

[5] Turned over to the State of Wyoming in cooperative work.
[6] In addition to 52,000 fingerling brook trout turned over to the State of Utah in cooperative work.
[7] In addition to 741,250 fingerling brook trout turned over to the State of West Virginia in cooperative work.
[8] In addition to 141,000 fingerling Loch Leven trout turned over to the State of West Virginia in cooperative work.
[9] In addition to 611,400 fingerling rainbow trout turned over to the State of West Virginia in cooperative work.
[10] In addition to 182,000 fingerling brook trout turned over to the State of Virginia in cooperative work
[11] In addition to 187,000 fingerling rainbow trout turned over to the State of Virginia in cooperative work.

TRANSFERS OF EGGS BETWEEN STATIONS

The adequate stocking of the various trout and salmon stations necessitates a widespread shipment of eggs from collecting stations and hatcheries that maintain brood stocks. A consignment of 100,000 trout or salmon eggs may be shipped by express across the continent at a negligible cost, whereas the transfer of fish requires the services of a special messenger with his attendant expenses or the movement of a fish car at 36 cents a mile. The following table illustrates the sources from which the bulk of egg supplies are obtained:

Transfer of eggs between stations, fiscal year 1929

Species	Number of eggs	From—	To—
Atlantic salmon	50,000	Craig Brook, Me	Northville, Mich.
Black-spotted trout	566,000	Yellowstone Park, Wyo	Bozeman, Mont.
	1,000,000	do	Glacier Park, Mont.
	300,000	do	Leadville, Colo.
Brook trout	200,000	Craig Brook, Me	Grand Lake Stream, Me.
	150,000	do	Pittsford, Vt.
	500,000	do	Nashua, N. H.
	50,000	do	Northville, Mich.
	200,000	Leadville, Colo	Do.
	100,000	St. Johnsbury, Vt	Do.
	100,000	York Pond, N. H	Craig Brook, Me.
	400,000	do	Erwin, Tenn.
	5,000	do	Pittsford, Vt.
	517,000	do	St. Johnsbury, Vt.
	300,000	do	Wytheville, Va.
	20,000	Saratoga, Wyo	St. Johnsbury, Vt.
Chinook salmon	628,000	Mill Creek, Calif	Baird, Calif.
	10,000	Quinault, Wash	Central Station, Washington, D. C.
Cisco	1,200,000	Cape Vincent, N. Y	Do.
	400,000	do	Nashua, N. H.
Grayling	25,000	Meadow Creek, Mont	Bozeman, Mont.
Landlocked salmon	20,000	Craig Brook, Me	Nashua, N. H.
	55,000	do	Northville, Mich.
	25,000	do	Pittsford, Vt.
	15,000	do	St. Johnsbury, Vt.
	300,000	Green Lake, Me	Craig Brook, Me.
Loch Leven trout	75,000	Bozeman, Mont	Cape Vincent, N. Y.
	200,000	do	Spearfish, S. Dak.
	4,502,000	Meadow Creek, Mont	Bozeman, Mont.
	50,000	do	Crawford, Nebr.
	50,000	do	Erwin, Tenn.
	400,000	do	La Crosse, Wis.
	150,000	do	White Sulphur Springs, W. Va.
Rainbow trout	1,132,000	do	Bozeman, Mont.
	600,000	do	Glacier Park, Mont.
	25,000	do	Neosho, Mo.
	344,000	Manchester, Iowa	La Crosse, Wis.
	153,000	do	Northville, Mich.
	225,000	Neosho, Mo	Bozeman, Mont.
	25,000	do	Meadow Creek, Mont.
	105,000	do	Northville, Mich.
	25,000	Bourbon, Mo	White Sulphur Springs, W. Va.
	223,000	Lost Creek, Wyo	Saratoga, Wyo.
	100,000	White Sulphur Springs, W. Va	Barneveld, N. Y.
	44,000	do	Central Station, Washington, D. C.
	300,000	do	La Crosse, Wis.
Silver salmon	506,000	Quinault, Wash	Clackamas, Oreg.
	1,607,000	do	Hoods Canal stations, Wash.
Sockeye salmon	50,000	Baker Lake, Wash	Birdsview, Wash.
	723,000	Quinault, Wash	Hoods Canal stations, Wash.
	40,000	do	Rogue River, Oreg.
Steelhead salmon	100,000	Applegate Creek, Oreg	Big White Salmon, Wash.
	200,000	do	Clackamas, Oreg.
	506,000	do	Rogue River, Oreg.
	25,000	do	St. Johnsbury, Vt.

GENERAL FISH-CULTURAL NOTES

NEW STATIONS

One new station, located at Crawford, Nebr., was placed on a producing basis during the year. Although the hatchery building was not completed at the close of the year, a number of trout fingerlings, which had been transferred from the Spearfish (S. Dak.) station, were distributed during the spring. These fish had been reared in ponds constructed on the Fort Robinson Military Reservation. Work completed at the close of the year included, in addition to these ponds, a foreman's dwelling and combination shop and garage, which, with minor improvements to the grounds, gave the bureau a very creditable plant.

Work at the Valdosta (Ga.) pond substation was impeded by difficulty encountered in securing drainage by means of drilled wells tapping a subterranean drainage passage. During the progress of this drilling two dwellings were constructed, pipe lines were laid, roads constructed, and fences erected. It has been possible to introduce a brood stock of bass and bream, and a limited output is expected during the fall of 1929.

Little additional work was accomplished at the Fort Worth (Tex.) substation, but all ponds were stocked with brood fish, and prospects indicate a satisfactory hatch, which is being held for fall distribution. Sufficient land was finally acquired to permit the development of the Tishomingo (Okla.) pond station, and at the close of the year plans were being drawn for immediate construction of a dwelling and dam for the water supply.

At Creede, Colo., work on the new trout substation consisted in the construction of a reservoir, into which the spring water supply was conducted by tile laterals. Excavation for the main pipe line was completed, a complete survey of the tract was made, and the heavier construction work to be undertaken immediately after July 1, was laid out.

At Yellowstone Park a splendid new log hatchery was erected and lacks only the installation of troughs and other equipment. The building has facilities for an aquarium and for the demonstration of fish-cultural work for the benefit of the many visitors. Construction of a bunkhouse and mess house of a similar type of architecture was well under way at the close of the year. When completed the bureau will have a highly efficient fish-cultural plant here and one especially in keeping with the surroundings. In addition to these activities, ten 60-feet rearing ponds were constructed at Mammoth Hot Springs, waste water from a power house constituting the water supply. These ponds will be operated until October, permitting the distribution of a large number of fingerlings in place of the advanced fry that have been handled in the park work hitherto. The Glacier Park hatchery has likewise been equipped with a series of rearing ponds with the same object in mind. Additions to both the Saratoga (Wyo.) and Springville (Utah) stations have increased materially the rearing capacity of these plants.

FISH FOODS

At a number of stations trials of various fish foods have been under way on an experimental basis. The most promising results were secured at the Bozeman (Mont.) station, which has been feeding a dried liver-meal preparation and a dried material derived from salmon eggs. This station reared a large number of fingerlings with unusual success, and part of the credit for the results was ascribed to the new diet. Dried buttermilk is now a regular article of diet at several of the trout stations.

TRANSFER OF SPINY LOBSTERS

Near the close of the fiscal year a shipment of adult female and male spiny lobsters was transported from Key West, Fla., to Galveston, Tex., for planting on the jetties at that point. The consignment was sent by steamer in large tanks and was accompanied by an employee of the bureau to supervise planting. Observations will be made to learn whether the crustaceans will become established in this new environment.

EARLY SPAWNING OF BLACK-SPOTTED TROUT

For several years the bureau has received reports that black-spotted trout were spawning in February and March in Glacier National Park. Accordingly, in March the foreman of the Bozeman (Mont.) station investigated the situation in Logging Lake. Ripe males and females with mature eggs were found in the lake under thick ice, and it was demonstrated that this unusual aberration in the spawning habits of the species actually exists. Inasmuch as eggs of this species in this latitude are generally taken not later than May or June, it is obvious that an egg supply from such early spawners would be of material benefit. Since weather conditions require the planting of the fish in the early fall in high altitudes, the collection of eggs in February or March would permit the distribution of good-sized fingerlings in place of fish that are little more than advanced fry. Efforts will be made to develop Logging Lake as a source of eggs.

COMMERCIAL SPECIES

The collections of eggs and the resultant distribution of fish throw a significant light on the status of the commercial fisheries. The past season's work showed a maintenance of earlier levels or an increase in the marine and anadromous forms on both coasts. In the interior waters, especially the Great Lakes, a recession was evident. It is to be assumed from such a situation that the basic resources in the coastal areas are so extensive as to permit natural recuperation from the drain arising from the fisheries. It may be judged that the same or more intensive efforts applied to the fisheries of the interior waters, with their limitations of area, are depleting basic stocks in a few instances, and that artificial propagation is not able to overcome the reduction. Again emphasis should be placed on the fact that the propagation of some forms, such as cod, haddock, pollock, shad, and striped bass, is truly a by-product recovery, in that the hatchery eggs are secured from fish caught for market prior to the full exercise of their reproductive functions.

PACIFIC SALMONS

In spite of an unsatisfactory season with the chinook salmon in California, the aggregate production was brought above that of last year by an increased output of sockeye salmon. The virtual destruction of the sockeye run in Baker River, Wash., by the construction of a high dam forced a sharp curtailment in the operations of the Baker Lake hatchery. At the Columbia River stations extensive marking experiments, designed to show the effectiveness of artificial propagation, have been continued.

AFOGNAK (ALASKA) STATION

[FRANK L. SNIPES, Superintendent]

During the year the telephone line between the station and the cannery building was rebuilt. The escapement of sockeye salmon to Letnik Lake exceeded 20,000, and from less than 8,000 females that spawned over 20,000,000 eggs were secured. The hatch was above 90 per cent. As usual, the fingerlings were liberated in Letnik Lake and its tributaries. At the close of the fiscal year over 14,000 salmon were being held in the lake, with a very satisfactory collection of eggs in prospect. An attempt to trap downstream migrants was made in May, but high water prevented the effective operation of the trap. During the fall 2,300,000 humpback-salmon eggs were collected, the majority of which were transferred to the State of Washington. Arrangements have been made for the construction of a road from the station to Letnik Bay by the Department of Agriculture.

YES BAY (ALASKA) STATION

[A. T. LOOFF, Superintendent]

Quite extensive repairs and improvements to the station buildings and equipment were made during the year. The first step toward rebuilding the pipeline trestle was completed with the renewal of the high 450-foot section of the trestle. The 350-foot flume carrying the water supply from the pipe line into the hatchery building was reconstructed. The rebuilding of the station tramways, which has been in progress for the past three years, was completed with the renewal of the 1,500-foot tramway extending from the boathouse to the pipeline trestle. All station walks were rebuilt. The rack apron was repaired successfully, and a new set of rack horses and picket sections was constructed. The exterior surface of several buildings and the roofs of all buildings were painted. New foundations and floors were put in the dynamo and feed room in the hatchery building. The bunk house, three cottages, and the mess house were repapered. The outdoor toilet of the lower bunk house was rebuilt and a flushing system, together with sewage pipe line to the river, installed. A new float was built for the landing at Back Bay.

Sockeye-salmon fingerlings to the number of 16,284,715, carried over from the previous year, were planted as fingerlings No. 1 in July. Spawn-taking operations in August and September resulted in the collection of 24,036,000 sockeye eggs, of which 2,493,000 were shipped away from the station on reaching the eyed stage. Of the remaining eggs, 20,779,500 were hatched and successfully carried through the yolk-sac absorption period. All of these fish were held in the station ponds and fed until May, when 5,000,000 were planted as fingerlings No. 1; 10,000,000 of the same size and 3,000,000 fingerlings No. 2 were planted in June; and at the close of the fiscal year 2,440,000 fingerlings No. 2 were still on hand in the ponds. Early in September a sufficient number of humpback-salmon eggs were collected to furnish a shipment in excess of 2,000,000 eyed eggs for transfer to the Washington State Fish and Game Commission. On the 11th of June 150,000 eggs were taken from a small run of steelhead salmon intercepted by the station trap and were on hand as eyed eggs at the close of the year.

Baker Lake (Wash.) Station and Substations

[Joseph Kemmerich, Superintendent]

Operations in this field were conducted at five permanent stations. The steelhead trout and all of the Pacific salmons, excepting the humpback, were propagated. A recession in numbers marked the activities with all varieties, with the exception of steelhead trout. The total collection of eggs of all species amounted to 30,393,800, which was some 13,000,000 below the total of the previous year. A number of streams were investigated with the object of determining whether it would be possible to establish a run of salmon therein or to utilize them as bases for fish-cultural operations. As in previous years, a close inspection was maintained over the working of the power dam in the Baker River at Concrete to determine the value of the fish ladder installed. A negligible number of sockeye salmon was put over the dam by artificial means, with the result that the activities of the Baker Lake station were restricted still further.

Baker Lake (Wash.) station.—The traps were installed in Baker Lake very early, but only 895 sockeye salmon and a very small number of silver salmon were taken. The eggs secured from the former species amounted to 661,000, most of which were hatched and the product reared for distribution as fingerlings in Baker Lake. It was noted that a run of landlocked sockeye salmon has become established apparently due to the creation of a large artificial lake in Baker River.

Birdsview (Wash.) substation.—A new dirt pond was constructed for the purpose of holding adult fish prior to spawning. A new water-supply dam and headgate were constructed in Grandy Creek, replacing the old ones, which were washed out by high water. The feeding of young salmon and trout to the full capacity of the station was again carried on during the spring. Considerable trouble was experienced among the sockeye fingerlings due to the pop-eye disease. Low water in Grandy Creek resulted in a poor run of chinook and silver salmon, with a consequent reduction in the number of eggs secured. A number of eastern brook trout also were handled.

Duckabush (Wash.) substation.—A new permanent trap was constructed in the Duckabush River. Shortly after its installation, however, unusually high water washed out the abutment, necessitating immediate repairs pending its permanent reconstruction. A new water-supply flume was likewise constructed. The old decayed rack in the creek near the station was torn out and a new permanent rack built. The old water-supply flume, which had become unsafe, was replaced by a new one extending from the intake dam down to the settling tank. The run of chum salmon in the Duckabush River was very large, and the collection of 10,000,000 eggs does not represent more than half of the number available had there been sufficient room to handle them. The station also collected a large number of eggs of the late chum salmon from the Walcott Slough trap. Shipments of chinook salmon eggs were received from other stations, and the resulting fingerlings planted in local waters in the hope of establishing a run. The run of silver-salmon eggs was below normal, and the shortage of eggs was further emphasized by the defective traps, which allowed the escape of many of the brood fish. A few steelhead eggs also were secured.

Quilcene (Wash.) substation.—Some remodeling and enlargement work was completed on the living quarters of the station. Eggs of the chum salmon, silver salmon, and steelhead were collected at the station, and chinook and silver-salmon eggs transferred from other points were handled also. Four and one-half million chum-salmon eggs were transferred to Quilcene from the Duckabush station because of a water shortage at that point. In common with all the other stations in the field, the collection of silver-salmon eggs was below normal.

Sultan (Wash.) substation.—High water in Elwell Creek apparently damaged the trap, necessitating temporary repairs. Very few chum salmon were caught in the trap, and most of the eggs obtained for the station were secured through trapping operations farther downstream. Low-water stages in the creek at the height of the silver-salmon run resulted in a limited collection of eggs of that species. Conditions were favorable during the spring for a good collection of steelhead eggs.

Quinault (Wash.) Station

[Marcus S. Meyer, Superintendent]

While eggs of the different species of Pacific salmon are handled in this field, the principal activities of the station are concerned with the propagation of the sockeye salmon. During the fall spawning season, extending from October 23 to December 14, eggs of this species to the number of 5,840,000 were collected, together with 5,100,000 of the silver and 65,000 of the chinook salmon. These results were accomplished despite the very unfavorable weather conditions, all streams of the region being at such a low stage practically throughout the fishing season as to cause large numbers of fish to spawn in the lower Quinault River or along the shores of Quinault Lake. After developing the eggs to the eyed stage a number of shipments were made to State hatcheries in Washington and Oregon and to other stations of the bureau. The fry produced from the remainder of the stock were distributed in the station ponds during the spring, with the intention of holding them for several months before liberating them in Quinault Lake.

In the course of the fiscal year a 7-room dwelling for the superintendent was completed and a small building equipped with an underground gasoline storage tank was constructed for the safer storage of gasoline. The interiors of two of the station dwellings were painted and papered. In advance of the transfer of young salmon the station ponds were drained and the bottoms and sides painted with asphaltum paint to serve as a check against the too profuse development of algæ.

Clackamas (Oreg.) Station and Substations

[Philo B. Hawley, Superintendent]

The egg collections at the Oregon group of stations for the year amounted to approximately 52,570,000, or 4,296,000 less than were secured last year. The usual efforts were made to obtain eggs from the chinook and silver salmons and the steelhead and rainbow trout, and an attempt was made to collect eggs of the chum salmon in the Little White Salmon field.

Clackamas (Oreg.) station.—In the course of the year three new concrete ponds for the exhibit of goldfish were constructed, and minor improvements to station roadways, buildings, and equipment were made. The covering of the rearing pools by a growth of vines over a pipe framework has proven very successful. The season's collection of chinook-salmon eggs in the Clackamas River proved an entire failure, the reason advanced being the pollution of the Willamette River. A number of chinook-salmon eggs were transferred from the substations, including 1,400,000 from the Big White Salmon field and over 2,000,000 from the State of Oregon. The eggs at the upper Clackamas substation also were developed here. The fingerling chinook salmon and steelhead trout on hand at the beginning of the year were liberated. A number of rainbow-trout eggs were incubated, and a small shipment of black-spotted trout eggs was received from Montana. Half of these were immediately transferred to the Big White Salmon hatchery, and the fingerling fish resulting from the remainder were distributed locally. Eastern brook trout, silver trout, and steelhead salmon also were handled.

Little White Salmon (Wash.) substation.—A large cold-storage plant was under construction at this substation at the close of the year. The purpose of this building is to freeze and store large quantities of spawned-out salmon for use as fish food. Considerable attention was given to the repair of the water-supply flume, which will require replacement in the near future. The year's collection of chinook-salmon eggs was somewhat below that of an average season, the shortage amounting to approximately 6,000,000. Practically 10,000,000 were transferred to other stations. A very successful percentage of hatch was attained by means of the stacked-tray system. The young fish were fed on horse meat and spawned-out salted salmon, about 70 barrels of the latter being used.

