U. S. COMMISSION OF FISH AND FISHERIES,

JOHN J. BRICE, Commissioner.

PART XXII.

U. S. Bureau of Commercial Fisheries.

REPORT

OF

THE COMMISSIONER

FOR

THE YEAR ENDING JUNE 30, 1896.

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National Oceanic and Atmospheric Administration

Report of the United States Commissioner of Fisheries

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REPORT

OF THE

UNITED STATES COMMISSIONER OF FISH AND FISHERIES

FOR THE

FISCAL YEAR ENDING JUNE 30, 1896.

I have the honor to submit an outline of the operations of the United States Commission of Fish and Fisheries during the year ending June 30, 1896, together with the detailed reports of the work of its different divisions, and appendices embracing the reports of the exhibit at the Atlanta Exposition and of special investigations. After the death of the late Commissioner, Marshall McDonald, which occurred September 1, 1896, the affairs of the Commission were directed by the chief clerk, Herbert A. Gill, as acting Commissioner, until March 30, 1896, when John J. Brice was appointed to fill the vacancy.

When the present Commissioner assumed charge special attention was at once directed to increasing the supply of the commercial fishes of the ocean and inland waters, and the propagation and rearing of certain coarser species was discontinued in order to increase the output of the more important ones. The principal fish-cultural work in hand was the propagation of shad, and the available force was concentrated at the shad-hatching stations at Bryan Point on the Potomac River and Battery Island on the Susquehanna. Work on the New England coast followed, and besides the usual provisions at Woods Hole and Gloucester, Mass., for collecting lobster eggs the force was increased by the detail of men from other stations. In addition to the lobster work the propagation of tautog was undertaken at Woods Hole. The steamer *Fish Hawk* was also engaged in shad hatching on the Delaware, and afterwards in collecting lobster and mackerel eggs on the Maine coast, where she was assisted by the schooner *Grampus*. The results, as compared with the previous year, were very satisfactory, 148,000,000 shad, 105,000,000 lobster, and 31,000,000 tautog eggs being secured. The number of fry successfully hatched from these eggs and planted is shown hereafter.

The scarcity of mackerel made it desirable that the Government should endeavor to increase the supply of this valuable fish, and steps were taken early in April to engage in the propagation of the species at various points on the New England coast. The work was in a manner experimental, and the experience gained warrants the expectation of good results for the future. About 24,000,000 eggs were obtained.

Plans were considered to materially increase the output of shad and salmon by the establishment of auxiliary stations at favorable places on the Atlantic and Pacific coasts, respectively. The fisheries for these important species, representing more than one-tenth of the yield of the fishing industry of the coastal States, are known to depend largely on artificial propagation, and their yearly increase in extent, resulting in a corresponding diminution in natural reproduction, makes it advisable that active artificial measures be taken for their preservation. Comparatively small sums expended in maintaining fish life in important streams before they become depleted will accomplish more than years of expensive effort after the supply is limited or exhausted. With this in view, the Commissioner went to the west coast to personally examine the field, select suitable sites for salmon hatcheries, and make arrangements for the collection of eggs when the season should open.

Details of the fish-cultural work of the year and distributions of fish and eggs are shown in the reports of the various hatcheries and stations which are given hereafter.

While the collections of eggs have been satisfactory, the number of fry hatched and reared has at some stations been less than should be expected, because of an inadequate or impure water supply or of water not of a proper temperature. Steps have been taken to rectify this, and it is expected that a better output will result in the future.

The following stations were operated during the year:

Craig Brook, Me.	Battery Island, Md.	Alpena, Mich.
Green Lake, Me.	Bryan Point, Md.	Duluth, Minn.
St. Johnsbury, Vt.	Central Station, Washington, D. C.	Quincy, Ill.
Gloucester, Mass.	Fish Ponds, Washington, D. C.	Neosho, Mo.
Woods Hole, Mass.	Wytheville, Va.	Leadville, Colo.
Cape Vincent, N. Y.	Put-in Bay, Ohio.	Baird, Cal.
Delaware River (steamer *Fish Hawk*).	Northville, Mich.	Fort Gaston, Cal.
		Clackamas, Oreg.

There have been distributed in suitable public and private waters, by means of the cars and messengers of the Commission, 498,488,268 eggs, fry, yearlings, and adults of various fishes. The output of some of the more important species, which is markedly in excess of the previous year, is as follows:

Shad	93,481,500
Salmon	10,845,852
Lake trout	8,996,618
Whitefish	189,740,000
Cod	66,212,000
Flatfish	8,472,000
Lobster	97,079,000

Plants were made in all the States and Territories, and eggs of various species were sent to representatives of foreign governments and fish-cultural societies in return for similar courtesies received from them, as follows:

Quinnat salmon	95,000
Steelhead trout	75,000
Rainbow trout	125,000
Lake trout	50,000
Whitefish	50,000
Total	395,000

Another attempt was made to acclimatize quinnat salmon in east-coast waters by the transfer of 10,000 eggs to Craig Brook, Maine, where they were hatched and retained for distribution in the fall. Large consignments of steelheads were also brought east to be introduced into the coastal waters of New England, and besides the usual plants of salmon fry in the Columbia and Sacramento rivers, over 750,000 fingerling salmon were liberated in the Clackamas and McCloud rivers, which should produce valuable results.

Further experiments have been made in using artificial nests for spawning black bass at Wytheville, the fish ponds at Washington, and at Put-in Bay. From the results secured at the former station, it is believed that artificial nests may be successfully used and the problem of raising this species simplified. Efforts were again made to artificially fertilize the eggs of black bass; and though in one or two instances the eggs were fertilized, as yet the experiments have not disclosed a method of conducting the work on a large scale; first, because of the difficulty of securing ripe fish, and second, of expressing the milt and eggs.