Big White Salmon (Wash.) substation.—Two earth rearing ponds for trout were constructed and several of the salmon-rearing ponds in upper Hatchery Creek were enlarged. A new concrete dam also was installed in one of the upper ponds of this series. A section of the main water-supply pipe crossing the railroad track was replaced with a new line and other minor items of upkeep and repair received attention. Chinook-salmon egg collections at this point were approximately normal, over 15,000,000 being secured. These eggs were transferred from the collecting points to the hatchery by motor truck immediately after hardening. Over 6,000,000 eggs were shipped and some 7,500,000 fry resulting from the remainder were retained for rearing and subsequent liberation in the Columbia River. Extensive marking experiments, utilizing over 150,000 fingerlings, were carried on from May to the following March. The station also handled some brook-trout fingerlings and 125,000 black-spotted trout eggs for the account of the State of Washington. Limited numbers of rainbow-trout and steelhead-trout eggs likewise were incubated, and the resulting fry were distributed for the State.

Rogue River (Oreg.) substation.—A new electric pump was installed to provide a water supply for the rearing ponds. Fishing for chinook salmon commenced somewhat in advance of the usual time, and over 4,000,000 eggs were secured, with the possibility of obtaining a million additional had incubating facilities been available. Approximately 500,000 of these were shipped to other points, and the fingerlings resulting from the remainder were liberated near the close of the year. A few sockeye salmon and steelheads were transferred from other points, and a number of fingerlings of both species were on hand at the close of the year.

Applegate Creek (Oreg.) substation.—Approximately 500,000 spring chinook-salmon eggs were transferred from the McKenzie River hatchery of the Oregon Fish Commission with the object of establishing a run in local waters. Some trouble was experienced in rearing the fry, due to the cold water. The collection of silver-salmon eggs was limited, amounting to only about one-third of the previous season's take. A collection of steelhead-trout eggs to the number of 5,500,000 represents the largest season's total at this station for a number of years. Approximately one-half of them were shipped to other points, and 1,700,000 of the resulting fingerlings were on hand at the close of the year after making heavy plants of the species in Applegate Creek.

Salmon (Idaho) substation.—At the beginning of the year almost 900,000 rainbow-trout fry obtained from the new egg-collecting station at Williams Lake were on hand. These were liberated at various points during the year. The collection of chinook-salmon eggs in the Lemhi River was somewhat less than that of the previous year. A shipment of 3,000,000 of these eggs was also received here from the State of Oregon to be incubated and the product utilized for stocking local waters. The spring collection of rainbow-trout eggs in the Williams Lake field was slightly below that of the previous spring due to unfavorable weather conditions.

Baird (Calif.) Station and Substations

[W. K. Hancock, Superintendent]

The work at the main station was carried on very much the same as last year. The racks were installed at the usual time, but for some reason the run of salmon in the McCloud River was light. Only 200,000 eggs were collected from the spring run. It was thought best to try for the fall run again, so the racks were left in until the late run was over. Only 50,000 eggs were collected, however. There being no gravity water in the hatchery, this small lot of eggs was held in outside batteries until the arrival of the 1,000,000 eggs transferred from the Mill Creek substation. From the combined lots 1,211,000 fingerling salmon were developed and planted in the Sacramento River, and in order to get below the head of a large irrigation canal the fish had to be hauled about 20 miles. During the year portions of all the buildings were painted and a number of cement walls were poured, materially improving the appearance of the grounds around the buildings. Two new settling ponds were constructed near the garage. Four or five rearing boxes were made and floated in the river below the upper rack for holding fish after the gravity ditch failed, and the only means of obtaining a hatchery water supply was by pumping. The floating boxes worked very satisfactorily, and it is likely that more of them will be used next season.

Battle Creek (Calif.) substation.—The fall collection of chinook-salmon eggs was light, totaling 2,347,000. About 98 per cent were hatched, and 2,189,600 fingerling fish were produced and planted in Battle Creek near the substation. It has been the practice for several years past to seine the main river in search of brood fish, but an unfortunate delay in installing an engine in the boat needed for the work made it impossible during the past season, as the larger portion of the run had spawned before operations could be undertaken, and the few that had not spawned could not be captured in the high water prevailing at the time. While engaged in placing racks in the creek a driveway was connected to the lower side of the structure as a convenience in crossing the stream. A 30-foot tower was built, an old tank formerly used at Baird station was set up, and a small centrifugal pump and water tower were installed for irrigating the station grounds.

Mill Creek (Calif.) substation.—The work was carried on as in past years. The run of salmon was light and the collection of eggs below the average take. A storm in November damaged the racks, allowing many of the salmon held below to pass up the creek. Of the 2,350,000 eggs secured, 1,000,000 in the eyed stage were transferred to the main station. The remainder were hatched at the point of collection, and the output amounted to 1,312,000 fingerlings. All of these were planted early in the spring, due to cessation of the station water rights at that time.

FISHES OF THE GREAT LAKES

While a marked decline was evident in the output of three important species, the whitefish, lake trout, and pike perch, it is only in the case of the former that there is real evidence that a shortage of fish was responsible. Local weather conditions can be definitely ascribed as the cause of the decline in the other species. There were obtained a large number of cisco or lake herring eggs, further illustrating the fluctuations that take place in the propagation of this form. Adverse weather likewise affected unfavorably the operations with carp and yellow perch during the spring. Where it is difficult to secure increased quantities of eggs the efficiency of the activities may be improved by bettering the quality of the eggs, since the percentage of hatch with the species included in this group is usually low enough to admit of considerable increase.

DULUTH (MINN.) STATION

[WARD A. COOK, *Superintendent*]

Arrangements were made early in the fall for the collection of lake-trout and whitefish eggs at the various Lake Superior egg-collecting ports formerly occupied; and between September 28 and November 2 eggs of the former to the number of 20,702,000 were secured, of which a surplus of 167,000 in the green stage was turned over to the Minnesota State hatchery at French River. Previous plans made for securing whitefish eggs around Munising, Mich., could not be carried out owing to the heavy storms prevailing during the spawning period. Collections of this species were therefore confined to the area in the vicinity of Isle Royale, and the take of eggs was light, amounting to only 1,480,000. After partial development in the Duluth hatchery, 30,000 of the eyed lake-trout eggs were transferred to the Leadville station with the view of completing incubation there and supplying the resulting young fish to a Colorado applicant. With the exception of a few small shipments of fingerlings, utilized for stocking inland waters in the surrounding region, the entire output of fry and fingerling lake trout and whitefish was returned to the native spawning grounds around Isle Royale and along the southern shore of Lake Superior.

From a shipment of 250,000 eyed eggs received from Colorado late in November the station produced 170,000 fingerling brook trout, all of which were distributed to applicants in northern Michigan, Wisconsin, and Minnesota. Approximately 25,000,000 cisco (lake herring) eggs were collected during November at Bayfield, Wis. Owing to the extremely unfavorable conditions under which they were secured, they were of very inferior quality, and a hatch of only 5,000,000 fry resulted. One small lot of these eggs, taken from a skiff fishing near the shore in the vicinity of the station, were of such high grade that the loss in hatching was merely nominal. Through cooperative collections with the Minnesota Game and Fish Department at Bemidji, Minn., the station acquired 30,100,000 green and 4,900,000 eyed pike-perch eggs. Though the losses on the green stock were heavy, a sufficient number of fry were produced to fill all requirements for pike-perch fry in the Minnesota field. In the course of the year the old worn-out station boiler was replaced by a new one of 25 horsepower of the Leffel Scotch marine type.

NORTHVILLE (MICH.) STATION AND SUBSTATIONS

[W. W. THAYER, *Superintendent*]

The number of brook and rainbow trout eggs handled at the main station amounted to 1,591,750, or about 500,000 less than were acquired the previous year. All of the resulting fry were reared to the fingerling stage and were then delivered to applicants in Michigan, Indiana, and Ohio, and to the cooperative nurseries operating in conjunction with the Northville station. During the spring 2,500 landlocked salmon were hatched and turned over to an applicant at Alpena, Mich. The smallmouth bass were just as disappointing as last year. About 70 fish, enough to stock one pond, were carried through the winter. A shipment of adult smallmouth bass from the Lake Erie field suffered heavy loss en route, and all of the survivors died within a few days after being placed in the station ponds. The output of fish from one pond amounted to slightly over 90,000, delivered to applicants in Michigan, Indiana, and New Jersey, and 20,000 fingerlings were estimated to be in the pond at the close of the year. The stock of adult bluegills, about 35 in number, was transferred last fall from pond R, where they had been kept previously, to pond N. This pond has never produced many bass, and it was believed that the bluegills would do better in a pond used exclusively for that species. To the 35 adults available were added about 125 yearling fish taken in traps in the creek running across the reservation. At the close of the year the fish were spawning and the indications pointed to a good output of fingerling fish later in the season.

About 100 loads of mud were hauled from four of the bass ponds to facilitate removal of fish. The retaining wall along the creek crossing the reservation was repaired in several places and is now in good condition. A new wall was built at the north side of pond K, and two cement ponds were rebuilt. The hatchery and residence were shingled and the residence was repaired, so that now it is a modern dwelling. All troughs, trays, etc., were given a heavy coat of asphaltum varnish, and repairs were made to fit them for use. Two Leach hatching troughs were made and used during the season.

Alpena (Mich.) substation.—The first whitefish eggs were received on November 5, and a total of 21,880,000 was handled until the closing of the season on December 1. A shipment of 3,000,000 whitefish eggs was made to the Japanese Government. Material assistance was received from the State game wardens and hatchery officials during the egg-collecting season. Twenty-five quarts of eggs of poor quality were received from Sturgeon Bay on Lake Michigan. It is believed that many tons of whitefish were caught by the fishermen from which few or no eggs were secured. A close supervision of fishing operations would be desirable to prevent this waste. The resulting fry were planted on the various fishing grounds. Catches of whitefish were reported as poor, but large numbers of immature fish were seen in Thunder Bay.

The first test nets for lake trout were set on October 18. Up to December 1, the close of the season, over 17,000,000 eggs were received, somewhat above the average in quality. The resulting fry were moved to outside ponds in the spring because of a scarcity of boats for distributing them. The resulting overcrowding caused considerable loss. Two nursery ponds were maintained near by, and 800,000 fingerlings were placed in them for rearing. One of the station employees was detailed to take charge of the nursery and attend to the feeding, etc. One thousand and seven hundred quarts of pike-perch eggs were taken during the spring and turned over to the State hatcheries. These lots were low in fertility.

Under a special appropriation there was constructed a 5-room cottage for the apprentice fish-culturist. A cement floor was laid in the hatchery, and two new whitefish batteries as well as 36 trout troughs were constructed. The unprecedented high water during the past year has undermined the shore line, and there is a possibility of considerable damage being done to the property if protective cribbing is not erected.

Charlevoix (Mich.) substation.—This station handled a smaller number of lake-trout and whitefish eggs than usual, the total of both species being only about 43,000,000. The falling off was due in part to rough weather during the spawning season and also to lack of fishermen to take all eggs available. The percentage of eyed eggs was somewhat better than in the previous year, but it was necessary to employ extra egg pickers in order to keep the eggs clean and prevent their being killed by fungus. It is believed that if a number of experienced spawn takers were available for detail to the Charlevoix station during the spawning season a larger number of eggs could be collected and a high percentage of fertilization attained. Good fertilization and proper handling of the eggs in the field would lighten the work and reduce the expense of operations.

During the summer of 1928 the hatchery was painted inside and minor repairs were made. The cottage was painted inside during the fall, and the work of painting the exterior of the hatchery was begun toward the end of the year. The aquaria room was put in shape for the summer season and is attracting considerable attention. Rainbow, brook, Loch Leven, and lake trout, yellow perch, a rock sturgeon, a rock bass, and a few fancy goldfish have been obtained for the exhibit.

In the course of the winter material was purchased and racks made for installing a trap in Boyne River for the purpose of collecting steelhead eggs. The trap was put in on April 10 but later was moved down the river about three-fourths of a mile, as it was discovered that fish were not running up to the trap but were spawning farther downstream. In its new location the trap was hard to hold on account of water washing under the racks and permitting the fish to escape up the river. The work was a failure so far as egg collections were concerned, but the experience gained should be valuable in another season. The trap was also bothered by poachers and all of the fish being held in it were speared and taken out.

Put in Bay (Ohio) Station

[David Davies, Superintendent]

Shortly after the 1st of November arrangements were made with the commercial fishermen to collect whitefish eggs, and on the 9th of that month station employees equipped with the necessary collecting outfit were detailed at the various field stations occupied last year to receive eggs and forward them to the hatchery. The spawning season, which extended from November 15 to December 10, proved a very discouraging one, the work being handicapped by a great shortage of fish at all points. Only 66,640,000 eggs were secured, this total constituting the smallest year's collection of whitefish eggs in Lake Erie since 1899. Equally discouraging conditions were encountered during the following spring in the pike-perch work. Not only were the catch of fish and the daily egg collections much lighter than in recent years but the comparatively few eggs secured were of such inferior quality that only 23,000,000 fry resulted from a collection of 121,800,000 eggs. Incidental to the pike-perch work 20,750,000 yellow perch eggs were obtained and hatched with only normal loss. Due to the high water prevailing in June in Sandusky Bay and Portage River, the carp work was almost a failure, the only results being 3,750,000 eggs collected and 2,500,000 fry hatched. In addition to the propagation work outlined above, the Put In Bay station collected 569 adult smallmouth bass in Lake Erie for use as a brood stock at other stations of the bureau.

During the year extensive repairs and improvements were made to the station steamer *Shearwater*, which was then turned over the division of scientific inquiry for use in investigation work. The station gas boat was repaired and painted, and considerable repairs were made on the wharf in front of the hatchery. Old paint was removed from the walls of the hatchery room, boiler room, office, kitchen, and bath and toilet rooms at the residence and replaced with new paint. New window sash were placed in the attic of the residence, and the roof of the storehouse was shingled. The tin roofs of the annex building and the porches of the residence were repaired and painted. All large field egg cases were repaired, painted, and stenciled. Repairs were made on the station boilers and pumps.

Cape Vincent (N. Y.) Station and Substations

[J. P. Snyder, Superintendent]

The damage caused by two unusually severe storms and the highest water level in the St. Lawrence River since 1889 necessitated extensive repairs to the station docks. One of the garages was enlarged to provide room for an additional truck, all buildings and boats were painted, and the lawn and flower beds were improved. The collection of lake-trout eggs was the second largest in the history of the station, but, due largely to adverse weather, the holding of trout in pens to ripen was not as successful as in the preceding fall. No trouble was experienced in keeping the fish alive and in good condition, and the eggs taken from them were of high quality, but, because of storms, only a limited number of brood fish could be obtained. The collection of whitefish eggs exceeded that of the previous year by 13,692,000, while the take of cisco eggs was in excess of last year's to the extent of 44,340,000. A total of 1,091,458 brook-trout and 75,000 Loch Leven trout eggs was received in exchange for other eggs, and all fry from these, with the exception of 181,000 distributed in New York State, were assigned to the station's field and cooperative nurseries. In addition to the Watertown and Barneveld substations, the Cape Vincent station supervises the work at five coöperative nurseries, located at Averill, Vt., Malone, N. Y., Adams, N. Y., Oneonta, N. Y., and Arena, N. Y. The combined output from these nurseries during the year consisted of 8,595 18-months-old brook-trout from 5 to 12 inches long and 71,500 brook-trout fingerlings Nos. 2 and 3.

Watertown (N. Y.) cooperative substation.—This project comprises 84 nursery troughs, a cottage, a garage, and a meat house. In addition to handling 110,000 trout in cooperation with the Jefferson County Fish and Game Association and the French Lake Development Association, the bureau produces independently each year about half a million fingerling trout. The output from this nursery in 1928 was as follows:

Brook-trout fingerlings	401, 650
Rainbow-trout fingerlings	95, 150
Brook-trout fingerlings produced in cooperative work	84, 000
	580, 800

There were on hand at this substation at the close of the fiscal year 608,960 brook-trout and 34,000 Loch Leven trout fingerlings.

Barneveld (N. Y.) cooperative substation.—This nursery is operated throughout the year in cooperation with the Utica Chapter of the Izaak Walton League, and its output for the year was 4,675 brook-trout and 74,075 rainbow-trout fingerlings Nos. 2 and 3. There were on hand at the end of June, 1929, a total of 2,649 yearling brook trout and 9,970 yearling rainbow trout, also a total of 174,770 brook-trout and 77,600 rainbow-trout fingerlings.

Swanton (Vt.) substation.—Adverse weather conditions caused serious trouble, not only in connection with the propagation of pike perch but involved considerable damage to the plant. The foundation walls of the boathouse and the canal walls to the fish pens required extensive repairs. The excessive wash along the the lake shore was counteracted by driving willow posts and distributing rock and gravel. Unseasonably warm weather during March caused the pike perch to begin their spawning migration unusually early, but ice in the lake prevented the setting of nets until April 7. Notwithstanding the poor catches of pike perch in the trap nets, a total of over 4,500 brood fish was taken and penned, this aggregate being appreciably larger than that of the previous year. For some reason the eggs matured very slowly, and by May the condition of the fish necessitated their release. Up to that time only 940 female pike had spawned, yielding approximately 70,000,000 eggs. The eggs taken were distributed in accordance with the existing cooperative agreement, part of them going to the State of Pennsylvania. The remainder were incubated in the Swanton hatchery and the resulting fry distributed to the credit of the bureau and the State of Vermont. Efforts were made to collect yellow-perch eggs. When about 7,000,000 had been secured and many more were available a heavy storm destroyed and scattered the masses, so that subsequent collections were negligible. The majority of the fry hatched were planted in Vermont waters or returned to Lake Champlain. A few eggs of the white sucker were collected and turned over to the State of Pennsylvania.

RESCUE OPERATIONS

The activities in connection with the salvaging of stranded fishes from overflowed areas along the Mississippi River, administration of the fisheries phases in the upper Mississippi River wild-life and fish refuge, supervision of the Mississippi Valley, middle western, and intermountain hatcheries, as well as temporary field work, such as the collection of trout eggs in Yellowstone Park and the propagation of buffalo fish, are directed from headquarters at La Crosse, Wis. A more or less mobile organization, which operated in sections as divergent as Arkansas and Montana, has been developed for this work. Weather conditions rendered the salvaging of fish unnecessary and virtually impossible during the year, and the efforts of the personnel were directed toward their other duties.

La Crosse (Wis.) Station and Substations

[C. F. Culler, in charge]

The rescue work in the upper Mississippi River, which is normally taken up in August, was negligible during the summer of 1928. The river remained at an exceptionally high stage, making it unnecessary and impossible to carry on rescue activities and the mussel-infection work, which is dependent upon the above operations. Various trials were made at different points, and only a very few fish were taken. The trout work carried on in connection with the cooperative rearing plan was to a considerable extent successful, although a heavy mortality was experienced in May. The cooperative ponds supervised by this station numbered 76 in Wisconsin and 22 in Minnesota. Rainbow, brook, and Loch Leven trout were the species propagated. A few eggs of the last-named species were collected near Eau Claire, Wis. A personnel was detailed to various field hatcheries, including the collection of lake-trout eggs in cooperation with the Lincoln Park (Chicago) aquarium, propagation of buffalo fish in cooperation with the State of Arkansas, and the usual details to Michigan waters for the propagation of lake trout, whitefish, and pike perch.

Homer (Minn.) substation.—Fish-cultural operations at this point consisted almost wholly of the limited amount of refuge work that was possible under prevailing water conditions. The station served as a base for biological investigations in connection with the upper Mississippi wild-life refuge. Considerable work in the overhauling of boats and trucks, as well as the construction of new boats, was also carried on at Homer. One of the most important items in this respect was the construction of a houseboat, 16 by 50 feet in dimensions, for use in the wild-life refuge.

Lynxville (Wis.) substation.—Activities at this point were also confined to routine upkeep of property and a few scattering collections of fish from the river for distribution.

Marquette (Iowa) substation.—This substation was practically on an inactive basis during the year for the reason cited above.

Bellevue (Iowa) substation.—With the exception of the collection of a limited number of carp and buffalo-fish eggs, which were fertilized and planted in the Mississippi River, no fish-cultural activities were carried on.

MARINE SPECIES

Three stations located in New England are responsible for over 90 per cent of the numerical output of fish and fish eggs. The great fecundity of the marine fish such as cod, haddock, pollock, etc., together with the short incubation period, permits the handling of millions of eggs. The fish hatched from these are necessarily planted in parental waters as fry, and in some instances the eggs are returned directly to the water immediately after fertilization to hatch in the natural way.

Boothbay Harbor (Me.) Station

[Thomas H. Dorr, Superintendent]

The year's fish-cultural work at this station was devoted to the propagation of winter flounder or flatfish and the handling and planting of fertilized cod and haddock eggs on the fishing grounds. During the spawning season of the first-named species, extending from March 5 to April 23, unusually heavy windstorms were prevalent, but as the traps were set in sheltered coves the work of capturing a brood stock proceeded without interruption. From the 8,996 gravid females secured 2,161,051,000 eggs of fine quality were obtained and hatched without unusual loss, and the resulting fry were returned to the natural spawning grounds from which the brood stock was derived.

In the early part of the cod-spawning season, which extended from April 3 to June 13, only one boat was available for making collections of eggs. On the completion of the winter-flounder operations, however, the boat that had been engaged in that work and also the bureau's launch took part in the cod work, and by means of the three boats all fishing grounds from Pemaquid Point to Seguin Island were covered. While the results of the operations fell short of the record collections of last year by about 200,000,000 eggs, the season's total amounted to 1,068,142,000. Between April 22 and May 29 eggs of the haddock were taken along with the cod eggs, the total collections of this species numbering 132,977,000. The usual aquarium exhibit was maintained at the station during the summer months.

Gloucester (Mass.) Station

[C. G. Corliss, Superintendent]

Active fish-cultural operations began November 1 with the opening of the pollock-fishing season. Fishing was poor and daily egg collections were much below normal, except for three days near the middle of December, when nearly two-thirds of the season's collection of 596,132,000 were taken. Much better success was attained in the prosecution of the cod work. Eggs of this species were taken from early November to the last week in May, but the bulk of the season's total, amounting to 1,124,802,000, was secured during the three months beginning January 1. Of these eggs 763,163,000 were fertilized and immediately planted on the fishing grounds, the unsuitable water conditions at the time of their collection making it impracticable to incubate them. From eggs developed in the hatchery 274,033,000 fry were hatched and liberated at suitable points along the Massachusetts coast between Rockport and Manchester. Inshore haddock fishing was poor throughout the season, and with only one steamer fishing regularly egg collections were necessarily lighter than under the more favorable conditions of preceding years. Between April 1 and May 25 an aggregate of 104,046,000 was taken, and, owing to unsuitable hatchery-water conditions, all of them were fertilized and planted at the point of collection. Between March 11 and April 8, from a stock of 342 gravid winter flounder secured in the outer harbor, an aggregate of 178,209,000 eggs was taken and incubated, the hatch being slightly in excess of 90 per cent.

Offshore operations.—On February 1 three spawn takers were detailed to accompanying the fishing vessels operating in the offshore fisheries. For a month the take of eggs was light, as most of the fish handled were unripe. Improved conditions prevailed in March but were not sufficiently favorable to counteract the early lack of success. When the work was discontinued on April 25 a total of 50,009,000 cod eggs and 113,720,000 haddock eggs had been fertilized and planted.

Woods Hole (Mass.) Station

[G. R. Hoffses, Superintendent]

The fish-cultural work at this station differed from that of previous years inasmuch as no cod were propagated. The old water-supply tanks were replaced and the new tanks could not be completed in time to permit of the conduct of cod-hatchery work. However, two of the station employees were detailed on trawlers on one of the large fishing companies to collect and plant fertilized eggs. In view of the large number of fish caught, the number of eggs taken was somewhat disappointing, but the possibilities seem to warrant further consideration of the project. The usual propagation of winter flounder was carried on, and the attempt to secure a brood stock was undertaken somewhat earlier than usual. The results showed, however, that no benefit accrued from these early attempts. The operation of about 25 fyke nets in Waquoit Bay from January to March gave a total of 3,350 adult fish, of which 2,846 were females. Eggs to the number of 880,000,000 were obtained from them, and a very satisfactory hatch of fry was attained. A number of eyed eggs were planted in suitable waters when the hatchery was overcrowded. The fry developed from those undergoing incubation were returned to the natural spawning grounds and to several new locations in Massachusetts and New York. It is reported that highly favorable results have followed previous planting of flounder fry off Marthas Vineyard and at Provincetown. Statements are made to the effect that flounder fishing has become more productive since the first plants were made. An improvement in the method of handling the adult fish has resulted in a reduced loss percentage.

Investigations at to the possibility of propagating alewives were conducted, but it was found that the capture of sufficient fish with mature eggs was too difficult to warrant the effort. A limited number of mackerel eggs was taken from fish obtained at the trap fisheries in the vicinity of the station. The usual exhibit of marine and fresh-water specimens was maintained during the summer in the aquarium. In addition to the replacement of the water tanks, considerable other work was done pertaining to the upkeep of wharves, boats, and buildings. A septic tank was completed, and considerable piping, not only for the water line but for the gas and air line, was replaced at a cost in excess of $1,200.

ANADROMOUS SPECIES, ATLANTIC COAST

The transfer of the Potomac River shad station to a new location at Fort Humphreys, Va., was marked by a hatch of shad closely approximating the highest records of earlier years. The run was abundant and the fish were unusually large. A good hatch of yellow perch was secured also, but the propagation of these forms at the Edenton (N. C.) station gave an output somewhat below normal. Striped bass were again propagated at Weldon, N. C., in cooperation with the State. Only 1,000,000 Atlantic-salmon eggs were handled at the Craig Brook (Me.) station, but it is purposed to rear a larger number to fingerling size before distribution, which will result in a higher stocking value in spite of the reduced number.

Fort Humphreys (Va.) Substation

[L. G. Harron, Superintendent, and R. W. Owens, Acting Superintendent]

The construction of this station, established for the continuation of the shad and yellow-perch propagation heretofore pursued at Bryans Point, Md., had advanced sufficiently toward completion at the opening of the 1929 fish-cultural season to permit of the conduct of hatchery work. The present location of the station is a much more favorable one than the old site, being farther removed from city pollution and much nearer the field where shad eggs are available. The initial fish-cultural work was the assembling of a brood stock of yellow perch, and approximately 22,000 adult fish of that species were obtained from commercial fishermen. Of the 184,470,000 eggs produced by this stock, 92 per cent were hatched and the fry returned to points in the Potomac River from which the brood fish were taken. Between April 22 and May 19, 76,095,000 shad eggs were collected and incubated, this total having been exceeded only once in the history of the work on the Potomac River. All of the fry resulting from this stock, amounting to 88 per cent of the egg collections, were distributed on the native spawning grounds in the river.

Edenton (N. C.) Station and Substation

[William S. Vincent, Superintendent]

The collection of brood yellow perch was almost a failure, due to the prevention of fishing by stormy weather until many of the fish had spawned. The same adverse conditions prevented a satisfactory collection of herring eggs. The destruction of gear necessitated a halt in fishing, and by the time the equipment was again in readiness for operations the fish had migrated to other waters and spawned. The percentage of hatch resulting from the 37,000,000 eggs secured was somewhat higher than usual. The catch of shad at the only grounds in the region now operated was below normal, amounting to approximately 13,000. The catch averaged about 40 per cent of roe fish, and from them over 7,000,000 eggs were obtained for incubation.

Weldon (N. C.) substation.—The striped-bass station at Weldon was again operated in conjunction with the State department of conservation. Considerable work was required to put the plant in condition for operations. A satisfactory run of fish occurred, and over 13,000,000 eggs were taken, which gave a hatch averaging about 70 per cent. Experiments were made in hatching eggs in city water, and the results were satisfactory, although a somewhat longer time was required for incubating them.

FISHES OF MINOR INTERIOR WATERS

The species included under this head comprise virtually all of the game varieties, which are distributed upon the application of individuals or organizations rather than upon general plants made directly from the hatcheries.

While the technique of hatching the trouts, pondfishes, etc., is so well developed as to permit a high percentage of hatch, two aspects add to the difficulty and expense of this work. The first is the popular demand, undoubtedly justified, that the fish be reared to a larger size, sometimes to a legal length, before distribution; the second is the fact that frequently they must be transported hundreds of miles for planting in depleted waters.

In the case of trout the maximum number of fish available for any given season is determined months previously, when the eggs are laid down in the hatchery, and consequently production can not be increased on short notice to meet sudden demands. The production of pondfish is, to a great extent, influenced by weather conditions, which also affect the collection of eggs from wild trout to a considerable degree. A 100 per cent production at each of the 25 stations supplying this class of fish would undoubtedly enable the bureau to fill all current applications with assignments sufficiently large to meet the reasonable expectations of the applicants.

Records of the individual stations show, in most cases, a gratifying increase in the number of fingerlings produced. After years of development work the establishment at York Pond, N. H., was able to supply a number of high-quality brook-trout eggs for other stations. Results have demonstrated the soundness of devoting an entire hatchery to the production of eggs.

As has been frequently emphasized, the production of warm-water pondfish is directly dependent upon the available pond space. Moderately increased outputs can be obtained by intensive and scientific utilization of existing facilities. The bureau leases water acreages, uses natural ponds and sloughs, and in every way attempts to meet the demands of that large section of the country which is adapted to the pondfishes only and calls insistently for bass to the exclusion of other varieties.

ROCKY MOUNTAIN TROUT STATIONS

The six stations and the substations in this area supply the demands of the general public and in addition must furnish fish for the national parks and forests. In the past, western sportsmen were satisfied with the planting of small fish, but it is now necessary to rear a good proportion of the trout to larger size before distribution, and facilities have been expanded at Springville, Utah, Saratoga, Wyo., Yellowstone Park, Wyo., and Bozeman, Mont., in order to meet this requirement. None of the Western States has more than one Federal hatchery at the present time, and the vast area to be stocked has necessitated the operation of this group of stations at the utmost safe limit of their capacity.

Bozeman (Mont.) Station and Substations

[W. T. Thompson, Superintendent]

The close cooperative relations heretofore existing between this station and the Montana Department of Fish and Game were maintained. During the year the station received from the State 802,000 black-spotted trout eggs, 1,335,000 grayling eggs for development at its Meadow Creek auxiliary, and a consignment of more than a million eggs of that species for its Glacier Park substation. In return the State was furnished over 2,000,000 eggs of the Loch Leven trout. The State also supplied two consignments of adult aquarial specimens, most of them grayling.

The year's output was somewhat smaller in numbers than that of the past two years, but the quality and size of the fish sent out were the highest in the history of the work in this field. The good results were made possible by the fact that there was an entire absence of disease during the spring, and at the close of the fiscal year brook and rainbow trout fingerlings No. 4 were being shipped at the rate of 125 to 150 per can or pail. The total collection of trout eggs for the year amounted to 17,122,200, and 5,639,735 additional were received through the medium of exchange. Over 10,000,000 eggs were shipped on assignment in addition to those transferred between Bozeman and its auxiliaries. The utilization of the remodeled nursery and rearing ponds, together with the increased water supply, has tended toward the production of much larger and better fish than formerly.

No brook-trout eggs are taken in the Bozeman field and all needed eggs are obtained by exchange. During the winter 500,000 eyed eggs of this species were received from Colorado in return for eggs of the rainbow trout. With the view of hastening distribution, 225,435 eggs of this variety, taken early in the season, were obtained from the Neosho station in December and January. These were not more than average in quality, and the loss suffered during the incubation and sac stages was heavy, due partly to the numerous crippled fish eliminated. After feeding commenced, however, conditions improved, and the quality of the fingerling fish distributed was satisfactory. Ninety-six thousand early Montana rainbow eggs were received from a commercial hatchery in that State, in exchange for an equal number of eggs from wild trout of the Madison Valley region, the latter being desired for improving the brood stock. More than half a million eyed rainbow eggs were received at the station from the Madison Valley field in June.

In July, 1928, 210,000 eyed black-spotted trout eggs were received from the Montana commission, and 505,000 were derived from the bureau's station in the Yellowstone Park. In May, 1929, additional early black-spotted trout eggs to the number of 853,200 were received through exchange with the Nevada fisheries authorities. The securing of these early taken rainbow and black-spotted trout eggs has proved a distinct advantage, as it has made possible an early distribution of large fingerling fish and has obviated the necessity of deferring deliveries until late in the season. It is hoped that this practice can be continued on an extensive scale in the near future.

The Loch Leven trout is our pride and also our despair. Probably no other eggs equal in quality those obtained in Odell Creek from wild trout of the Madison Valley, but the fry and fingerlings in troughs, but more especially in ponds, are decidedly bad actors. Green eggs of this species to the number of 4,562,400 were transferred directly from the Odell Creek traps of the Meadow Creek auxiliary, 4,000,000 eyed eggs were shipped on assignment from the Washington office or in exchange, and some 200,000 fingerlings were on hand at the close of the year. Bozeman station was fortunate in securing 50,000 eggs of the golden trout from California. They were divided into two lots, one going to the Glacier Park hatchery and the other was incubated at Bozeman and the product planted as fingerlings in a virgin lake.

Profitable experiments with prepared fish foods were conducted. These foods may be grouped into three lots. The first proved excellent in combination with fresh liver or as a substitute in periods of scarcity. The second group was found to promote the growth of the fish satisfactorily for a period of three or four months. It then appears to break down as a sole food, which, necessitates the use of a supplementary food to maintain the health and growth of the fish. The third appears to be a perfect food when used alone, giving better results than even the best of fresh liver up to four and one-half or five months. What results can be obtained by feeding these two higher groups in combination and also with fresh liver remains to be seen, but it is confidently believed the results will be better than when any one of the three is used alone.

Meadow Creek (Mont.) substation.—For the third successive year this auxiliary secured upward of 14,000,000 eggs from wild Loch Leven trout in the Odell Creek field. Green eggs numbering 2,023,100 were shipped to the Montana State hatchery at Big Timber, and 4,562,400 were transferred to the Bozeman station by truck, being carried in ordinary distribution cans. These eggs were eyed, part of them shipped, and the remainder hatched with a total loss of only 4½ per cent. The rainbow-egg harvest exceeded that of the previous year by more than a half million, amounting to 3,002,300 as against 2,450,000 in 1928. Their quality was excellent. After developing to the eyed stage 561,400 were shipped on assignment and 1,055,500 were transferred to Bozeman and the Glacier Park hatchery. Fry to the number of 1,032,000 were produced from the retained eggs. Green black-spotted trout eggs to the number of 592,000 and 1,335,000 grayling eggs were received from the Montana commission's spawning field at Georgetown Lake. The grayling eggs were of exceptionally fine quality and were very large, running about 600 to the ounce as against the usual 800 or more.

Glacier Park (Mont.) substation.—This field was exceptionally active along formerly established lines, and much new work outlined had progressed well along toward completion by the close of the year. This includes the construction of a series of eight large rearing ponds, the provision of a new and improved water supply and the construction of new troughs for the hatchery. Experimental field operations, which appear to hold considerable promise for the future, also were inaugurated. Some interesting investigations made in March demonstrate beyond question that in at least one lake on the western slope—Logging Lake—the black-spotted trout spawns in February and March under heavy ice in a bottom temperature around 35° to 36°. It is hoped that practical work can be undertaken during the coming year to secure these valuable early eggs.

At the opening of the fiscal year 123,000 eyed eggs of rainbow trout and 318,000 fry of that species were on hand. From these, 435,000 fingerlings were developed and planted by the National Park Service. Additional eyed eggs to the number of 463,000 were received in June, 1929, and at the close of the year were partly hatched. In July, 1928, 994,600 black-spotted trout eggs were received, from which 983,300 fry were hatched and 965,000 fingerlings No. 1 reared and distributed in park waters before the close of fall operations. A lot of 89,500 early black-spotted trout eggs was received by exchange from the Nevada fish and game commission, and 119,200 eggs were secured as a result of experimental field work on Fish Creek. This stock, in the form of fingerlings and eyed eggs, was on hand when the year closed. Twenty-five thousand eggs of the beautiful golden trout of California were received in July, and from them 21,000 fingerling fish were developed and planted, a distant virgin lake well up toward the crest of the Continental Divide being selected for the purpose.