In accordance with previous custom, the use of the laboratory at Woods Hole was granted to the representatives of various colleges for biological study, in order that the Commission might be benefited by the results of their researches. This station, equipped as it is with extensive buildings and costly appliances, and situated on a bay which is a natural spawning-ground for the more important marine fishes, is a valuable property to the Government, and it is designed to so extend the work of the station that it shall be a hatchery and biological station second to none.

The canvass of the fishing industries of the interior waters of the United States, begun in the winter of 1895, was resumed and actively pushed during the entire year, and is now complete. The inquiry did not cover the Great Lakes, which were canvassed the previous year, but included all those interior States in which the industry was carried on to any great extent. These fisheries are of considerable economical importance; in 1894 they employed 11,282 persons, represented a total capital invested of $722,328, and yielded to fishermen a product valued at $1,791,145. While many varieties of fresh-water fishes are represented in the catch, the most prominent and those of most pecuniary importance are sheepshead, black bass, crappie, whitefish, sturgeon, sunfish, buffalo-fish, catfish, and yellow perch.

From February to April, 1896, a canvass was made of the contiguous waters of Maine and New Brunswick to obtain certain data regarding the commercial aspects of the herring and sardine industries for the use of the International Fisheries Commission, and at the same time much valuable statistical information was collected regarding the herring fisheries and their related branches, which will be embodied in a report to be issued later. There was also obtained for the International Fisheries Commission desired information relative to the mackerel fisheries of New England.

In May, 1896, a general canvass of the shad, alewife, and salmon fisheries of the Atlantic coast was begun, to determine their present commercial value, the number of persons employed, the value and kind of apparatus used, with other important statistical details. At the same time a similar investigation of the general fishery industries of the Pacific coast was begun, particularly as to the development of the California sardine industries and the condition of the shad and striped-bass fisheries, to determine the advisability of establishing hatcheries for these species. An examination of the results of the former plants of eastern lobsters in California waters was also made to obtain data for further experiments. At the close of the fiscal year these inquiries were satisfactorily progressing.

The inquiries conducted by local agents at Gloucester and Boston, covering a large part of the offshore vessel fishing of New England, serve the purpose of keeping the Commission well informed regarding the condition of the great fishing banks off the coasts of New England, Nova Scotia, and Newfoundland. The statistical tables published hereafter (pages 132–135) show the extent of the fisheries centering at these important fishing centers during the calendar year 1895. At Gloucester there were discharged by American fishing vessels about 76,631,000 pounds of fish and salt fish, valued at $2,205,600; at Boston the quantity of fish landed aggregated 73,808,000 pounds, having a value of $1,346,000. The combined receipts were thus 150,439,000 pounds, valued at $3,551,600. As compared with the previous year there was a net decrease in the quantity of fish landed at Gloucester amounting to about 3,000,000 pounds, the falling off being principally in mackerel, halibut, cusk, and hake, while the receipts of cod exceeded those of 1894 by 5,430,000 pounds, and of 1893 by 8,781,000 pounds. The fish brought into Boston in 1895 weighed 13,657,000 pounds less than in the previous year, nearly all of the important species showing a decrease.

In the spring of 1896 the investigations of the salmon streams of the Pacific coast were planned, with a view to select suitable sites for hatcheries, as well as to continue the natural-history studies carried on in former years. Examinations of Lakes Washington, Pend d'Oreille, Cœur d'Alene, Crater, and Klamath were also to be made by the same field parties, chiefly with a view to determine the outcome of plants of whitefish made in them in previous years and the advisability of introducing other new species. At the close of the fiscal year this work had been begun and was being actively carried on.

In addition to the regular annual investigation of the fur-seal rookeries required of the Fish Commission by act of Congress, arrangements were made for special studies during the summer of 1895 of the natural history of the herds on the Pribilof and Commander islands, for purposes of comparison with their condition in former years, and with reference to the means necessary for their protection, as well as a comparison of conditions on the Asiatic and American coasts. The investigations on the Commander Islands were made possible through the courtesy of the Russian Government and were conducted by Mr. Leonhard Stejneger, while the work on the Pribilofs was carried on by Mr. F. W. True; both of these gentlemen, who are connected with the National Museum, were temporarily employed by the Fish Commission for this purpose. Other agents of the Commission conducted the usual investigations on the islands, besides which observations were made on board a vessel of the sealing fleet and with the Fish Commission steamer *Albatross* at sea. These inquiries confirm the conclusions reached in former years, that the fur-seal herds are steadily diminishing and that their depletion is caused by pelagic sealing. The investigations are described in detail in the exhaustive report of Mr. Stejneger, published in the Bulletin of this Commission for 1896, and in Senate Document 137, Fifty-fourth Congress, first session.

The fur-seal investigations for 1896 were planned in accordance with a joint resolution of Congress, approved June 8, which provided for a scientific investigation into the present condition of the fur-seal herds on the Pribilof, Commander, and Kuril islands, to be conducted under the direction of the Secretary of the Treasury by persons employed for the purpose or detailed from the Government service. Dr. David S. Jordan, of Leland Stanford Junior University, was selected to take charge of the party, assisted by Mr. Leonhard Stejneger and Mr. F. A. Lucas, of the United States National Museum; Lieut. Commander Jeff. F. Moser, U. S. N., commander of the steamer *Albatross*, and Mr. C. H. Townsend, naturalist; Col. Joseph Murray, special agent of the Treasury Department, and Mr. G. A. Clark, secretary. The *Albatross* was detailed by the President to convey the party to Bering Sea, and sailed from Seattle June 24 with the investigators on board. A similar commission was appointed by the British Government, and though there was no provision for the coöperation of the two parties, transportation was afforded to Prof. D'Arcy W. Thompson, of University College, Dundee, Scotland; Mr. James M. Macoun, of the geological survey of Canada, and Mr. A. Marett, photographer, representing Great Britain.