Miles City (Mont.) substation.—A small consignment of largemouth black bass breeders was introduced in this lake in April, 1928. When drawn down during the succeeding October for the removal of carp, which were supposed to have gotten in the lake with the water pumped from the Yellowstone River, 4,810 choice bass fingerlings No. 5 were found. In November, 1928, and January, 1929, two carloads of assorted largemouth black bass, crappie, and sunfish were received and deposited in the lake, and early in March two additional consignments of bass, received through the cooperation of local organizations and residents of the region, were also introduced. The total of these two plants aggregated 935 bass, 677 crappie, and 611 sunfish, all of excellent quality. A cold spell was experienced shortly after the lake had been stocked, and ice to a depth of 30 inches formed on the surface, followed by a covering of heavy wet snow. This resulted in a heavy loss of brood fish through suffocation. A drain has been excavated from below the outlet of the lake to a slough connecting with the Yellowstone River. This will aid materially in draining the lake.

Leadville (Colo.) Station

[C. H. Van Atta, Superintendent]

Somewhat extensive improvements were made to the station buildings and equipment. A commodious combination carpenter and machine shop was completed and the machinery installed. A station garage, 24 by 66 feet in dimensions, with a concrete floor, was constructed, the building being of sufficient size to accommodate all of the station trucks and other vehicles. In the course of the year 30,000 feet of lumber were sawed and planed into sizes suitable for future repair and construction work, making possible a reduction in building costs to a very low minimum. The rest of the station buildings were kept in good repair. A "Caterpillar Ten" tractor and a "Novo Double-Drum" hoist were purchased for use in putting Crystal Lake in condition to be stocked. The tractor will also be used for clearing roads in winter and for many other purposes.

The station's output of fish, distributed by fisheries car No. 8 during the fall, consisted in the shipment of approximately 3,635,000 brook, 175,000 black-spotted, and 173,000 Loch Leven trout fingerlings, as well as 2,700 largemouth black bass, the latter having been collected by the station force from a reservoir that was being drained at Rifle, Colo. During July the station acquired, by shipment from the Yellowstone Park, a consignment of approximately 300,000 black-spotted trout eggs. During the fall the usual egg-collecting fields were operated on the established share basis and yielded 6,221,000 brook and 133,000 Loch Leven trout eggs. Of this total, 1,050,000 eyed eggs were shipped to other stations and 4,723,000 healthy fry were hatched from the remainder—a percentage of 91 of the retained stock. After making deductions to cover the owners' share of these fish, there were on hand at the close of the fiscal year, in round numbers, 3,260,000 brook and 115,250 Loch Leven trout fingerlings, and 65,000 rainbow, 150,000 black-spotted, and 250,000 brook trout from the hatch of the previous year.

Crystal Lake, a privately owned property leased by the bureau, is being developed as a future source of supply for rainbow-trout eggs. This 9-acre lake, situated about 4½ miles from the station reservation, was formerly a brook-trout water. It having been ascertained, however, that it would be of more value to the bureau as a rainbow-trout egg-collecting field, the work with brook trout will be abandoned and all efforts confined to stocking the waters with the rainbow species.

Creede (Colo.) substation.—The site for the new substation at Creede was surveyed during the year, and the water-supply system is in course of development. When completed, which will be some time during the fiscal year 1930, this substation will be equipped for the propagation of brook, rainbow, and black-spotted trout on an extensive scale.

Yellowstone National Park (Wyo.) Substation

[C. F. Culler, in charge]

Field activities at this point cover two fiscal years. At the beginning of July, 1928, the collection of black-spotted trout eggs was proceeding very satisfactorily and the final collection for the season amounted to 23,000,000, of which over 12,000,000 were taken after July 1. Average success in incubating the eggs was experienced, and the usual plan of distribution in park waters was followed. Normal weather conditions permitted the construction of a new hatchery building, and other necessary construction work was carried on, including the completion of 10 new rearing ponds at Mammoth Hot Springs during the spring. The egg-collecting season that was opening at the close of the fiscal year failed to show as satisfactory results as those of the previous year. Up to the end of June 6,500,000 eggs had been taken.

Saratoga (Wyo.) Station

[S. M. Ainsworth, Superintendent]

Under authority of a special appropriation, considerable work was done on the construction of a new cottage for housing station employees; the station garage was enlarged to nearly double its former capacity, and a new 12-inch wood-stave pipe line was laid to connect the spring-water supply with the distributing reservoir. The station buildings were repainted, and the appearance of the reservation was further improved by the grading of grounds and driveways, cleaning up sagebrush, etc.

The season's collection of brook-trout eggs was the largest in the history of the station, 1,930,000 being secured in the Big Creek Lakes field and 227,000 from the domesticated brood stock. All eggs taken were a little above the average in quality. Eyed eggs to the number of 420,000 were transferred to other stations, and, owing to insufficient holding capacity at the station, 460,000 fry were turned over to the Wyoming State hatchery for rearing. A satisfactory egg supply was produced from the Loch Leven brood stock, though the average yield per fish was not large, many of the breeders being very young. A shortage of nearly a million rainbow eggs, as compared with last year's returns in the Lost Creek field, is ascribed partially to the very late spring in that region. An excessive rise in water temperature, occurring in the latter half of the spawning period, also caused heavier-than-normal losses. Part of the eggs taken were shipped in the eyed stage, and approximately 708,000 fry were hatched and returned to their native waters. A lot of 100,000 black-spotted trout eggs forwarded to the station from the Yellowstone Park field yielded more than 77,000 fingerlings Nos. 1 and 2 for distribution in Wyoming waters. From a consignment of 305,000 eyed eggs of this species, furnished by the Nevada State Fish Commission in return for an equal number of rainbow eggs, 271,000 fry were hatched, of which 262,000 in the fingerling No. 1 stage were on hand at the close of the fiscal year, together with over a million fry and fingerlings of other species.

SPEARFISH (S. DAK.) STATION AND SUBSTATION

[D. C. BOOTH, Superintendent]

The young game trout on hand at the beginning of the fiscal year were given wide distribution as large fingerlings during the fall months. The main entrance drive, with a massive concrete wall on each side, on which are electrically lighted columns, was completed during the year. While there has been an ample supply of pure mountain spring water for incubating the eggs and carrying the young fingerling trout in the troughs, the station has long been handicapped by an inadequate volume for holding over any considerable number in nursery ponds for distribution after attaining a length of 4 or 5 inches. This condition was changed last fall by the construction of a concrete dam, providing sufficient head, and laying some 700 feet of 8-inch wood-stave water pipe. An adequate volume of water is now available for every pond, 14 in number, on the lower grounds. In addition to caring for several thousand adult and yearling fish, approximately 250,000 fingerling brook, rainbow, and Loch Leven trout 2 inches in length are now being held in nursery ponds supplied with this water, with the intention of distributing them when they have attained a length of 4 or 5 inches. The brood-stock ponds were deepened and enlarged, a long concrete wall was constructed along the storm channel, a portion of the hatchery-building roof was reshingled, and the whole station is in good condition.

Fish-cultural operations were conducted along the same general lines as in previous years, eggs being taken from the station brood stock and their numbers supplemented by collections from wild trout and by purchase and exchange. Two million brook, rainbow, and Loch Leven trout eggs were handled during the year, over 900,000 fish were distributed, and upward of 600,000 were on hand at the close of the year awaiting shipment later as large-sized fingerlings. Several kinds of food were used, but none was found as satisfactory as beef liver and beef heart for the small fish and sheep liver for the adults. The station personnel was able to render considerable assistance to various clubs and individuals interested in restocking public waters, including several commercial fish culturists. The station also cooperated with officials in solving stream-pollution problems.

Crawford (Nebr.) substation.—This substation has been under construction during the entire year. A building 24 by 52 by 12 feet was erected for use as a garage, shop, fish-food room, and for storage. A 1-story frame cottage for the use of the foreman was completed, and at the close of the year the frame hatchery building, 35½ by 65 feet in dimensions, was about 85 per cent completed. Three nursery ponds were constructed at the pumping plant on the Fort Robinson Military Reservation and put in service. They seem to be well adapted to trout rearing. The ice pond was converted into a breeding pond for rainbow trout by putting an 8-inch pipe through the dam. A sunfish pond was constructed and stocked. The city installed a 6-inch iron pipe connecting the city mains with the hatchery, and a fire hydrant was installed near the hatchery with plugs to fit the Crawford fire department hose.

SPRINGVILLE (UTAH) STATION

[CLAUDIUS WALLICH, Superintendent]

During the year the station brood-pond system was improved by the construction of walls and bottoms of concrete. This change proved very advantageous in the handling and stripping of the rainbow-trout brood stock. Between early December and the middle of March nearly 2,500,000 eggs were taken from this stock, and at the close of the fiscal year the No. 2½ fingerling rainbows on hand as a result of this spawning amounted to 620,000, a pronounced increase over work of the same character last year. To offset this increase the station collections at the cooperative field station at Fish Lake, Utah, fell off, due in a measure to a smaller total collection, with a consequent reduction in the bureau's share. A total of 5,500,000 brook-trout eggs was collected in this field, of which the station received 780,000, shipped 246,400 to the Nevada fish and game commission, and hatched 450,000 to fill local requirements, 80 per cent in the fingerling No. 3 stage being returned to parent waters. The remaining 20 per cent was turned over to the State of Utah for stocking some lakes that are not accessible until July.

The rainbow-trout work in the Fish Lake field was hampered by a late spring and a low water level. Great difficulty was encountered in getting to the lake, huge snowdrifts from 6 to 20 feet deep and a quarter of a mile long in places necessitating an immense amount of shoveling to open the roadway. The take of eggs amounted to slightly under 5,000,000 and the station received 682,000 as its share. Of these, 50,000 were shipped in the eyed stage to Missouri and the remainder were hatched. A high percentage of fry was obtained from the brook trout and the station stock of rainbow trout. In the case of the wild rainbow trout, however, many of the females produced eggs of a glassy appearance with a clearly visible opaque spot inside. Much cooperative assistance was received from the Utah Department of Fisheries in the course of the year. The loan of the State tank trucks in connection with the distribution of fingerling trout was of special aid, enabling the station to accomplish the work much more economically and efficiently than has heretofore been possible. The new concrete-tank system is virtually completed. Ninety-six single or 48 twin tanks, 15½ feet long, 30 inches wide, 30 inches deep at foot, and 25 inches deep at head of tank, have been cast. The tanks will be supplied with water from a concrete flume.

NEW ENGLAND TROUT AND SALMON STATIONS

In no region is the efficiency of artificial propagation of game fishes better attested than in the New England States. While no Federal hatcheries are maintained in Connecticut and Rhode Island, the distribution problem is simplified by comparatively short hauls, and the planting of large fingerlings has been followed to the point where much good fishing is available in spite of the populous conditions in this area.

HARTSVILLE (MASS.) STATION

[E. P. THOMPSON, Acting Superintendent]

During the year four artesian wells were driven and put in service, increasing the station water supply by approximately 150 gallons per minute. The dam of pond E was repaired, and a new sluiceway and outlet box were installed. A cement foundation was placed under the woodshed at the clubhouse, hardwood floors were laid in the fish-culturist's residence, and other needed repairs connected with the upkeep of buildings, equipment, and grounds were made. The station stock of brook trout yielded 350,000 eggs, from which 290,000 fry were hatched and reared to fingerlings. The fingerling fish resulting from a lot of 26,026 rainbow-trout eggs received from the Manchester (Iowa) station were on hand at the end of the year, together with 102,000 brook-trout fingerlings, the remainder of the stock having been distributed previously. The station distribution included an output of 7,064 catfish fingerlings. In the course of the year the station cooperated with nine individuals and clubs, furnishing brook trout for 13 rearing ponds.

CRAIG BROOK (ME.) STATION AND SUBSTATIONS

[GEORGE N. MONTGOMERY, Superintendent]

Extensive improvements were made during the year. Two ponds were combined with a larger one, and five old ponds out of commission were repaired and put in condition to hold fish. Pond No. 35, which for several years has not been used, was cleaned, its banks raised, and a concrete spillway constructed, making available a pond 2,300 square feet in area. Considerable grading of pond banks and roadways was done. A change was made in the piping system so as to permit the flow of waste water from the upper hatchery directly into the lake. A large concrete tank, 98 feet long by 6 feet wide, was constructed below the hatchery building for use during spawning operations, being divided into compartments by wooden racks. The lower hatchery building was painted, and an abandoned boathouse at the Green Lake substation was torn down and the material utilized for constructing a storehouse. Work was begun on the erection of a foreman's cottage. Most of the troughs in the lower hatchery building were replaced by new ones of improved design, which permits their being moved.

The collection of brook-trout eggs from the station brood stock was the highest on record for this field, reaching a total of 2,704,450. Of these, 900,000 in the eyed stage were transferred to other stations. A number of exchanges were made whereby brook-trout eggs were secured from commercial hatcheries and other sources. There were on hand at the close of the year almost 250,000 fingerling brook trout to be distributed during the fall.

At the opening of the year the station was carrying 120,000 landlocked-salmon fingerlings, which were distributed later. During November 182,000 landlocked-salmon eggs were transfered to the station from the Green Lake field, and, after developing to the eyed stage, 122,500 were shipped to other points. From the Grand Lake Stream substation 300,000 eggs of this species were received, and 85,000 of them in the eyed stage were forwarded to other hatcheries and to applicants. Some of the fry resulting from the remainder were distributed before the close of the year and some were retained for fall planting. The fry resulting from the usual assignment of landlocked-salmon eggs from the State hatchery at Caribou, Me., were all distributed before the end of June.

In July, 1928, the station was carrying 50,000 Atlantic-salmon fingerlings, all of which were shipped in September. In the following spring 1,000,000 Atlantic-salmon eggs were received from Canada. A number of these were transferred to State hatcheries in Maine. The fingerlings resulting from those incubated at Craig Brook station were distributed in the various salmon rivers, with the exception of a lot of 108,000, which were held for fall planting.

Grand Lake Stream (Me.) substation.—The number of rearing ponds for the landlocked-salmon and brook-trout work at this point was increased to seven by the addition of the new one constructed during the early fall of 1928, the series being capable of holding approximately 500,000 fingerlings of these species. The salmon fingerlings on hand at the opening of the year were fed through the summer and distributed during the fall with merely nominal losses. The collection of landlocked-salmon eggs extended from early October to late November. Water conditions throughout the season were favorable, and 975,500 eggs of superior quality were secured. The brood fish taken included many first spawners of both sexes. Only two barren females were found, though many were immature, and these were liberated as soon as caught. The loss of eggs in the hatchery was considered normal. On reaching the eyed stage 300,000 were shipped to the Craig Brook (Me.) station. Of the young fish hatched from the remainder, 47,000 in the No. 1 fingerling stage were delivered to applicants, and at the close of the year nearly half a million were being held in six of the rearing ponds and fed. The large number of young salmon now present in Grand Lake is an indication of the excellent results accruing from the liberal planting of large fingerlings therein.

The year opened with 117,445 brook-trout fingerlings on hand from the stock of the previous year. The fish fed freely, grew rapidly, and the loss that usually occurs when the water temperature reaches 70° or over was averted by making an early distribution in the No. 3 fingerling stage. Approximately 200,000 eyed brook-trout eggs received from the main hatchery at Craig Brook were hatched with merely nominal losses. About half of the young fish produced from them were distributed as fingerlings No. 1, and the remainder were being carried at the close of the year awaiting distribution in the fall.

St. Johnsbury (Vt.) Station and Substation

[A. H. Dinsmore, Superintendent]

Damage to the dam in Sleepers River by the disastrous flood in November, 1927, was repaired and a new concrete hatchery intake constructed. The usual number of brook-trout eggs transferred from York Pond (N. H.) substation and purchased from a commercial dealer was incubated, and the fry were distributed to applicants and planted in local public waters. In addition to the above, 400,000 eggs of this species, the property of the Caledonia County Forest and Stream Club, were hatched and turned over to the members of the club as fry for stocking public waters in the county. Small numbers of landlocked salmon and steelhead salmon eggs were hatched. All fry of the former species, excepting 3,000, which were transferred to York Pond to test their action in the flowing well water being developed there, were delivered to applicants and distributed in public waters as fry. At the close of the year the young steelheads were being held and reared for distribution as fingerlings.

York Pond (N. H.) substation.—Improvements to the mess house were continued. A stock room was finished in the basement, the entire roof of the old camp was removed, a story added, and a new roof of composition shingles put on. Ground for canal extension and for much needed pond space was cleared, and at the close of the year new ponds and races were being constructed. The flowing well area is being developed to afford a copious supply of water of uniform temperature. About 15,000 yearling brook trout selected from fish reared from the fry of the previous year have been added to the station brood stock. These and the large stock of adult trout were held with slight losses. Brook-trout egg collections amounted to nearly 3,000,000, being almost twice the collections of the previous year. Of these eggs, 727,307 were transferred to the St. Johnsbury hatchery, other stations of the bureau, and to applicants. The remainder were incubated at York Pond. The usual large plants of fry were made in local waters, and at the close of the year there remained 235,810 of these fish, running at that time up to 2½ inches in length. Fish from eggs forced along in the well water began to feed early in March and were handled with far better results than any attained previously. As usual, the natural fingerlings, resulting from eggs deposited by small females not handled and by the larger fish after stripping, were picked up during the late summer from the spawning races. Approximately 3,000 were obtained. Up to midsummer these fish make a far better growth than the artificially fed fry, but beyond that time they make practically no growth unless fed.

PITTSFORD (VT.) STATION

[DR. H. S. DAVIS, Director; R. F. LORD, in charge]

The Pittsford station is being operated as an experimental trout station, special attention being paid to brook trout. Small numbers of rainbow, steelhead, and black-spotted trout are also kept for experimental purposes. During the past year the experimental work has been largely devoted to an investigation of various dry food products that offer possibilities as subsitutes for meat in the diet of fingerling and older trout. It has been found that there are a number of such products that can be fed successfully in combination with fresh meat at a very considerable saving in the cost of food. It is not believed, however, that any of these dry products can be fed alone for any considerable length of time without detriment to the fish.

In addition to the feeding experiments an extensive series of experiments in selective breeding has been inaugurated. This work consists largely in mating individual fish and rearing the young of those pairs that show the greatest promise for further breeding work. While definite results will not be forthcoming for several years, it is hoped that by this means it will be possible to develop strains of trout that will excel in hardiness and rapidity of growth.

NASHUA (N. H.) STATION

[J. D. DEROCHER, Superintendent]

In addition to the routine minor work of maintaining the buildings and grounds in good condition, two new bass ponds were completed and stocked with small-mouth black bass. The station brood stock of brook trout yielded nearly 200,000 eggs, and almost 100,000 were obtained from the station brood stock of rainbow trout. The usual attempts were made to collect eggs from wild rainbow trout at Lebanon, N. H., but a scarcity of mature males made it impossible to fertilize the 69,000 eggs obtained. Shipments of brook-trout eggs from commercial hatcheries and other sources gave the station a total of approximately 1,000,000 of that species. A successful hatch permitted the distribution of a normal output of fry, and at the close of the year a considerable number of fingerlings was being retained and reared for distribution in the fall. A small consignment of landlocked-salmon eggs was received from the Craig Brook (Me.) station. Nashua station has been actively engaged in developing cooperative nurseries in the State, and a number of brook trout were allotted to the five establishments in operation during the year.

COMBINATION TROUT AND POND STATIONS

A water supply adapted to the propagation of trout may be utilized in propagating pondfishes, although the reverse may not be true. Consequently, while the surrounding waters are suited to bass and there is sufficient area available, some of the stations in the Middle West and Middle Atlantic region operate a considerable acreage of ponds for bass, sunfish, and crappie. The output of pondfish from these stations has generally not been large but is sufficient to provide for local distribution and relieve the pressure upon the regular pond stations.

Erwin (Tenn.) Station

[A. G. Keesecker, Superintendent]

During the year the station plant was improved by the construction of a concrete retaining wall approximately 150 feet long and 8 feet high, creating a catch basin for flood waters caused by drainage from the new Federal highway through the station grounds. Thus far this wall has prevented overflow of the trout ponds, but some other arrangement will have to be made for the protection of the bass ponds, as the wash from the road is filling them gradually with mud and sediment. About 200 cubic yards of mud were taken out of the ponds in the course of the year, materially increasing their rearing capacity. A new driveway was constructed from the hatchery to the superintendent's residence, and concrete walks were built from the main hatchery to the fish-culturist's residence and to the spring. The pond system was improved by raising the walls of several ponds and afterwards refilling them with earth and resodding them. Improvement of sanitary conditions by eliminating the disposal of sewage into the waste branch required the building of three concrete sanitary tanks with the necessary drains.

Between November 1 and February 28, 868,880 rainbow-trout eggs were taken from the station brood stock. Two lots of brown-trout eggs, aggregating approximately 153,000, were incubated for private parties. All brook-trout eggs handled were received by transfer from the St. Johnsbury (Vt.) station, and the average number of fingerling brook trout was produced and distributed. The output of rainbow trout was about the same as last year. The very cold and rainy spring retarded the spawning of the pondfishes, and the roily water hindered the collection of the fry to a great extent. However, approximately 34,000 fry and fingerling largemouth black bass were distributed, and it was estimated that about 20,000 remained in the brood ponds. A normal season's output of rock bass and sunfish is expected.

Manchester (Iowa) Station

[G. H. Gill, Superintendent]

The output of rainbow trout from this station was larger than for the past 10 or 12 years. One-third of the 2½-year-old brood stock produced eggs of high quality at the rate of 650 per female, and between December 12 and April 24 a total of 1,200,000 eggs of this species was collected. Brook-trout eggs to the number of 602,000 were received, 500,000 being shipped from the State of Idaho and the remainder from a commercial hatchery. All arrived in good condition, and there was entire freedom from diseased conditions throughout the year. Some trouble was experienced with rats, however, and before they could be exterminated many brook-trout fingerlings had been destroyed. The rodents consumed the body but discarded the head of the fish. At the close of the year there were on hand 90,000 rainbow and 100,000 brook trout fingerlings. A few adult smallmouth black bass constituted the station's entire brood stock of warm-water fishes during the spawning season. From these nearly 3,500 2½-inch fingerlings were produced, and the brood stock was augmented by the addition of 35 breeders matured during the year in the station ponds. Experience has shown that these fish develop rapidly by using young goldfish as forage for them. Painting and repairing the hatchery and two other buildings and the construction of 500 feet of cement side wall, drains, and cross dams in two large canal ponds constituted the most important work in the maintenance of the station. A new Reo 1-ton truck was received by transfer from the La Crosse (Wis.) station.

Neosho (Mo.) Station and Substations

[W. H. Thomas, Superintendent]

The special appropriation available since December, 1927, has been utilized in making extensive repairs to the trout and bass ponds, the creek retaining wall, and the water-supply system; all buildings have been placed in good repair and painted; most of the sediment clogging the McMahon Spring water-supply line has been removed by the insertion of two 6-inch blow-off valves at proper intervals. New fencing has been built around the station grounds, piping for natural gas has been run to all of the buildings, and needed alterations to the annex have been effected. A mechanical refrigerator recently installed for the preservation of fish food has proved effective and economical, the food being held in better condition than formerly and at a cost not exceeding one-fifth of the former outlay for ice.

The propagation of rainbow trout was conducted by segregating the adult fish according to age. By this means the egg-taking process involves less work than by the former method of mixing the eggs from fish of different ages. At this station all rainbow trout are distributed or planted after attaining the age of 3 years. The parasite Gyrodactylus infected all the rainbow-trout fingerlings during the early part of their existence, but it was easily controlled by treatment. Horse meat was used for feeding a portion of the adult and fingerling rainbow trout at Neosho until near the close of the year, when it was discontinued because of the expense and the fact that such food makes the ponds unsightly. The parasite *Proteocephalus ambloplitis* is prevalent among the pond fishes at this station, and to break up the life cycle of the parasite it is essential to "winter" the ponds. However, this operation causes excessive seepage from the ponds and a resulting depletion in the microscopic life so necessary as food for the young fish. In order to at least partially overcome these conditions fertilizer was used extensively and Daphnia planted at intervals in all of the ponds. Approximately 32,000 fingerling bass were collected and distributed prior to June 30, and the indications are that the fall collections will be somewhat in excess of those of the previous year. Rock bass, crappie, and catfish also were propagated, and the prospect of securing a large collection of crappie for fall distributions is very good.

Bourbon (Mo.) substation.—Although the season's egg collections of rainbow trout were the largest ever made since the bureau began its cooperative work at this point, their quality was somewhat inferior to that of last season. The fingerling rainbows developed normally untill the beginning of May, when an organic disease made its appearance, and the various remedies applied proved ineffective. For the past 18 months horse meat has been used for feeding the rainbow-trout adults and fingerlings above the No. 2 stage. The trout at this point are held in a raceway, which does not become unsightly from the use of the food owing to the large volume of water that passes through the race. The hatchery grounds were inundated by heavy rains, but this resulted in no loss of fish because of the security afforded by the fine-mesh wire fence recently installed for the protection of the raceway and ponds.

Langdon (Kans.) substation.—Receipts of warm-water fish from ponds in this section have exceeded all previous records. There were collected and distributed approximately 203,000 fish, consisting of largemouth black bass, crappie, rock bass, sunfish, catfish, and yellow perch. More than half of the fall distribution was of black bass.

WHITE SULPHUR SPRINGS (W. VA.) STATION

[EDWARD M. HAYNES, Superintendent]

A new electric light and power line was installed throughout the station during the year at a cost of $515, and an electric refrigerator was purchased and installed. Partial painting of the interior and exterior of the station buildings was accomplished. The activities in respect to the number of trout eggs handled did not equal those in 1928 by more than 500,000, the shortage being due to the smaller number of brook-trout eggs obtained from commercial fish-culturists. The grand total of output for the past year amounted to 3,882,810, in addition to the stock furnished to the State of West Virginia. In all, 3,464,000 trout eggs were collected from the station brood fish. The Cheat Club cooperative nursery at Durbin, W. Va., was conducted as heretofore under the supervision of the station. The agreement hitherto governing cooperative work with the West Virginia Game and Fish Commission was again effective. In pursuance of this plan the station incubated 1,200,000 brook-trout eggs for the State, receiving 350,000 of the eyed eggs in payment for this service. All brook-trout eggs handled at the station were derived from exchanges or from purchases made by the State. The station Loch Leven brood stock yielded 354,000 eggs of excellent quality, and approximately 140,000 additional were received from the Bozeman (Mont.) station. Rainbow eggs of superior quality were collected from the 3, 4, and 5 year old fish held in the station ponds. In addition to numerous shipments of eyed rainbow eggs sent to various parts of the United States, one consignment was sent to Cuba and one to South America.

Wytheville (Va.) Station

[C. B. Grater, Superintendent]

One of the minor improvements begun at this station was the widening of the road connecting the station grounds with the county highway. The production of rainbow-trout eggs from the station brood stock was limited to 400,000, as the 3-year-old fish, from which a large number of eggs had been expected, failed to reproduce in significant numbers. An epidemic of Octomitiasis caused heavy losses among the fingerlings. The cooperative nursery work in conjunction with the State of Virginia has been extended so that now four large nurseries, capable of handling over 500,000 fish, are in operation. These were stocked with brook and rainbow trout fry from the Wytheville station, but the infection previously mentioned caused heavy losses after the fish were transferred. All brook-trout eggs handled were secured by transfer from other points, and this species also suffered heavy mortality in the fingerling stage. The production of pondfish was about normal, with 9,000 fingerling largemouth bass distributed in October and 6,000 fry during the spring. Twenty-one thousand smallmouth bass fry were also produced for the spring distribution, together with a small production of rock bass.

PONDFISH STATIONS

Seven stations comprise this group. Several of them are required to spread their output over two States, with consequent difficulty in meeting all demands. An important function of this group is the stocking of numerous small private artificial lakes and ponds in the Southern States.

Cold Spring (Ga.) Station

[Charles A. Bullock, Superintendent]

Five of the station ponds were enlarged, giving them an area from 5 to 50 per cent greater than formerly. All remaining wooden overflow boxes in the larger ponds were replaced with new ones of concrete; the channel of Cold Spring brook was straightened and confined with concrete retaining walls, and various repairs were made to buildings, including the shingling of one of the residences and reweatherboarding the open side of the barn. The old wagon shed and stables were razed. A new highway through the station grounds from the main entrance to the rear entrance was completed by building up and widening the banks of two ponds bordering the main station brook and by building a concrete bridge across Cold Spring brook at its junction with the main brook. Notwithstanding the frequent roiling of the pond-water supply from the wash occasioned by the building of a State highway across the reservation, and an apparent shortage of fish food through the comparatively small production of daphnids in the ponds, the station was able to establish a record in its yearly output of bass, the 404,000 distributed exceeding slightly the number in any previous year since the station was established. The two ponds devoted to the propagation of bream yielded an output of 50,000, and about 6,000 catfish were raised in a pond set aside for the breeding of that variety.

Work at Harris Ponds was conducted along the same lines as in the previous year. Only a limited number of adult bream was available for brood stock, and after placing them in the ponds no food or other attention was given. When the ponds were drawn in September about 37,000 young bream were secured and added to those awaiting distribution in the ponds at Cold Spring station.

The work of developing the newly acquired hatchery site near Valdosta, Ga., was begun in the summer of 1928 and continued throughout the year. About 200 acres of this site can be converted into fish ponds. The property has been fenced, a foreman's cottage, garage, and workshop constructed, and two boats built. One natural pond, over 40 acres in area, was drained with about 250 yards of large-diameter tile, and a holding platform, pools, and water-supply line were installed. Underbrush and trees have been cleared from the timbered section between and around the margins of the two natural ponds. One well was driven and a second is being constructed to serve as outlets for the larger natural pond.

EDENTON (N. C.) STATION

[W. S. VINCENT, Superintendent]

During the year an effort was made to increase the production of pondfish by fertilizing the ponds and introducing fish food. A driveway of the tarvia and rock type was constructed from the station grounds to the new State highway. A garage and storehouse were constructed, and minor improvements and repairs were made to other buildings. The dilapidated boathouses were torn down and the lumber stored for future use. The former submarine telephone line was abandoned, and connection was made with the line following the new highway. The production of sunfish was very satisfactory, an output of over 40,000 closely approximating previous records at this station. In spite of a large brood stock of crappie, the production of this species was practically negligible. Following a limited distribution of bass fingerlings in the fall there was every prospect of a first-class hatch during the spring months. Bad weather developed, however, making it impossible to collect the schools, and the fry distribution was limited. It is expected, however, that the large number of fingerlings remaining in the pond will insure a comparatively large distribution during the fall months. Considerable distribution was carried on by truck and it was found that this method of handling fish results in a material saving.

LOUISVILLE (KY.) STATION

[CHARLES W. BURNHAM, Superintendent]

Only the more necessary construction, painting, and repair work was given attention, and all of it, with the exception of installing new rain gutters on the fish-culturist's house and repainting the water tank and tower, was performed by the station employees. The ceilings and walls of the living room, kitchen, and bathroom in the superintendent's residence were repainted. The floors in the living room, dining room, halls, and stairs of this building were revarnished. New tar-paper roofing was put on the stable. Six wire-screen covers for fish troughs were made and painted. The stable and storehouse were each given two coats of paint, and all fish-cultural equipment was repaired and repainted as usual. This year the city of Louisville built a new concrete road, 20 feet wide, on the Western Parkway between the State fair grounds and the station reservation.

Operations connected with the propagation and distribution of smallmouth black-bass fry and fingerlings constituted the principal fish-cultural work of the year. The output of this species amounted to 531,000 fry and 11,060 fingerlings, slightly exceeding the station's record for any preceding year. The successful production of more than 500,000 smallmouth-bass fry annually over a period of years indicates that climatic and other conditions at Louisville station are favorable for such work. The loss of eggs or fry because of unfavorable weather is a rare occurrence, and the station is not subject to the floods that have caused such serious losses of eggs and fry elsewhere. The station also handled small numbers of largemouth black bass, rock bass, and bream fingerlings. As the station is not equipped with rearing ponds, the production of fingerling fish is confined to such as may be taken from the breeding ponds. Owing to the dense growth of aquatic vegetation, it was necessary to remove large quantities from every pond.

MAMMOTH SPRING (ARK.) STATION

[DELL BROWN, Superintendent]

The usual work of keeping the station grounds in good condition was performed by the station force. The old warehouse was moved to a new site, placed on a concrete foundation, and fitted up as a warehouse, workshop, and garage. The old barn was rebuilt on a concrete foundation. The completion of this work places all buildings on the station reservation in excellent repair. Though a large stock of smallmouth black bass breeders was available for spring spawning nesting was greatly interfered with by unfavorable weather. There were only 56 nests of eggs, but of these 43 were productive, and the season's output of this species amounted to 116,000 fingerlings. The schools of young bass from the nesting of the largemouth species were unusually large, and 144,800 fingerlings were produced. There was also a satisfactory output of rock bass and sunfish. For the greater part of the year the superintendent was engaged in cooperative fish-cultural work and in supervising the construction of the new State hatchery at Lonoke, Ark. Six thousand No. 5 largemouth bass were shipped from the Mountain Home (Ark.) cooperative pond, and the output from the Lonoke cooperative station amounted to 411,000 of the same species. It is expected to have a much larger pond area available for the work at Lonoke in advance of next season's work.

Orangeburg (S. C.) Station

[G. W. N. Brown and S. A. Scott, Superintendent]

A drainage canal approximately one-fourth mile long, 4 to 10 feet wide, and about 8 feet deep, was excavated on the south side of the two reservoirs to take care of excess surface water collecting above the station grounds. At the lower end of this canal two retaining walls, 8 inches thick, 8 feet high, and 200 feet long, were constructed to prevent the current from undermining the reservoir banks and to form a division between reservoir No. 2 and the canal. Approximately 400 feet of drain pipe from five ponds had to be dug up and replaced for the most part with new pipe, the old line being broken apart or clogged with sand, making it almost impossible to draw down the ponds. The interior of the first story of the superintendent's residence was painted, the floors milled and varnished, and new electric-light fixtures installed. The heating system was repaired and placed in working condition. New lawn fence was placed between the station grounds and the superintendent's residence. Two large gate posts were built at the vehicular entrance to the station property. On September 18 and 19 a severe wind and rain storm damaged the station considerably, uprooting 130 trees, some of which fell across the buildings. More than 7 inches of rain fell within 48 hours, flooding practically all the ponds and washing out the roads.

As a whole, the fish-cultural work was successful. The collection of large-mouth black bass was one of the largest in the history of the station, the output amounting to 376,780, of which number 129,300 were advanced fry and the remainder fingerlings. Other species handled were bluegill bream, crappie, spotted catfish, and warmouth bass. Crappie and catfish are only a partial success at this station. For the first time at this station the distribution of fish by truck was undertaken on a large scale and proved a very economical and successful method for distributions within a radius of 150 miles. A new 1½-ton truck was equipped to carry 42 cans as a maximum load. The spring distribution by truck cost approximately 2 cents per mile, as against 6 cents per mile where distributed by train. The station trucks traveled over 3,000 miles in connection with the spring distribution.

San Marcos (Tex.) Station and Substations

[O. N. Baldwin, Superintendent]

Work at this station included the painting of three dwellings. Additions were built on the workshop and the garage, and an abandoned pumphouse was dismantled. The station property was wired for electric lighting, and seven large street lights were erected in the grounds. The work of pond improvements was continued by the excavation of pond No. 6 and the erection of 225 feet of concrete wall to prevent seepage. Several other ponds were given attention in the way of deepening and expanding their area. A rack was constructed across the slough in the San Marcos River, cutting off an area of approximately 5 acres for use in the propagation of bass. Considerable effort was necessary to remove an enormous growth of aquatic vegetation, logs, stumps, and other débris. The ponds were stocked with 100 brood bass, but the flood near the close of the fiscal year washed out part of the rack, and all of the adult and young fish retained therein were lost. The appearance of the station grounds was improved materially by the removal of old fencing, grading of grounds, etc. The brood stock of bass was increased by a number of fish secured from a private club lake. There was every indication that the output of fry and fingerlings would have been equal to or greater than that of the previous year if the above-mentioned flood had not mixed the fish and halted the distribution, causing considerable loss. However, 153 applications were filled, utilizing approximately 150,000 fish. The much larger number of fingerlings now being distributed from this station has the effect of reducing the numerical output though it increases the stocking value. Bream were also propagated, and the usual plan of propagating crappie by stocking private ponds on neighboring ranches was followed. Fish obtained from this source were sufficient in number to supply approximately 150 applicants. A few rock bass, warmouth bass, green sunfish, and Rio Grande perch also were propagated.