During the season of 1895 the *Albatross* was not attached to the patrol fleet in Bering Sea, as in previous years, though she was authorized to board and inspect sealing vessels. Having landed on the Seal Islands the naturalists detailed to study seal life during the season, the vessel remained at the Pribilofs during the remainder of July assisting in the work at those islands, and during August was engaged at sea in making investigations of the habits and movements of seals while in search of food. Observations of the water temperatures and densities were made, soundings were taken, and much progress was made in collecting information as to seal life. The *Albatross* left Unalaska August 30 for the waters of the Puget Sound region, going via Sitka and the inland passages, and from September 22 to October 16 was engaged in collecting data concerning the salmon industry, when she proceeded to the navy-yard, Mare Island, Cal., to undergo necessary repairs. On January 28, 1896, the steamer sailed for the waters of southern California, where investigations were carried on in the vicinity of San Diego, and of

Cortez and Tanner banks. She returned to San Francisco April 28, and from May 7 to 17 was used by the Navy Department in connection with the speed trials of the *Oregon*. On completing this duty a series of observations and dredgings was carried on in San Francisco Bay, in connection with an investigation of its waters with reference to the cultivation of oysters. Tables showing results of the work of the vessel for the year are published as an appendix to this report.

In the spring of 1896 arrangements were made for a survey of the fishery resources of southeastern Alaska, by the *Albatross*, in addition to the regular sealing work, but the detail of the vessel for the use of fur-seal investigators necessitated the postponement of these plans.

May 19, Lieut. Commander F. J. Drake, U. S. N., was detached from the command of the *Albatross*, and Lieut. Commander Jeff. F. Moser, U. S. N., assumed command, in obedience to orders from the Secretary of the Navy.

The usual studies of the mackerel fisheries were made by agents of the Commission, along the Atlantic coast and on board the schooner *Grampus*, which accompanied the mackerel fishermen during the summer of 1895, particular attention being given to the offshore waters of New England and the conditions in the Gulf of St. Lawrence.

A resolution was adopted by the Senate February 15, 1895, calling for information as to the condition of the oyster fisheries on the coast of Florida, and investigations were begun November 12 in Apalachicola Bay by Lieut. Franklin Swift, U. S. N., with the steamer *Fish Hawk*. The survey covered not only areas where oysters are now found, but an examination of the bottom to determine its suitability for oyster-planting, and necessarily included a hydrographic survey and the taking of densities and temperatures. Valuable information was collected, as shown in the report of Lieutenant Swift, published as an appendix to this report (pp. 187–221).

Various areas of the bay were found favorable for the cultivation of oysters of an excellent quality, and if the protective laws of the State could be enforced oyster-culture could be made an important industry.

In accordance with an item in the sundry civil act approved March 2, 1895, calling on the Commissioner of Fisheries to make a special investigation as to the extermination of migratory fishes in the Indian River, Florida, an investigation, designed to embrace both the natural-history and commercial aspects of the subject, was made in January and February, 1896, under the direction of Messrs. B. W. Evermann and W. A. Wilcox. The fishing industry of this arm of the Atlantic is of recent growth, its commencement dating from 1878, though the business of taking green turtles was engaged in before the civil war. Since the building of railroads, affording easy communication, the industry has grown, and in 1895 represented an investment of $41,512, and yielded products valued at $37,657. The investigation showed that while the fishing resources of this region are great, many valuable species being found in the river, the present tendency to overfishing will result in the ultimate destruction of the business unless proper restrictive laws are enforced. The report upon this investigation was printed as Senate Document 46, Fifty-fourth Congress, second session, and will also be found as an appendix to this volume, pp. 223–262.

The sundry civil act of 1895 appropriated $500 for an investigation and report as to the advisability of establishing a fish-hatchery at some suitable point in the State of New Hampshire, and accordingly arrangements were made for an inspection of the conditions on the Merrimac River for the collection of Atlantic salmon eggs and the operation of a hatchery with a view to restocking the rivers of the State with that important commercial fish. A careful examination was made in July and August, 1895, of the Soucook River, the dams and fishways on the Merrimac at Livermore Falls, Sewall Falls, Gavins Falls, Amoskeag Falls, Lowell, and Lawrence. The results of this examination show that while there may be such a revival in the run of salmon as to insure the successful operation of a salmon hatchery at some point on the Merrimac River or its tributaries, neither the present conditions nor the immediate prospects warrant the expenditure of money and effort in the attempt. Further investigations will be made to decide as to the desirability of establishing a hatchery for the propagation of other species of fish of commercial value.

The exhibit of the Commission, under the direction of Mr. W. deC. Ravenel, at the Cotton States and International Exposition, held in Atlanta from September 18 to December 31, 1895, was considered one of the most attractive and popular features of the exposition, particularly the aquarium. The operations of the Commission were shown by models of hatcheries and apparatus used in the collection, hatching, and transportation of fish and fish eggs, and of vessels and appliances employed in scientific investigations and in the fisheries. There were also exhibited photographs of hatcheries, casts of fishes, specimens of marine life, statistical and other charts, and pictures illustrating fishery methods. Especially interesting to visitors was the practical illustration of fish-culture. Two hatching troughs and a hatching table were fitted up, and in December, when the water became sufficiently cool, lake-trout and quinnat-salmon eggs were hatched, and the fry planted in a pond near Atlanta and a lake in the Exposition grounds.