Fort Worth (Tex.) substation.—While this substation was not entirely completed, the installation of temporary standpipes in the ponds permitted the introduction of a brood stock, and a reasonable output of fish is expected during the coming year. The work accomplished to date consists in the construction of five ponds with main-pipe connections and the erection of a dwelling.

New Braunfels (Tex.) substation.—This substation was operated with average success, furnishing approximately 15,000 bass and a considerable number of bream, which were transferred to the San Marcos station.

Medina Lake (Tex.) substation.—The ponds at this point produced approximately 25,000 bass and a few bream. Twenty thousand rainbow trout were received from the Neosho (Mo.) station for rearing and planting in near-by waters.

Tupelo (Miss.) Station

[Charles R. Wiant, Superintendent]

Very satisfactory work in fish culture was accomplished at this station. As regards numbers, the production of black bass was not as large as in 1928, but the fish distributed were of greater value than last year, as approximately 38.37 per cent were large fingerlings that had been held and fed throughout the summer and early fall. During the past two years the proportion of fingerling bass produced was not greater than 22 per cent of the entire output. Of the 43,055 fingerling bass collected when the ponds were drained, 7,530 were taken from one 3-acre pond that had been stocked with 23,000 fry during the preceding May. Most of the bream distributed were also sent out in the late fall and consisted mainly of large fingerlings. After completing all shipments in the Tupelo field a surplus load of bass and bream was taken on board by fisheries car No. 8 to be supplied to applicants in Indiana and Illinois. The total output of these species exceeded 721,000. The distributions also included 1,875 catfish.

One of the more important improvements during the year was the erection, near the new pumping plant, of a 10,000-gallon steel tank on a 25-foot steel tower and the laying of new piping to connect it with all buildings on the reservation. A 1½-story building, 18 by 30 feet in dimensions, was constructed on the site of the old workshop for general utility use. This structure has been fitted up to house a carpenter shop, meat room, coal room, and tool room, with storage space overhead. A double garage to accommodate the two station trucks was built from lumber salvaged from the old workshop.

Aliceville (Ala.) substation.—This plant consists of four ponds having a combined area of 6.53 acres, two of which were used for the rearing of bass and two for the production of bream. Only fingerlings were distributed, and the output of the two species for the year amounted to approximately 33,500. Practically all of these were called for at the station, and delivery was made at the expense of the applicants. To augment the water supply, which is from two flowing wells, a well was excavated and a pump and engine installed. At the site of one of these wells a shipping shed, sheltering three large holding tanks, was erected. A garage was also constructed.

Lakeland (Md.) Ponds

[E. K. Burnham, acting in charge]

Distribution of fish from these leased ponds, located just outside of the city of Washington, is carried on in the fall. The output for the season was disappointing, comprising approximately 40,000 sunfish, 8,400 crappie, and 13,500 bass. Apparently the hatch of the preceding spring was below normal in spite of favorable weather. The ponds were wintered dry and stocked with the requisite number of brood fish during the spring of 1929. The ensuing hatch of bass was excellent, over 100,000 fry being accounted for by transfer among the various rearing ponds. A normal hatch of sunfish and crappie was observed, and at the close of the year there was no indication of any marked decline in fingerlings. A brood stock of bass is now being reared at these ponds, which will obviate the necessity of making replacements with wild fish. One of the chief problems confronting the fish-culturist at this location is the difficulty of preventing the entrance of coarse fish into the ponds through the water-supply intake and the admixture of the different species in the various ponds.

FAIRPORT (IOWA) STATION

[THOMAS K. CHAMBERLAIN, Director]

Practically all of the ponds at this station are being utilized for experimental work in pondfish culture, with special reference to the propagation and rearing of largemouth black bass. The primary object of these experiments, which are under the immediate supervision of Dr. A. H. Wiebe, is to work out the most practicable methods of rearing bass to fingerling size with a minimum amount of labor. It has been found that by stocking the ponds with forage fish and adding small amounts of fertilizer at frequent intervals during the spring and early summer as many as 10,000 3-inch fingerlings per acre can be produced at comparatively low cost. It has also been found that it is entirely feasible to rear brood bass in hatchery ponds, and additions to brood stock are now confined to fish that have been reared in the station ponds.

UPPER MISSISSIPPI WILD LIFE AND FISH REFUGE

In the spring of 1928 a study of conditions in the sloughs and ponds, which are characteristic of the bottom lands in the refuge, was undertaken by Eugene W. Surber. His investigations showed that a certain class of slough appears to offer favorable conditions for the propagation of bass and other pondfish. Several sloughs in the vicinity of Trempealeau, Wis., were selected for experimental work to determine the practicability of utilizing such ponds for fish-cultural purposes. With this object in view, the dense growth of willows and other vegetation along the margins of the sloughs was cleared away. The larger aquatic plants also were removed so as to permit the use of a seine to capture predacious fish, which would prey on the more desirable game fishes. Owing to the impossibility of obtaining brood fish, these ponds could not be used for the propagation of bass during the present season. Efforts are being made, however, to obtain a stock of brood fish for next year, which will be wintered in spring-fed ponds at Trempealeau.

Mr. Surber's investigations have shown that the sloughs are rich in food and are apparently capable of supporting a large fish population. One of the greatest problems is the control of the aquatic vegetation, which grows so rapidly in the shallow ponds as to offer a serious obstacle to fish-cultural work. Fortunately, preliminary experiments in treating the ponds with sodium arsenite indicate that it will probably be possible by this means to prevent excessive growth of aquatic plants without detrimental effect on the fish or their food.

Part 2.—DISTRIBUTION OF FISH AND FISH EGGS

[E. C. FEARNOW, Superintendent of Fish Distribution]

The output of fish and fish eggs by the bureau's stations—7,060,369,500—exceeded that of last year by nearly a quarter of a million. Greater outputs were had of shad, cisco, landlocked salmon, black-spotted trout, striped bass, haddock, pollock, and other species. That the output of fingerlings was not as large as it was in 1928 was due to the high stage of the water along the Mississippi River, which prevented rescue operations on a large scale during the summer and fall months. In 1928 the rescue fields yielded 158,154,200 fingerling fish, while in 1929 only 5,202,250 fish were obtained from this source. A large proportion of the fry and fingerlings was planted in waters in the vicinity of the hatcheries or released from the rearing stations nto streams without resorting to shipment by railroad. This is especially true of the commercial and rescued species.

Shipments of fish eggs were made to Canada, Cuba, Japan, Peru, and Switzerland, and a consignment of 250 fingerling smallmouth black bass was forwarded to Sweden. Ninety-five per cent of the year's output consisted of eggs and fry of the commercial species. Virtually all of these, with the exception of a comparatively few furnished the State fish commissions, were planted in the waters from which the eggs were obtained. Included in this classification are the buffalo fish, shad, glut herring, whitefish, cisco, salmon, lake trout, mackerel, pike perch, yellow perch, striped bass, cod, haddock, pollock, and winter flounder.

The species distributed to interior waters are the brook trout, rainbow trout, black-spotted trout, Loch Leven trout, golden trout, smallmouth black bass, largemouth black bass, crappie, rock bass, bream, and catfish. While the number of these species represents but a small per cent of the entire output, at the time of shipment such fish were quite large and their distribution was a difficult problem. Fry of the commercial species are carried 50,000 to 100,000 to the pail, while not more than one hundred 4-inch fish can be carried in one of the regulation containers.

The trout distribution was quite heavy, due to the greater number of cooperative stations and the tendency to rear trout at the bureau's stations (where facilities are available) until they are 3 or 4 inches in length. In addition to the general distribution of trout to applicants during the spring and early summer, approximately 20 carloads of trout were delivered to cooperative projects in Pennsylvania, West Virginia, Virginia, New York, Minnesota, Wisconsin, and New Hampshire.

The following table summarizes the distribution of fish and fish eggs during the fiscal year to applicants in the United States and its Territories. It also shows the plants of fish made by the bureau in public waters of the country in connection with the propagation of commercial fishes and the salvage of fish from temporarily flooded lands.

Summary, by species, of the distribution of fish, fiscal year 1929

State and species	Number
Alabama:	
Catfish	1,300
Largemouth black bass	299,275
Sunfish	61,215
Alaska: Sockeye salmon	46,084,715
Arizona:	
Catfish	300
Rainbow trout	6,000
Brook trout	10,000
Largemouth black bass	4,502
Rock bass	600
Sunfish	225
Arkansas:	
Rainbow trout	68,455
Crappie	875
Largemouth black bass	192,443
Smallmouth black bass	117,000
Rock bass	15,250
Sunfish	26,525
California: Chinook salmon	4,546,800
Colorado:	
Catfish	2,400
Rainbow trout	460,000
Black-spotted trout	146,125
Loch Leven trout	172,970
Brook trout	2,831,300
Crappie	720
Largemouth black bass	12,917
Rock bass	40
Sunfish	1,500
Yellow perch	1,000
Connecticut:	
Catfish	70
Rainbow trout	200
Brook trout	1,500
Crappie	100
Largemouth black bass	200
Smallmouth black bass	28,200
Yellow perch	300

Summary, by species, of the distribution of fish, fiscal year 1929—Continued

State and species	Number
Delaware:	
Rainbow trout	1,000
Largemouth black bass	975
Sunfish	600
District of Columbia:	
Rainbow trout	20
Brook trout	19
Crappie	260
Smallmouth black bass	560
Sunfish	260
Florida:	
Rainbow trout	430
Largemouth black bass	4,000
Smallmouth black bass	400
Sunfish	600
Georgia:	
Catfish	4,675
Rainbow trout	37,400
Brook trout	100,800
Largemouth black bass	277,425
Rock bass	600
Sunfish	62,600
Idaho:	
Chinook salmon	6,477,500
Rainbow trout	877,900
Illinois:	
Catfish	51,625
Buffalo fish	5,450
Carp	7,350
Crappie	12,018
Largemouth black bass	10,679
Sunfish	10,147
Yellow perch	498
Indiana:	
Catfish	400
Rainbow	33,800
Brook trout	24,600
Crappie	225
Largemouth black bass	16,000
Smallmouth black bass	139,200
Rock bass	700
Sunfish	17,085
Iowa:	
Catfish	365,092
Buffalo fish	29,255
Carp	22,895
Rainbow trout	17,120
Brook trout	21,900
Pike and pickerel	22,301
Crappie	957,453
Largemouth black bass	21,293
Smallmouth black bass	1,050
Sunfish	244,608
Pike perch	373
Yellow perch	2,410
White bass	302
Kansas:	
Catfish	450
Crappie	1,300
Largemouth black bass	5,145
Rock bass	5,000
Sunfish	2,575
Yellow perch	4,500
Kentucky:	
Largemouth black bass	2,700
Smallmouth black bass	457,400
Rock bass	1,425
Sunfish	2,325
Louisiana:	
Largemouth black bass	18,650
Rock bass	1,800
Sunfish	2,225
Maine:	
Landlocked salmon	516,850
Atlantic salmon	725,350
Brook trout	1,793,350
Smallmouth black bass	9,358
Winter flounder	2,011,009,000
Maryland:	
Shad	30,681,000
Cisco	1,000,000
Chinook salmon	4,000
Maryland—Continued.	
Rainbow trout	21,300
Loch Leven trout	7,200
Brook trout	16,800
Crappie	650
Largemouth black bass	2,605
Smallmouth black bass	29
Rock bass	600
Sunfish	7,000
Massachusetts:	
Catfish	8,998
Rainbow trout	2,420
Loch Leven trout	900
Brook trout	160,155
Mackerel	2,778,000
Crappie	100
Largemouth black bass	310
Smallmouth black bass	5,500
Sunfish	2,524
White perch	340
Cod	274,853,000
Pollock	358,442,000
Winter flounder	783,327,000
Michigan:	
Whitefish	25,408,800
Steelhead salmon	29,800
Rainbow trout	201,975
Lake trout	34,621,000
Brook trout	537,000
Smallmouth black bass	70,000
Pike perch	2,015,000
Minnesota:	
Catfish	174,450
Carp	1,010
Whitefish	300,000
Cisco	400,000
Rainbow trout	79,790
Loch Leven trout	97,420
Lake trout	472,500
Brook trout	217,100
Pike and Pickerel	12,500
Crappie	845,100
Largemouth black bass	3,479
Sunfish	1,362,680
Pike perch	4,000,000
Yellow perch	107,740
White bass	30
Fresh-water drum	2,850
Miscellaneous fishes	660,000
Mississippi:	
Catfish	750
Largemouth black bass	471,255
Sunfish	85,760
Missouri:	
Rainbow trout	133,245
Crappie	6,880
Largemouth black bass	57,062
Smallmouth black bass	525
Rock bass	3,000
Sunfish	13,250
Yellow perch	1,000
Montana:	
Rainbow trout	1,089,580
Golden trout	9,000
Black-spotted trout	882,375
Loch Leven trout	379,000
Brook trout	219,255
Grayling	1,750,000
Crappie	678
Largemouth black bass	942
Sunfish	612
Nebraska:	
Catfish	4,050
Rainbow trout	34,900
Loch Leven trout	17,000
Brook trout	21,300
Largemouth black bass	14,650
Sunfish	4,025
Nevada:	
Rainbow trout	110,000
Brook trout	12,000

Summary, by species, of the distribution of fish, fiscal year 1929—Continued

State and species	Number
New Hampshire:	
Catfish	420
Landlocked salmon	9,600
Rainbow trout	12,197
Brook trout	287,498
Smallmouth black bass	5,500
Pike perch	200,000
New Jersey:	
Catfish	1,825
Rainbow trout	4,150
Loch Leven trout	1,350
Brook trout	10,600
Largemouth black bass	6,245
Smallmouth black bass	3,450
Sunfish	240
New Mexico:	
Catfish	5,300
Carp	250
Rainbow trout	39,000
Black-spotted trout	4,000
Brook trout	219,000
Largemouth black bass	9,100
Sunfish	5,000
Yellow perch	440
New York:	
Catfish	279
Whitefish	22,705,000
Cisco	116,000,000
Rainbow trout	169,375
Loch Leven trout	12,700
Lake trout	2,365,490
Brook trout	762,323
Largemouth black bass	3,000
Smallmouth black bass	375
Sunfish	5,000
Pike perch	2,100,000
North Carolina:	
Catfish	109
Shad	6,500,000
Glut herring	11,500,000
Rainbow trout	90,810
Loch Leven trout	118,450
Brook trout	176,700
Crappie	1,370
Largemouth black bass	70,100
Rock bass	8,575
Warmouth bass	75
Sunfish	46,645
Yellow perch	1,200,575
Striped bass	9,661,000
Ohio:	
Carp	2,500,000
Whitefish	45,981,000
Rainbow trout	4,000
Loch Leven trout	2,700
Brook trout	23,000
Crappie	2,500
Largemouth black bass	8,070
Sunfish	125
Pike perch	23,000,000
Yellow perch	18,000,000
Oklahoma:	
Catfish	6,370
Rainbow trout	6,440
Crappie	2,270
Largemouth black bass	29,800
Rock bass	1,560
Sunfish	15,385
Yellow perch	1,410
Oregon:	
Chinook salmon	7,374,600
Sockeye salmon	68,000
Silver salmon	778,400
Chum salmon	777,000
Steelhead salmon	125,000
Rainbow trout	192,400
Black-spotted trout	20,000
Brook trout	165,400
Pennsylvania:	
Catfish	5,740
Rainbow trout	367,375
Loch Leven trout	153,050
Brook trout	1,178,880
Pennsylvania—Continued.	
Crappie	8,464
Largemouth black bass	29,677
Smallmouth black bass	1,250
Rock bass	150
Sunfish	16,430
Yellow perch	54
Rhode Island:	
Catfish	52
Rainbow trout	50
Brook trout	50
South Carolina:	
Rainbow trout	20,700
Brook trout	43,200
Crappie	600
Largemouth black bass	303,775
Rock bass	1,500
Warmouth bass	5,790
Sunfish	16,760
South Dakota:	
Catfish	1,330
Rainbow trout	149,750
Loch Leven trout	117,800
Brook trout	329,710
Largemouth black bass	125
Sunfish	300
Tennessee:	
Rainbow trout	93,200
Loch Leven trout	20,800
Brook trout	82,800
Largemouth black bass	71,560
Smallmouth black bass	2,000
Rock bass	2,920
Sunfish	7,960
Texas:	
Rainbow trout	18,000
Crappie	11,620
Largemouth black bass	186,429
Rock bass	2,170
Warmouth bass	15
Sunfish	42,080
Utah:	
Rainbow trout	1,382,400
Brook trout	472,000
Vermont:	
Steelhead salmon	1,029
Landlocked salmon	19,214
Rainbow trout	40,037
Loch Leven trout	954
Brook trout	463,665
Smallmouth black bass	500
Pike perch	13,400,000
Yellow perch	7,700,000
Virginia:	
Catfish	409
Shad	34,170,000
Rainbow trout	298,600
Loch Leven trout	5,400
Brook trout	232,275
Crappie	6,685
Largemouth black bass	41,795
Smallmouth black bass	19,000
Rock bass	20,825
Sunfish	18,990
Yellow perch	166,023,000
Washington:	
Chinook salmon	19,810,300
Chum salmon	19,202,000
Silver salmon	7,207,635
Sockeye salmon	3,264,200
Steelhead salmon	2,973,000
Rainbow trout	24,200
Black-spotted trout	15,500
Brook trout	93,000
West Virginia:	
Rainbow trout	923,939
Loch Leven trout	172,065
Brook trout	864,874
Crappie	12,250
Largemouth black bass	6,250
Rock bass	2,054
Sunfish	12,250

Summary, by species, of the distribution of fish, fiscal year 1929—Continued

State and species	Number	State and species	Number
Wisconsin:		Wyoming:	
Catfish	1,500	Catfish	150
Whitefish	200,000	Rainbow trout	538,990
Cisco	5,600,000	Black-spotted trout	5,874,415
Rainbow trout	382,490	Loch Leven trout	214,570
Loch Leven trout	68,180	Brook trout	943,380
Lake trout	12,000	Crappie	160
Brook trout	899,170	Largemouth black bass	4,655
Crappie	14,900	Sunfish	500
Largemouth black bass	2,485	Yellow perch	1,250
Smallmouth black bass	8,372		
Sunfish	11,605		
Pike perch	1,200,000		
Yellow perch	1,725		

METHOD OF DISTRIBUTION

In making the distribution of fish to from 12,000 to 15,000 applicants annually the bureau aims so to apportion the output of its hatcheries as to obtain the best results, giving special consideration to waters in which the fish will have an opportunity to mature and reproduce. In pursuance of this plan many difficulties are encountered, the chief of which is the insistence of applicants to obtain some favorite species regardless of whether or not the waters are suitable therefor.

It is the policy to supply first the waters from which the eggs are collected, after which shipments are made to suitable public and private waters on application submitted previously. Blanks on which formal applications may be made are furnished to applicants on request. Such blanks call for a complete description of the waters to be stocked, and from the information supplied the bureau assigns the species that are suitable.

Applicants are notified immediately as to the species that will be sent them and the approximate date of delivery, and they are given instructions for receiving and caring for the fish. Before shipment is made a second notice is given, usually by telegram, stating the exact time of arrival of the fish at the railroad station. The fish are delivered to the applicant's railroad station free of charge, and in the event that the shipment is delayed the applicant is notified accordingly.

Fish usually are shipped in carload lots to central points, and messengers leave the cars at various points to make deliveries to applicants whose railroad stations are located on branch lines. These messengers travel in the baggage cars of passenger trains, and deliveries must necessarily be made when the train makes its customary stops. A messenger often has a dozen or more deliveries to make before rejoining his car and must return his full quota of pails immediately in order that further shipments may be made in accordance with the prearranged schedule. As the pails are a part of the car's equipment, it is obvious that if they were lent to applicants it would necessitate a suspension of the bureau's work until they were returned. Applicants are expected to provide suitable receptacles for carrying fish, such receptacles to be in readiness at the railroad station specified in the advance notice of delivery. The vessels should be uncovered and empty.

In making allotments of fish on applications the following items are taken into consideration: Area of water to be stocked, as stated in the application; size and number of fish available for distribution; and the distance the fish must be transported. The bureau distributes fish as fingerlings or yearlings. At some stations, however, it is necessary to distribute a portion of the output as fry in order to prevent overcrowding.

The basses, sunfishes, and other pondfishes are distributed from three weeks to several months after they are hatched. The basses usually range from 2 to 6 inches in length, and the sunfishes from 2 to 4 inches in length. Commercial fishes, such as whitefish, yellow perch, etc., are produced in large numbers and are necessarily planted as fry. As a general rule the bureau delivers fish in the order in which the applications are received, and applications remain on file until delivery of the desired fish can be made.

Shipments of trout from the bureau's eastern stations are usually made during May and June, and applications received after April 1 will be carried on file for attention during the following year. The distribution of trout from stations in the Rocky Mountain region is made from May to October, and applications from that section should be submitted prior to May 1 in order to assure early delivery. Requests for bass, sunfish, and crappie should be on file with the bureau prior to May 1, as deliveries of such species are made between May and December.

During the year the bureau's cars traveled 79,646 miles, of which 1,828 were free. Detached messengers traveled 286,040 paid and 80,239 free miles, a total of 346,279 miles.

ORNAMENTAL FISHES, TOP MINNOWS, ETC.

The bureau receives frequent applications for goldfish and other ornamental fishes, also numerous inquiries pertaining to the construction of pools for goldfish and water lilies. As the bureau's fish-cultural activities are addressed to the propagation of the food fishes, its appropriation being specifically designated as for that purpose, it can not undertake to furnish applicants with the ornamental species.

Within recent years the demand on the bureau for information on ornamental fishes has increased to the point where it has been necessary to provide publications in order to handle such inquiries expeditiously and economically. Document No. 980, which deals with the care of goldfish in small aquaria and ponds, was published some years ago and may be purchased for 5 cents from the Superintendent of Documents, Government Printing Office, Washington, D. C. Just recently Economic Circular No. 68, dealing with the goldfish industry, was released and is now procurable from the Superintendent of Documents for 5 cents. This circular contains such information as was obtainable from the goldfish producers in regard to the types of goldfish cultivated, their value, distribution, etc. It also contains a list of goldfish breeders and jobbers. The bureau has no complete treatise on ornamental fishes, but excellent advice on the subject may be obtained from standard publications, which may be consulted in public libraries. Furthermore, books on ornamental fishes, containing information on the care of goldfish and tropical fishes, are now sold at bookstores. Practically all standard books on goldfish give information on the construction of pools for goldfish and water lilies.

The bureau does not propagate the top minnow (*Gambusia patruelis*), a fish that is in great demand for holding mosquitoes in check, being particularly fond of the larvæ or "wigglers." Persons interested in stocking stagnant pools with top minnows will, upon inquiry of the bureau, be furnished a list of dealers in this species.

The top minnow is a semitropical fish, being found in stagnant ponds in the Southern States as far north as southern Maryland. Persons living within the range of these minnows should be able to obtain their supplies from local waters.

The top minnow will not survive a northern winter in open waters, so where the winter is severe it is advisable to introduce fishes of the smaller varieties, as any top-feeding fish will feed on mosquito larvæ. The bureau's Document No. 923, Use of Fishes for Control of Mosquitoes in Northern Fresh Waters of the United States, is available only from the Superintendent of Documents, Government Printing Office, Washington, D. C., for 10 cents.

While it is recognized that in fish culture, especially in bass culture, it is necessary to provide an ample supply of living food, the bureau is not in position to furnish a brood stock of minnows for forage purposes. Practically all minnows are very prolific, and a few golden shiners introduced into a pond will multiply quite rapidly. A stock of a suitable variety of fish for forage purposes often can be collected from local waters. The common sunfish, or a pumpkin seed, and uncolored goldfish are frequently used for forage purposes.

NEW STEEL CAR

The 1928 appropriation carried an item of $60,000 for the construction and equipment of a steel railway car to take the place of car No. 4, which was condemned during the year and turned over to the District of Columbia for use at one of its institutions. In December, 1928, the bureau advertised for bids, and early in February the contract was awarded to the lowest bidder, the Bethlehem Steel Corporation, Harlan Plant, Wilmington, Del., the contract price being $59,000.

The new car will be approximately 70 feet over end sheets, with 4-foot platforms at each end, similar to those used on observation cars. The length, from buffer to buffer, will be approximately 81 feet. It will be designated "Bureau of Fisheries Car No. 10" and will probably be completed and in commission by December, 1929. This car will be strictly modern in every respect, affording the best possible accommodations for the crew, and will have insulated compartments of sufficient capacity to hold 325 of the bureau's standard fish containers. Its capacity load will range from 35,000 3-inch fish to 500,000 1-inch fish. An axle generator will charge the batteries, which have a capacity of 750 ampere-hours of 32 volts, sufficient power to light the car and operate the electric aerating plant.

FISH TRANSPORTATION

The transportation of the bureau's output of fish was accomplished with practically no loss. While a few fish succumb during transportation, due to injuries received in the collection or in transferring to the containers, the bureau has not had a large loss of fish for a number of years.

The distribution cars are fitted with steam and electric air compressors for forcing air into the water in which the fish are carried. However, messengers on detached shipments have to resort to other methods for aeration, usually dipping or agitating the water.

Within recent years it has been demonstrated that temperature is the most important factor in the successful handling of living fish and that excessive dipping often does more harm than good by exciting the fish, thereby causing them to use more oxygen than the water will hold in solution. The practice of constantly dipping and stirring up sediment has been reduced gradually to a minimum, and more attention is now paid to maintaining an even water temperature. In fact, the distribution cars often turn off the air pressure in the containers when the train is in motion, depending upon the agitation of the water caused by the motion of the train and the spontaneous absorption of oxygen by the water.

Some years ago three attempts were made to send a messenger shipment of trout from Virginia to Maine. The first two efforts met with complete failure. At that time aeration by dipping was practiced to the limit and little attention was paid to water temperature. The attendants stood by the fish constantly, dipping out water and pouring it back. Last June messenger shipments of brook trout (10 and 12 inch fish) were sent from Maine to Virginia, being en route 48 hours. Each messenger carried 35 pails of fish, an average of 6 fishes per pail, and not a single fish was lost while in transit. These messengers watched the water temperature closely, and on each trip the fish were aerated but once, which was during a lay-over in Philadelphia. With a minimum of disturbance the fish rested comfortably on the bottom of the containers, requiring very little oxygen.

Excessive agitation of the water by dipping or other means will cause the fish to exercise themselves to the point of exhaustion. For this reason the cans should be well covered and not disturbed except when absolutely necessary. Ordinarily, a 5-gallon pail of water at 60° will, if sufficient water surface is exposed to the air, absorb from the air enough oxygen to maintain 75 3-inch bass in a quiet state for three or four hours. The bureau's messengers have practically discarded the dipper, and at railroad junctions place the fish on express trucks and move the truck occasionally to aerate the water.

The liberation of too much compressed air in the water has a disastrous effect on small fish, the little ones being unable to withstand the boiling motion of the water. In the new distribution car special attention has been paid to providing means for controlling the water temperature.

RESCUE OPERATIONS

For years the bureau has depended on fish salvaged from the landlocked ponds and pools along the Mississippi River for pondfishes for filling applications in the upper Mississippi Valley. Last year was an off season, the Mississippi River remaining high during the summer and fall, so that no fish could be collected for shipment from sources that in the previous year yielded approximately 150,000,000 fish.

Regardless of the failure to obtain fish at the rescue stations, the distribution cars were kept in active service until late in the fall. The Langdon (Kans.) station, after completing its distribution, had a surplus of two carloads of bass, crappie, etc., which was shipped to Ohio and Indiana. The Fairport (Iowa) station provided two carloads of bass for waters ordinarily supplied from the rescue stations, and the output of the Lakeland (Md.) ponds was widely distributed in waters of Virginia, Maryland, West Virginia, New Jersey, and Delaware. The project at Miles City, Mont., yielded a fair output for the first year of its operation, and with a greater number of brood fish much better results are expected in the fall of 1929.

GOLDEN TROUT

For the first time the bureau's records show a distribution of the golden trout of Mount Whitney, the most beautiful of all our western trouts. It is an inhabitant of small mountain streams on the western slope of Mount Whitney, a tributary of Kern River, and is abundant in Volcano Creek and the South Fork of Kern River. The golden trout, while small, is remarkable for its gameness and unsurpassed beauty.

This species is listed in Jordan and Everman's American Food and Game Fishes, under the scientific name *Salmo agua-bonita*. In 1906 this beautiful trout was brought to the attention of Theodore Roosevelt, then President, who immediately got in touch with the bureau with the view of propagating the species. One of the distribution cars was ordered to Nevada, and arrangements were made with employees of the Baird (Calif.) station to make a collection of adult fish. Considerable trouble was experienced in transporting the fish from Volcano Creek to the railroad station at Mina, Nev., as the only means of transportation was by pack horses. Finally, a carload of golden trout, which recent writers designate *Salmo roosevelti*, was assembled and sent to Leadville, Colo., and Bozeman, Mont. The fish were propagated to some extent, but the fry inadvertently became mixed with the fry of the rainbow trout, and for various reasons the matter of propagating this species was neglected until within recent years. The shipment of 9,000 golden trout, 1½-inch fish, was delivered to the United States Forest Service and planted in high-altitude waters.

COOPERATION WITH THE UNITED STATES FOREST SERVICE

When we think of forests to-day we not only visualize trees and land mammals but fish as well. The great recreation grounds of the present and future furnish an environment congenial equally to game and fish. The trees, which provide a cover for game, hide many waters rich in natural food, where fish may propagate and the young develop and eventually drop down the streams to where they may be caught by the angler. Forests are the prime requisities for clear, cool streams with an even flow of water and suitable for the most desirable game fishes.

In line with the general demand for good fishing and the recognized importance of forests in relation to fish life, the Forest Service is actively cooperating with the United States Bureau of Fisheries and the fisheries authorities of the States in order to secure better plantings. The following table gives the species and number of fish planted by forest officers of the Rocky Mountain district in 1928:

State and forest	Black-spotted trout	Brook trout	Rain-bow trout	Loch Leven trout	Rock bass	Silver salmon	Perch	Blue-gill	Small-mouth black bass	Total
Colorado:										
Arapaho	19,575		7,200							26,775
Cochetopa	44,000	65,600								109,600
Colorado	18,750	248,000	54,000							320,750
Gunnison	430,500	228,000	117,500			20,000				796,000
Holy Cross	67,000	462,000								529,000
Leadville	73,000	10,450								83,450
Montezuma	4,000	184,000	170,000							358,000
Pike		82,600								82,600
Rio Grande	401,500	247,000	430,500	8,000						1,087,000
Routt	45,000		2,500							47,500
San Isabel	55,000		97,000							152,000
Uncompahgre	5,000	33,000								38,000
Michigan: Huron		342,000	50,000				9,500	3,000	3,000	407,500
Oklahoma: Wichita					8,000					8,000
South Dakota:										
Black Hill		46,000								46,000
Harney		50,000								50,000
Wyoming:										
Bighorn	190,000									190,000
Hayden	49,600	97,000								146,600
Medicine Bow	446,400	242,000		20,000						708,400
Shoshone	90,000	453,500								543,500
Washakie		1,700	1,700							3,400

The total number of fish planted by the forest officers is 5,735,075. In addition to the above, 4,490,500 were planted by other agencies. The totals do not include plants made in the forest by cooperative agencies, clubs, associations, and private parties.

Excellent relations exist between the Forest Service and the Bureau of Fisheries as well as with the various States. While forest rangers frequently are difficult to reach, due to the nature of their work, which calls them to points far away from civilization, there are not many instances of failures to meet fish, as it is generally understood that notice of deliveries must be sent far in advance of shipments.

The forest rangers meet the fish-distribution cars at designated railroad stations and transport the fish to the streams and lakes, sometimes far into the mountains, and often requiring the use of pack horses, the roads being inaccessible for other methods of conveyance. The following comments, taken from the report of District Forester Allen A. Peck, will give an idea of what is being done in the Rocky Mountain forests to maintain good fishing:

Supervisor Leighou, of the Arapaho National Forest, reports that fry are held in nursery ponds and systematically fed until they reach a sufficient size to care for themselves in open waters.

Supervisor Mack, of the Cochetopa National Forest, states that trout fishing in the Arkansas in and adjacent to Salida is reported by the oldtimers to have been better in the past season than for many years. He attributes this to a retaining pond in the forest 3 miles above Salida, where fry are kept until large enough to withstand the swift water of the streams and to cope with the large fish.

Ranger Ware, of the Colorado Forest, makes mention of a new $75,000 State reservoir that has been stocked with rainbow trout for the purpose of providing spawn. He further states that dwellings and 60 rearing troughs were built in 1928, and that it is thought that as many as 20,000,000 eggs will be taken from this lake annually.

In writing of Grand Mesa Forest, Supervisor Peck states that the new fish hatchery at Alexander Lakes has been built and will be ready to receive eggs in the fall of 1929. He reports that 3,000,000 eggs of the rainbow, yellow-fin, and black-spotted trout were taken at the Grand Mesa Lakes last spring and over 1,000,000 eggs of the eastern brook trout in the fall.

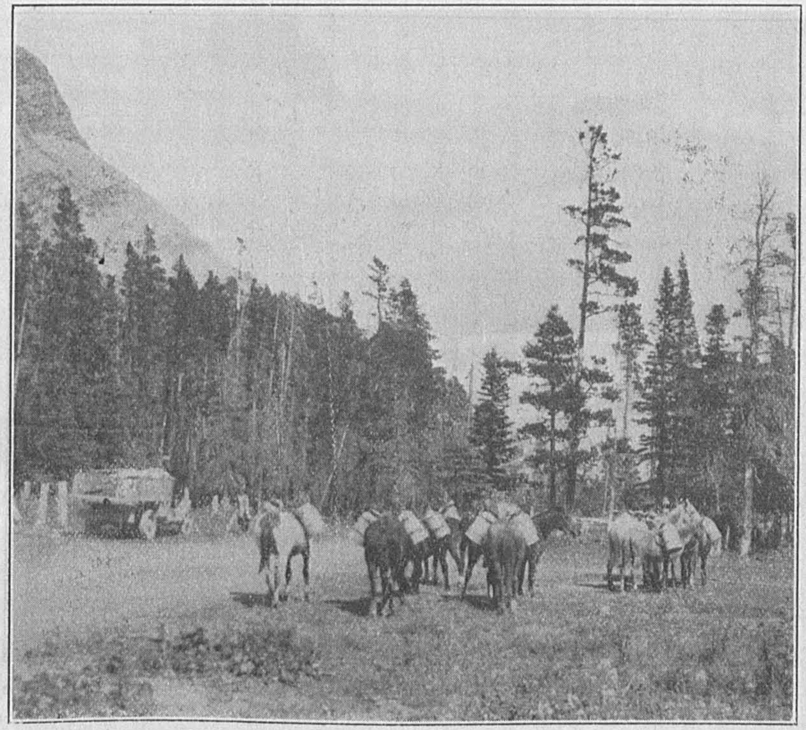


FIGURE 1.—The fish are hauled from the railroad station to where the mountain trails begin and are loaded on pack horses

Supervisor Krueger, of the Gunnison Forest, advises that the salmon trout introduced into Mirror Lake in 1925 made exceptional growth and in 1927 averaged 10 inches in length, but the slow growth of these fish since 1927 indicates that the supply of food is inadequate.

Junior Range Examiner Stell, Montezuma National Forest, reports large plants of fish but no efforts to screen the head gates of irrigation ditches; consequently, many fish find their way into these ditches and perish when the water is turned off. He also reports many retaining ponds under construction by sportsmen's clubs.

Supervisor Hutton, of San Juan, reports a spawn-taking station established in 1928 by the State of Colorado and the creation of a lake of approximately 100 acres, which has been stocked and is to be used exclusively as a rainbow-trout egg-collecting station.