The aquarium, intended to be a model of its kind both architecturally and in its arrangement of tanks and apparatus, was designed and constructed with great care. It contained seventy-six species, mainly showing the commercial fishes of the South, though other food and ornamental fishes and curious specimens of aquatic life were included.

The exhibit received the award of a grand prize, a diploma of recognition, and two gold medals. At the close of the exposition the aquaria, tanks, pumps, piping, etc., were turned over to the Smithsonian Institution for the use of the National Zoological Park. A detailed account of the exhibit will be found as an appendix to this volume, pp. 147–167.

In addition to the work of repairs and improvements at the various fish-cultural stations, under the direction of the architect and engineer of the Commission, the work of constructing the new stations at San Marcos, Tex., Bozeman, Mont., and Manchester, Iowa, was continued.

The artesian well at San Marcos has been completed, and furnishes an ample supply of water, the volume of flow being about 1,000 gallons per minute. Excavations for ponds were continued and preparations made for erecting the hatchery buildings early in the new fiscal year.

At Bozeman the hatchery buildings and the greater portion of work on the water supply and ponds were finished late in the summer of 1895, when the available funds were exhausted. A further appropriation was granted June 8, 1896, and steps were at once taken to complete the station.

Plans and specifications for the proposed Manchester station were prepared, but actual work was not begun, as the examination of the title to the land had not been completed by July 1, 1896.

The work of repairing the damage caused by the storm of January, 1895, to the breakwater at Woods Hole was continued by the Engineer Corps of the Army until August 21, when the available funds were exhausted, leaving the repairs still incomplete.

The naval engineer has supervised such repairs, alterations, and additions to the machinery at the various stations and upon the steam launches of the Commission as were necessary for their economical and efficient operation, and plans were prepared for such changes in the pumping apparatus at certain of the stations as would provide for an increase in the output of fry.

Passed Assistant Engineer C. W. Dyson, U. S. N., was detailed by the Secretary of the Navy as consulting and mechanical engineer for the Commission October 21, 1895, relieving Passed Assistant Engineer I. S. K. Reeves, U. S. N.

The value of the vessels belonging to the Commission, consisting of two sea-going steamers, the *Albatross* and *Fish Hawk*, and the schooner *Grampus*, besides several smaller steamers, and the amount of the expenditures necessary for their maintenance, made it desirable, in the interest of economy, to organize an office of vessels under a competent and experienced head, who should have general charge of their maintenance, repairs, and equipment. At the request of the Commissioner Lieut. C. M. McCormick, U. S. N., was detailed by the Navy Department for this duty, and was placed in charge of this office June 29.

The Commission has continued the practice of turning over to the National Museum collections made by its agents and vessels. October 19, 1895, there were presented to the United States National Museum ten sets of specimens of fishes, one set being intended for the series of the National Museum, and the others for distribution to the following institutions: Stanford University, Museum of Comparative Zoology, Indiana University, Iowa University, Nebraska University, Arkansas University, Duluth (Minn.) High School, Mankato (Minn.) State Normal School, and Oberlin College.

Much public interest has been shown in the work of the Commission, during the year and valuable assistance has been given its agents. Many railroads have furnished free transportation to the cars and messengers engaged in transporting fish, by which the distributions have been greatly facilitated. A list of these follows:

Summary showing total number of miles of free transportation furnished United States Fish Commission cars and messengers during the fiscal year ending June 30, 1896.

Name of railroad.	Cars.	Messengers.
Ann Harbor R. R	230	
Atchison, Topeka and Santa Fe Rwy	4,707	911
Atlantic and Pacific R. R		292
Burlington and Missouri River R. R. in Nebraska	840	
Burlington, Cedar Rapids and Northern Rwy	1,374	588
Boston and Maine R. R	1,507	1,732
Central Vermont R. R		870
Chesapeake and Ohio Rwy	2,234	
Chicago, Burlington and Quincy R. R	2,550	1,863
Chicago and Northwestern	1,982	
Central of Georgia Rwy	420	
Cincinnati, Portsmouth and Virginia R. R		142
Chicago and West Michigan Rwy	420	
Cleveland, Cincinnati, Chicago and St. Louis Rwy	4,284	
Cooperstown and Charlotte Valley R. R		16
Colorado Midland R. R		142
Delaware and Hudson R. R	402	
Denver, Leadville and Gunnison Rwy		514 604
Denver and Rio Grande R. R	1,662	2,432
Detroit, Lansing and Northern R. R	128	
Detroit and Mackinac Rwy	1,704	
Duluth and Iron Range R. R	228	
Duluth, South Shore and Atlantic Rwy	452	
Fitchburg R. R		114
Florida and East Coast Rwy		326
Florida Central and Peninsula R. R	1,124	
Flint and Pere Marquette R. R	1,359	
Fremont, Elkhorn and Missouri Valley R. R	1,087	
Fort Worth and Denver City Rwy		806
Grand Rapids and Indiana R. R	221	
Great Northern Rwy	659	877
Gulf, Colorado and Santa Fe Rwy	538	
International and Great Northern R. R	142	291
Jacksonville, Tampa and Key West Rwy	500	
Kansas City, Fort Scott and Memphis R. R	432	
Kansas City, Pittsburg and Gulf R. R	326	660
Louisville and Nashville R. R	1,764	
Maine Central R. R	2,730	26
Minneapolis, St. Paul and Sault Ste. Marie Rwy	252	
Michigan Central R. R	4,639	
Montana Union Rwy	44	
New York, New Haven and Hartford R. R	402	
Nashville, Chattanooga and St. Louis Rwy	14	
Northern Pacific R. R	5,425	991
Oregon Railway and Navigation Co	404	
Pennsylvania R. R	450	
Pecos Valley Rwy		178
Philadelphia, Reading and New England R. R		110
Plant System	287	
Rio Grande Western Rwy		196
Sioux City and Northern R. R	97	
Southern Rwy	2,857	
St. Johnsbury and Lake Champlain R. R		23
Texas and Pacific Rwy	1,122	1,089
Union Pacific Rwy	6,330	
Toledo, St. Louis and Kansas City R. R		902
Union Pacific, Denver and Gulf	660	170
Wabash R. R	442	1,989
Western Rwy. of Alabama and Atlanta and West Point R. R	700	
Wisconsin Central Lines	1,334	64
Total	61,654	18,918