The activities of the Izaak Walton League and other sportsmen's associations are manifested to a considerable degree in fish planting in the Black Hills. Nursery ponds were constructed in the Harney Forest, the fry doing very well under the care of the local members of the Izaak Walton League.

The bureau maintains a hatchery in Yellowstone National Park, which is concerned with the propagation of species indigenous to the waters of the park, and close cooperation exists between the bureau's representative and the park authorities. Similar relations also exist with the authorities of the Glacier National Park, where large plants of trout are made each year.

FIGURE 2.—Fishing in one of the isolated mountain lakes. Small trout are abundant in the log drift

The chain of national forests extending from Maine and New Hampshire on the north, Florida on the south, and Arkansas on the west contains thousands of miles of good fishing water. The bureau, in cooperation with the United States Forest Service, is making a consistent effort to increase the fish life in these streams in order that they may contribute to the recreation and enjoyment of fisherman throughout the region. To accomplish this objective requires the annual planting of fish in those waters in which the natural increases are not sufficient to maintain good fishing.

The Forest Service cooperates closely with the bureau, from which the planting stock is procured, and with the various State fish and game commissions, in the fish-cultural work, which is of a highly specialized nature. The actual planting work is accomplished by the helpful cooperation of the local fish and game associations, and through the services of the local forest officers. The beneficial results of this form of cooperation, which has been carried on for a number of years, now are clearly evident.

During the past year the bureau has furnished the Forest Service, for planting in the streams in the national forests of the East, a total of 413,700 brook trout, 218,500 rainbow trout, and 47,700 black bass.

It is now a well-recognized fact that successful fish plantings can not be made in all cases by the use of fry. Indeed, each stream must be studied in order to determine both the species and size of fish necessary to secure economic results. In view of this, an ever increasing number of fingerlings is now being used. In some cases rearing pools have been constructed, and the fish, before being planted, are fed until they are 4 to 5 inches long.

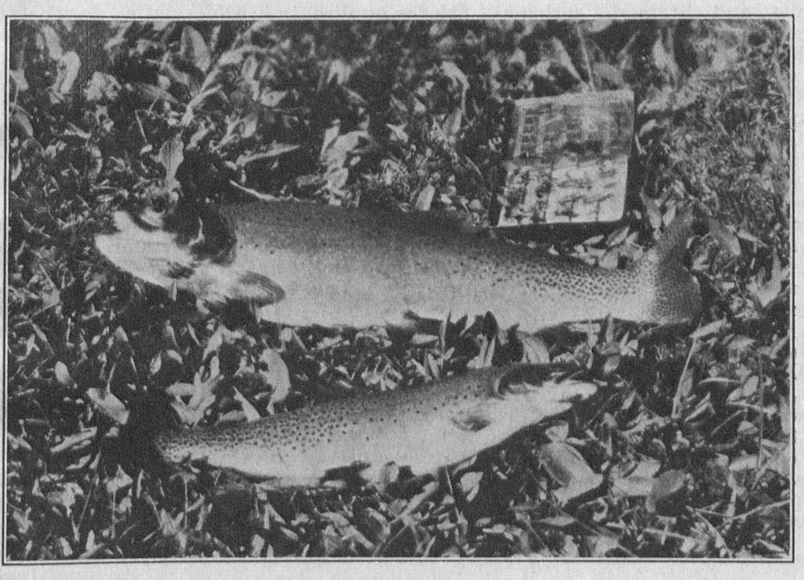


FIGURE 3.—Black-spotted trout are abundant in the Rocky Mountains and are commonly known in that region as cut-throat trout

The streams of the eastern national forests contain many miles of fishing waters, which are open to the public under the laws of the States in which they are located. To date, however, the work of stocking can only be considered as a start in the right direction. While some of the difficulties of successful fish-planting work have been solved, new problems are continually coming to light.

The bureau, with its experience and continuous research work, is consulted and its advice sought. It is believed more progress will result in the future, especially if the bureau is able to increase the capacity of its hatcheries to take care of the ever increasing demand for fish-planting stock.

From the foregoing it will be seen that the matter of fish propagation and fish planting is regarded by the Forest Service as one of its most important game problems.

DISTRIBUTION CARS

CAR NO. 3

[T. H. COPELAND, Acting Captain]

At the beginning of the fiscal year car No. 3 was completing the cooperative distribution from the La Crosse (Wis.) station and assisting with the distribution from the Manchester (Iowa) station. From July 2 to 12 messengers from the car moved 43,000 brook trout from the La Crosse hatchery to cooperative nurseries at Eau Claire, Boscobel, Merrill, Stanley, Osseo, Arcadie, and Tunnel City, Wis., which completed the trout distribution from La Crosse for the year. On July 17 the car loaded at the Manchester (Iowa) station and delivered the fish to applicants in northern Wisconsin, returning to La Crosse, where the crew was engaged in overhauling the equipment of car.

On September 29 the car left La Crosse for the Fairport station and at that point took up the distribution of bass and bream, moving three carloads of these species to waters in Iowa, Minnesota, Wisconsin, Ohio, and Pennsylvania, and returning to La Crosse on October 17. On November 1 the car left for Langdon, Kans., and obtained a carload of fish for applicants in Ohio and adjacent states. The car left Columbus, Ohio, on November 8 and arrived at La Crosse on November 9, where the crew, with the exception of the captain, was detailed to hatcheries to assist in the propagation of fish.

On January 2 the car was moved from La Crosse to the Milwaukee shops for general repairs.

On March 13 the car moved 194,716 trout from the La Crosse station to the Lynxville (Wis.) substation to be reared to fingerling size, the car returning to La Crosse on March 14. On May 6 the distribution of trout was begun at the La Crosse and Lynxville stations and completed on June 13. During this period six trips were made from La Crosse and Lynxville to points as follows: Tomahawk, Eau Claire, Stevens Point, and Neshkora, Wis., and Winona and St. Charles, Minn., delivering 218,300 fingerling brook trout, 149,500 fingerling rainbow trout, and 114,900 fingerling Loch Leven trout to cooperative nursery ponds. Messengers made detached trips from the car and delivered from the La Crosse and Lynxville stations 117,000 fingerling brook trout, 30,000 fingerling rainbow trout, and 16,000 Loch Leven trout to cooperate nursery ponds.

On June 17 the car left La Crosse for the Manchester (Iowa) station to take up the distribution from that point, moving two carloads of fish to points in Iowa, Wisconsin, and Minnesota and returning to Manchester before the close of the fiscal year.

The car traveled 11,239 miles over 8 railroad lines and delivered fish in 12 States during the fiscal year 1929. Detached messengers made 70 trips, traveling approximately 25,000 miles, and delivering fish in 16 States. The following tabulation will show the number, size, and species of fish delivered.

Species	Fingerlings No. 1	Fingerlings No. 2	Fingerlings No. 3	Fingerlings No. 4	Adults and yearlings
Catfish			2,250		
Rainbow trout		271,000			6
Loch Leven trout		130,900			6
Brook trout	104,140	476,500			6
Crappie		1,780	8,790		
Largemouth black bass	552		23,760	8,830	247
Smallmouth black bass		3,675			
Sunfish		2,615			500
Total	104,692	886,470	34,800	8,830	765

CAR NO. 7

[E. R. WIDMYER, Captain]

At the beginning of the fiscal year car No. 7 took up the distribution of rainbow and brook trout from the Manchester (Iowa) station, making three trips to points in Wisconsin and delivering 184,200 2-inch brook trout and 41,900 1½-inch rainbow trout. After completing the three car trips, two messenger shipments were made from the Manchester station to Neshkora, Wis., to deliver 27,450 fingerling rainbow trout.

On August 28 the car left Dubuque with 3,789 warm-water fishes for applicants in New Hampshire, Massachusetts, and Connecticut. After delivery the car proceeded to Bucksport, Me., to take up the distribution of trout and salmon from the East Orland (Me.) station. From September 6 to 20 the car made four trips from Bucksport, distributing 49,000 fingerling Atlantic salmon, 82,500 fingerling brook trout, and 19,700 fingerling landlocked salmon.

The car was ordered from East Orland to Watertown, N. Y., arriving there September 20. From September 21 to October 18 two car trips and 35 messenger shipments were made from Watertown, delivering 258,600 fingerling brook trout and 83,650 fingerling rainbow trout to applicants in New York State.

On completion of the Watertown work the car left for Langdon, Kans., where a carload of the warm-water species was obtained and taken to Indianapolis. After delivering 31,315 warm-water fishes to applicants the car returned to Dubuque arriving there on October 27.

During the winter months two car trips and one messenger shipment were made from Lynxville, Wis., to Miles City, Mont., delivering 2,147 adult pondfishes to the Miles City cooperative station. After completing the two car trips the car returned to Dubuque, where it was held on the Illinois Central Railroad Co.'s tracks during the remaining winter months. While the car was at Dubuque the crew went over the pails and aerating equipment, placing them in readiness for further distribution work.

The spring distribution work was begun from Manchester on April 27, when a messenger left with 100 yearling rainbow trout for the Northville (Mich.) station. The car left Manchester on May 1 with 123,600 1½-inch brook trout, 8,500 1½-inch rainbow trout, and 3,325 3-inch smallmouth black bass. After delivering these fish to Wisconsin applicants the car returned to La Crosse, where it obtained 29,700 fingerling Loch Leven trout, 38,500 fingerling rainbow trout, and 24,000 fingerling brook trout, which were delivered to applicants in Minnesota, Wisconsin, and Michigan.

On completion of the trip from La Crosse the car proceeded to Duluth, Minn., to take up the distribution of lake trout, pike perch, and brook trout from that station. Seven car trips, five boat trips, and a large number of messenger shipments were made from Duluth, delivering 12,526,000 lake-trout fry, 636,500 fingerling lake trout, 8,210,000 pike-perch fry, 149,000 1-inch brook trout, and 5,050 2-inch rainbow trout.

Immediately on completion of the distribution at Duluth the car was ordered to La Crosse with instructions to obtain applications from car No. 3 and proceed with the distribution. One car trip was made from Manchester to Wisconsin applicants, and three messenger shipments were made to Wisconsin and Minnesota cooperative stations, delivering 88,900 fingerling brook trout and 70,500 fingerling rainbow trout. A new set of Exide storage batteries was installed on the car in June.

During the fiscal year 1929 car No. 7 made 24 trips, traveled 18,376 miles, and delivered 22,697,995 fish. Messengers made 112 side trips and traveled 29,874 miles. The following table shows the number and species of fish delivered:

Species	Fry	Fingerlings	Yearlings	Adults
Catfish		1,520		75
Atlantic salmon		49,000		
Landlocked salmon		19,700		
Rainbow trout		275,550	100	
Loch Leven trout		29,700		
Lake trout	12,526,000	636,500		
Brook trout		910,850		
Crappie		950		678
Largemouth black bass		12,740	241	645
Smallmouth black bass		3,325		
Rock bass		700		
Sunfish		18,725	24	612
Pike perch	8,210,000			
Yellow perch		360		
Total	20,736,000	1,959,620	365	2,010

CAR NO. 8

[K. P. IRWIN, Acting Captain]

The car left Portland, Me., early in July and arrived at Bozeman, Mont., on July 15 to handle the output of trout from the hatchery at that place. The next day the car left with a special consignment of rainbow, black-spotted, and brook trouts assigned to the various waters in Glacier National Park. Another such trip was made to Glacier Park, and one was made to Yellowstone National Park later in the season. Trips for the purpose of supplying regular and Forest Service applications were made to Noxon, Missoula, and Lewistown, Mont., and Casper, Lander, and Newcastle, Wyo.

In making the distribution from the Bozeman (Mont.) station the car handled rainbow, black-spotted, Loch Leven, and brook trouts. It left Bozeman and arrived at Dubuque, Iowa, on August 30. Orders were received to proceed to Marquette, Iowa, to assist in the distribution of the warm-water fishes collected at the rescue station at that point. Several detached messenger trips were made from the Marquette station to points in Minnesota, Iowa, and Wisconsin. The species carried were catfish, crappie, largemouth black bass, sunfish, and yellow perch.

On September 20 the car left Marquette for La Crosse, Wis., where repairs were made to the running gear. The car left La Crosse on October 3 and arrived at Fairport, Iowa, on October 5, where a load of warm-water fishes was procured, and the car proceeded to St. Louis, Mo., to make delivery of these fish to points in Illinois and Missouri. On completion of this work the car left St. Louis and arrived in Tupelo, Miss., on October 9 to take up the distribution of fish from the hatchery at that point. Trips were made to Jackson and Union, Miss., and Mobile, Ala., by the car, and messengers made nine detached trips from Tupelo. The species handled in this distribution were strawberry bass, catfish, crappie, largemouth black bass, and sunfish. The car left Tupelo on November 3 with a carload of fish for Chicago, arriving there on November 4.

Orders were received to proceed to La Crosse and Lynxville, Wis., to pick up a load of specimens and brood fish for Central Station, Washington, D. C. The car left Chicago on November 16 and arrived in La Crosse on November 17; specimens were obtained on November 25, and the car left the same day for Lynxville to obtain the remainder of the shipment. It left Lynxville the next day and arrived in Washington on November 28, completing the distribution for the calendar year.

Extensive repairs to the car were made at the Baltimore & Ohio shops during February, and the car was returned to Washington early in March.

The car left Washington on March 24 and arrived at Erwin, Tenn., on March 25 to distribute the output of trout from the hatchery at that point. Trips were made to Gainesville and Cornelia, Ga., Lake Toxaway, N. C., and Knoxville, Tenn. The species handled in this distribution were rainbow, Loch Leven, and brook trouts and rock bass. This distribution was completed on April 18, and the car proceeded to White Sulphur Springs, W. Va., to assist in distributing the output of trout of that station. Car trips were made to Wildell and Cass, W. Va., and Harrisburg, Scranton, and Philadelphia, Pa. On completion of the Philadelphia trip the car proceeded to Nashua, N. H., where a load of brook trout was obtained and taken to Portland, Me., and distributed to points near by. The car left Portland on May 24 and proceeded to Bucksport, Me., to take up the distribution from the hatchery at Craig Brook.

Carload plants of Atlantic salmon were made at Dover-Foxcroft, Dennysville, and Grindstone, Me. Trips with brook trout and landlocked salmon were made to Presque Isle, Calais, Kineo, Vanceboro, and Portland, Me. The Maine distribution was completed on June 22, and the car left Portland for Nashua, N. H., arriving on June 23, where it picked up a solid carload of brook trout, which were taken to Harrisburg, Pa., and distributed to points near by. The car left Harrisburg on June 28 and arrived at Omaha, Nebr., on June 30.

During the year the car made 38 trips, traveled 22,946 miles, and supplied 1,980 applicants. It handled 4,752,016 fish. Detached messengers made 98 trips and traveled 27,000 miles. The number and species of fish distributed by the car during the year are shown in the following table:

Species	Fingerlings No. 1	Fingerlings No. 2	Fingerlings No. 3	Fingerlings No. 4	Fingerlings No. 5	Adults
Catfish				1,875		
Atlantic salmon	513,150					
Landlocked salmon	173,700					420
Rainbow trout	275,600	566,700	90,240			
Black-spotted trout		784,000	5,000			31
Loch Leven trout	50,400	187,575				
Brook trout	1,142,400	584,500	193,450	5,400		1,800
Grayling						15
Crappie		26,300				290
Largemouth black bass		8,700	15,640	11,995	6,000	150
Rock bass		5,775				
Smallmouth black bass		525				
Strawberry bass		3,250	4,750	4,650		170
Sunfish		46,875	35,635	3,480	210	198
Yellow perch			1,040			54
Miscellaneous fishes						73
Total	2,155,250	2,214,200	345,755	27,400	6,210	3,201

CAR NO. 9

[F. W. A. Englehardt, Captain]

This car completed the distribution from White Sulphur Springs, W. Va., in July and then proceeded to Colorado and took up the distribution of trout from the Leadville (Colo.) station. The Leadville distribution was completed on August 18, and the car proceeded to Neosho, Mo., where three carloads of fish were distributed prior to starting the distribution from the Langdon (Kans.) substation. Late in October the car departed from Langdon with a load of pondfishes for distribution in eastern Pennsylvania and Washington, D. C., arriving in Washington on November 1. After making several messenger shipments from Central Station and the Lakeland (Md.) ponds, the crew was detailed to work at fish-cultural stations during the winter months.

In February the car was taken to the shops of the Baltimore & Ohio Railroad at Baltimore for annual repairs and was returned to Washington on March 15, where the crew and equipment were assembled for the spring distribution of trout from the White Sulphur Springs station. The car left White Sulphur on June 13 for Bozeman, Mont., from where it made a shipment of trout to the Glacier National Park.

During the fiscal year the car and its messengers made distribution from White Sulphur Springs, W. Va., Leadville, Colo., Neosho, Mo., Langdon, Kans., Rifle, Colo., Washington, D. C., Orangeburg, S. C., Manchester, Iowa, and Bozeman, Mont.

The distribution included the following States: West Virginia, North and South Carolina, New Jersey, New York, Pennsylvania, Ohio, Virginia, Maryland, Nebraska, South Dakota, Iowa, Kansas, Oklahoma, New Mexico, Arizona, Missouri, Texas, Colorado, Arkansas, Wyoming, Montana, Illinois, Indiana, and Georgia.

The car made 35 trips during the year and traveled 27,085 miles, of which 680 were free. Messengers made 127 trips from the car and stations, supplying 2,028 applications. The number and size of the fish delivered by the car and its crew during the past fiscal year are shown in the following table:

Species	Fingerlings No. 1	Fingerlings No. 2	Fingerlings No. 3	Fingerlings No. 4	Fingerlings No. 5	Yearlings and adults
Catfish		23,470			300	
Rainbow trout	297,000	208,450	69,500	33,150	24,780	132
Black-spotted trout	164,000		38,500			
Loch Leven trout	154,600	45,400				
Brook trout	2,483,000	375,410	127,250	36,350		18
Grayling						53
Crappie		2,040	2,230			
Largemouth black bass		38,860	42,470	6,240	3,264	
Smallmouth black bass						50
Rock bass	1,400	600	200			
Sunfish	6,600	23,675	4,300	3,695		200
Yellow perch			4,350		150	
Total	3,106,600	717,905	288,800	79,435	28,494	543