The following extracts from the Bulletins and Reports have been issued in pamphlet form during the year, besides the bound Bulletin of the Commission for the year 1895:

Report proper of the Commissioner for the year ending June 30, 1893, Marshall McDonald, Commissioner, pp. 1-138.
The fisheries of the Pacific Coast, by W. A. Wilcox. (Report for 1893, pp. 139-304.)
The American lobster, by Francis H. Herrick. (Bulletin 1895, pp. 1-252.)
Salmon investigations in Idaho in 1894, by B. W. Evermann. (Bulletin 1895, pp. 253-284.)
Investigation of the menhaden fishery in 1894, by Hugh M. Smith. (Bulletin 1895, pp. 285-302.)
Fishes of the Neuse River basin, by B. W. Evermann. (Bulletin 1895, pp. 303-310.)
Notes on fish-culture in Germany. (4 articles.) (Bulletin 1895, pp. 311-324.)
Report of a reconnaissance of the oyster beds of Mobile Bay and Mississippi Sound, Ala., by H. P. Ritter. (Bulletin 1895, pp. 325-339.)

A list of fishes and mollusks collected in Arkansas and Indian Territory in 1894, by S. E. Meek. (Bulletin 1895, pp. 341-349.)

The sources of marine food, by James I. Peck. (Bulletin 1895, pp. 351-368.)

Contributions toward the improvement of the culture of salmonoids and crawfish in small water-courses, by Karl Wozelka-Iglau. (Bulletin 1895, pp. 369-378.)

A review of the history and results of the attempts to acclimatize fish and other water animals in the Pacific States, by Hugh M. Smith. (Bulletin 1895, pp. 379-472.)

Report upon the work of the U. S. Fish Commission steamer *Albatross* for the year ending June 30, 1893, by Z. L. Tanner. (Report 1893, pp. 305-341.)

Report upon ichthyological investigations in western Minnesota and eastern North Dakota, by Albert J. Woolman. (Report 1893, pp. 343-373.)

The food of the oyster, clam, and ribbed mussel, by John P. Lotsy. (Report for 1893, pp. 375-386.)

Establishment of stations for the propagation of salmon on the Pacific Coast, by John J. Brice. (Report for 1893, pp. 387-392.)

The Museum of Comparative Zoology, of Cambridge, Mass., has continued the publication of papers relating to investigations made under the direction of Professor Agassiz during the cruise of the Fish Commission steamer *Albatross*, referred to in the report for 1891, and has issued the following papers since the last report:

Birds from Cocos and Malpelo islands, with notes on Petrels obtained at sea; by C. H. Townsend. Bulletin of the Museum of Comparative Zoology, vol. XXVII, No. 3-XVII.

Die Comatuliden; by C. Hartlaub. Bulletin, vol. XXVII, No. 4-XVIII.

Die Ostracoden; by G. W. Muller. Bulletin, vol. XXVII, No. 5-XIX.

The Foraminifera; by Axel Goës. Bulletin, vol. XXIX, No. 1-XX.

The United States National Museum published the following report, the thirty-fourth in the series of papers relating to the scientific results of the explorations of the *Albatross*:

Report on Mollusca and Brachiopoda dredged in deep water, chiefly near the Hawaiian Islands, with illustrations of hitherto unfigured species from northwest America; by William Healey Dall. Proceedings U. S. National Museum, vol. XVII, pages 675-733, No. XXXIV.

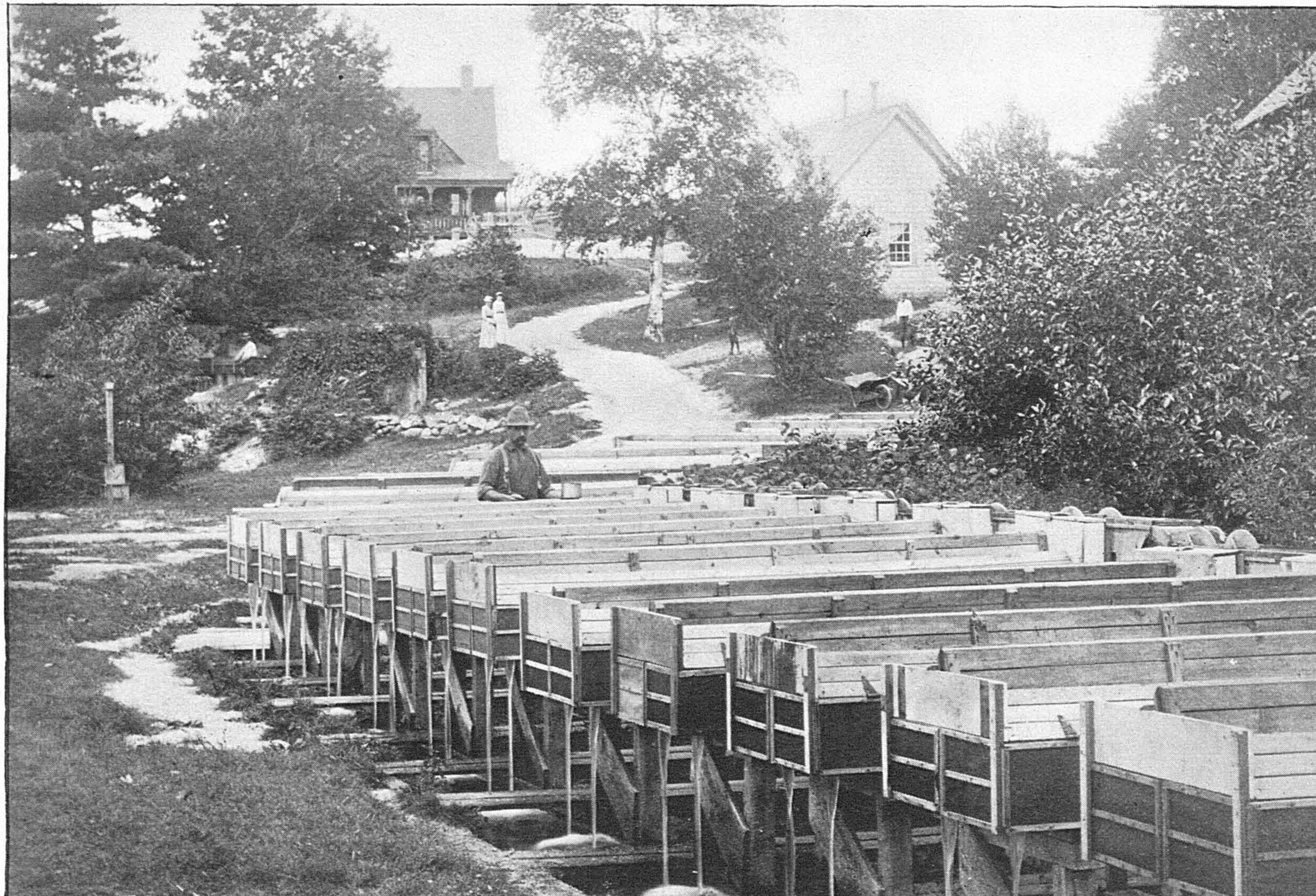
There have been distributed 6,904 pamphlet and 2,958 bound copies of publications, the greater portion to educational institutions, societies, and persons interested in fish-cultural subjects.

During the fiscal year ending June 30, 1896, the appropriations made by Congress for the operations of the Commission were as follows:

Salaries	$180,440
Miscellaneous expenses:	
Administration	9,000
Propagation of food-fishes	105,000
Maintenance of vessels	30,500
Inquiry respecting food-fishes	10,800
Statistical inquiry	5,000
For construction and repairs of fish-cultural stations located at—	
Put-in-Bay, Ohio; Duluth, Minn.; Green Lake, Me.; Craig Brook, Me.; and Neosho, Mo	8,450
Northville, Mich	13,000
For purchase and development of fish-cultural station at Wytheville, Va	10,000
For completion of fish-cultural stations now in course of construction at—	
Cape Vincent, N. Y	2,500
Manchester, Iowa	8,000
Bozeman, Mont	12,000
San Marcos, Tex	18,000
St. Johnsbury, Vt	7,000
For the establishment of a fish-cultural station in South Dakota	10,000

A report showing the details of expenditures from these appropriations was submitted to Congress December 7, 1896.

JOHN J. BRICE, *Commissioner.*



SALMON REARING TROUGHS, WITH RESIDENCE AND BARRACKS IN BACKGROUND, CRAIG BROOK STATION, ME.

REPORT ON THE PROPAGATION AND DISTRIBUTION OF FOOD-FISHES.

By W. DEC. RAVENEL, *Assistant in Charge.*

INTRODUCTION.

The work of the Division of Fish Culture was prosecuted on the same general lines as in past years, and its important features are shown in the following abstracts of the annual reports submitted by the superintendents of the various stations. The propagation and distribution of carp and tench were discontinued, the hatching of pike perch at the stations on Lakes Superior, Erie, and Ontario was suspended, and the collection and distribution of pike, catfish, yellow perch, and other coarse fishes from the overflows of the Mississippi and Illinois rivers were given up.

Recognizing the necessity of maintaining the supply of mackerel and lobsters, two of the most important fisheries of New England, the steamer *Fish Hawk* and the schooner *Grampus* were detailed by the Commissioner during the spring to collect eggs of these species. They were stationed in Casco Bay, Maine, where the eggs collected were hatched and the fry liberated. At Woods Hole and Gloucester stations the lobster work was increased and the propagation of mackerel was undertaken. While the results attained with the mackerel were not as large as anticipated, it is hoped, with the experience gained this year, that important work may be done in the future. At Woods Hole Station the propagation of tautog was also taken up, and the results were encouraging.

On the Pacific Coast a field station was established on the Snake River, near Weiser, Idaho, with the view to increasing the plants of salmon in the Columbia River Basin, and in addition to the usual plants of salmon fry in the Columbia and Sacramento rivers over 500,000 fingerling salmon, measuring from 2½ to 3 inches, were liberated in Clackamas River and 250,000 in the McCloud during May, from which it is believed important results will follow. Large deposits of steelhead fry were again made this year in the tributaries of Lakes Superior, Michigan, Huron, and Ontario, also in the Hudson River under the direction of the New York Fish Commission, and in the tributaries of Penobscot River, Maine.

In addition to his regular work the writer acted as representative of the United States Fish Commission on the Government board of management at the Cotton States and International Exposition, held at Atlanta, Ga., from September 18 to December 31. His presence was required in Atlanta during the month of September to superintend the installation of the exhibit, which embraced a display of the apparatus used in fish-cultural work and scientific investigations and fisheries of America, also a hatchery where practical fish-cultural work was conducted and a large aquarium where the important food-fishes of the South Atlantic, Gulf, and Middle States were displayed. While the writer was absent from Washington the work of the division was directed by J. F. Ellis, superintendent of the car and messenger service.

INSPECTION OF STATIONS.

The assistant inspected the fish-cultural stations at St. Johnsbury, Vt., Woods Hole and Gloucester, Mass., Wytheville, Va., Northville, Mich., and Put-in Bay, Ohio, during the year and submitted reports covering recommendations for improvements, etc.

STATION OPERATIONS.

The stations operated during the year and the number of fish and eggs furnished for distribution by each are shown in the following tables, also a summary of the fish distributed, including 32 species and 1 crustacean, the lobster. A comparison of this season's work with the previous one shows a large increase in the output of fry of most of the important commercial species propagated—such as the shad, salmon, lake trout, whitefish, cod, flatfish, and lobster.

Statement of fish and fish eggs furnished for distribution by the stations of the United States Commission of Fish and Fisheries during the fiscal year 1895–96.

Source of supply.	Species.	Eggs.	Fry and fingerlings.	Adults and yearlings.
Green Lake, Me	Landlocked salmon	4,000	67,621	37,382
	Brook trout	65,000	41,549	10,896
	Von Behr trout	35,000	19,305	
	Lake trout			2,175
	Golden trout		21,700	10
Craig Brook, Me	Atlantic salmon	270,000		151,676
	Landlocked salmon			12,225
	Brook trout			27,763
	Rainbow trout			10,000
	Scotch sea trout	5,100		1,376
	Steelhead trout		50,086	
St. Johnsbury, Vt	Atlantic salmon		19,000	
	Steelhead trout		4,000	1,035
	Brook trout	25,000	5,000	
	Rainbow trout		26,000	
	Lake trout		54,174	
Gloucester, Mass	Lobster		13,050,000	
	Cod		24,850,000	
	Mackerel		897,000	
Woods Hole, Mass	Lobster		83,707,000	
	Cod	840,000	40,507,000	
	Tautog		17,575,000	
	Flatfish		8,472,000	
	Mackerel		831,000	
Cape Vincent, N. Y	Lake trout		1,650,000	
	Brook trout		22,100	
	Rainbow trout		6,600	
	Whitefish		20,000,000	

Statement of fish and fish eggs furnished for distribution by the stations of the United States Commission of Fish and Fisheries during the fiscal year 1895–96—Continued.

Source of supply.	Species.	Eggs.	Fry and fingerlings.	Adults and yearlings.
Delaware River (steamer *Fish Hawk*).	Shad	1,183,000	22,056,000	
	Lobster		322,000	
	Mackerel		213,500	
Battery Island, Md	Shad	1,165,000	36,117,000	
Fish Ponds, District of Columbia.	Carp			91,105
	Goldfish			2,137
	Black bass (large mouth)			5,950
	Black bass (small mouth)			1,208
	Tench			50,363
	Golden tench			44
	Golden ide			87
	Shad			1,000,000
Central Station, District of Columbia.	Lake trout		8,947	
	Rainbow trout		12,540	
	Von Behr trout		8,422	
	Yellow perch		812,000	
	Shad		36,529,000	
Bryan Point, Md	Shad	44,174,000		
Wytheville, Va	Rainbow trout	185,000	112,000	74,243
	Black-spotted trout			(adult) 17
	Black bass			1,460
	Rock bass			12,945
	Carp			75
	Goldfish			30
Put-in Bay, Ohio	Whitefish		122,890,000	
	Lake trout		685,400	
	Lake herring		696,000	
Northville, Mich	Lake trout	955,000	1,295,000	
	Brook trout	40,000	210,000	300
	Von Behr trout		30,000	
	Loch Leven trout	20,000	17,000	
	Rainbow trout		21,000	
	Steelhead trout		55,000	
Alpena, Mich	Whitefish	50,000	35,850,000	
Duluth, Minn	Whitefish		10,000,000	
	Lake trout	50,000	4,400,000	
	Steelhead trout		135,000	
	Rainbow trout		16,000	
	Brook trout		3,200	
Quincy, Ill	Black bass			18,637
	Ring perch			3,100
	Pickerel			1,550
	Warmouth bass			200
	Crappie			51
	White bass		20,000	
	Carp			7,008
Neosho, Mo	Rainbow trout	222,694	30,940	88,933
	Von Behr trout			2,186
	Brook trout			600
	Black bass			9,338
	Rock bass			25,218
	Tench			49
	Goldfish			994
Leadville, Colo	Brook trout		332,000	47,800
	Rainbow trout		25,050	4,530
	Yellow-finned trout		7,700	
	Black-spotted trout	35,000	11,600	
	Loch Leven trout	30,000		
Baird, Cal	Quinnat salmon	6,170,800	650,000	
Fort Gaston, Cal	Von Behr trout	10,000		
	Rainbow trout	30,000		
	Steelhead trout	175,000	107,808	
	Quinnat salmon		65,700	
Clackamas, Oreg	Quinnat salmon		2,832,150	557,150

Summary of distribution.

Species.	Eggs.	Fry.	Adults and yearlings.	Total.
Carp			87, 203	87, 203
Tench			44, 149	44, 149
Goldfish			2, 875	2, 875
Golden ide			8	8
Golden tench			45	45
Shad	2, 228, 000	90, 253, 500	1, 000, 000	93, 481, 500
Quinnat salmon	6, 170, 800	3, 297, 850	807, 150	10, 275, 800
Atlantic salmon	279, 000	19, 000	151, 676	449, 676
Landlocked salmon	4, 000	67, 525	48, 851	120, 376
Steelhead trout	175, 000	345, 715	1, 035	521, 750
Loch Leven trout	50, 000	17, 000		67, 000
Rainbow trout	437, 694	237, 248	145, 934	820, 876
Von Behr trout	45, 000	57, 717	1, 000	103, 717
Black-spotted trout	35, 000	11, 600	17	46, 617
Brook trout	130, 000	601, 880	82, 179	814, 059
Lake trout	1, 005, 000	7, 989, 618	2, 000	8, 996, 618
Yellow-fin trout		7, 700		7, 700
Golden trout		21, 700	10	21, 710
Scotch sea trout	5, 100		1, 376	6, 476
Whitefish	50, 000	189, 690, 000		189, 740, 000
Yellow perch		812, 000	2, 235	814, 235
Pickerel			1, 400	1, 400
Lake herring		696, 000		696, 000
Black bass (large mouth)			33, 737	33, 737
Black bass (small mouth)			915	915
Rock bass			34, 791	34, 791
Sunfish			35	35
White bass		19, 500		19, 500
Cod	846, 000	65, 366, 000		66, 212, 000
Flatfish		8, 472, 000		8, 472, 000
Lobster		97, 079, 000		97, 079, 000
Tautog		17, 575, 000		17, 575, 000
Mackerel		1, 941, 500		1, 941, 500
Total	11, 460, 594	484, 579, 053	2, 448, 621	498, 488, 268

NOTE.—2,333,000 shad fry were deposited for rearing in the Fish Ponds, Washington, D. C., but these figures are not included in the summations.

In addition to the foregoing there were furnished for distribution, but lost in transit, 10,985 carp, 6,263 tench, 286 goldfish, 79 golden ide, 756 landlocked salmon, 31,772 rainbow trout, 1,186 Von Behr trout, 5,180 brook trout, 175 lake trout, 865 yellow perch, 150 pickerel, 1,657 black bass (large mouth), 293 black bass (small mouth), 3,602 rock bass (yearlings and adults). The following losses occurred in fry and fingerlings: 4,448,500 shad, 50,000 whitefish, 500 white bass, 103,903 lake trout.

GREEN LAKE STATION, MAINE (E. E. RACE, SUPERINTENDENT).

At the beginning of the year the stock of fish on hand was as follows:

Species.	Calendar year in which hatched.			
	1895.	1893.	1892.	1891.
Landlocked salmon	54, 950	3		3, 000
Brook trout	13, 350	138		
Golden trout	6, 480			
Lake trout	61, 539			
Von Behr trout			1, 150	
Rainbow trout		7		
Total	136, 319	148	1, 150	3, 000

Owing to the small amount of water available for the rearing-troughs and tubs at the temporary nursery east of the spawning-house, it became necessary to remove the brook and golden trout to the hatchery and the lake trout to the spring on the Government property near the main flume, between the hatchery and Rocky Pond.

PLATE 2.

RACK AND PENS FOR CAPTURING AND HOLDING SALMON AND TROUT AT GREAT BROOK, WHERE IT ENTERS GREEN LAKE. SPAWNING HOUSE TO THE RIGHT.

Heavy losses of salmon and lake-trout fry were sustained during July and August, due to the high temperature of the water. In September the stock remaining at the station was distributed, consisting of 37,382 landlocked salmon, 10,896 brook trout, 2,175 lake trout, 22,834 brook trout, and 9,208 rainbow trout, which had been transferred from Craig Brook Station.

The usual arrangements were made for collecting eggs from wild fish taken in Green Lake, Flood Pond, Patton Pond, and Winkempaugh Brook. In Green Lake a V-shaped trap was built at the entrance of Great Brook, and seven pens, varying in length from 30 to 50 feet, were constructed for holding the brood fish. Similar pens were constructed in Winkempaugh Brook, Patton Pond, and Flood Pond, and a pound net was set in Mann Brook, the crib being located in water 10 feet deep. The first landlocked salmon was caught in Green Lake on September 18 and the last on November 28. The first eggs were taken on November 3 and the last on November 27. The spawning season of the brook trout commenced October 19 and ended November 27.

The following table shows the number of brook trout and landlocked salmon taken from the various traps and the number of eggs obtained. At the close of the season the adult fish were returned without loss to the waters from which they had been taken.

Body of water.	Landlocked salmon.		Brook trout.		Golden trout.	
	Fish.	Eggs.	Fish.	Eggs.	Fish.	Eggs.
Green Lake	64	73,000	14	90,900		
Flood Pond	4	11,000	119	46,000	60	34,000
Patton Pond	15	2,500	136	60,000		
Winkempaugh Brook	5	9,400	232	198,000		
Total	88	95,900	501	343,900	60	34,000

The small collections of landlocked salmon eggs were very discouraging, as every effort had been made to increase the output of that species. The poor results were undoubtedly due to the fact that the water in Green Lake and its tributaries was so low that the salmon could not ascend to their usual spawning-grounds. Throughout the entire summer the water in the lake was lower than had been known for years, and the steamer *Senator* was unable to land at the station wharf for several weeks.

In addition to the collections secured from wild fish, 14,300 brook-trout eggs, 190,600 Von Behr, and 700 hybrid Von Behr and brook-trout eggs were taken from the brood stock at the station. Seventy-six domesticated landlocked salmon, which had been reared in the reservoir, were stripped during December, but most of the eggs secured from them were worthless. A lot of 4,500 was placed in the hatching-troughs, but no fry were hatched from them. The eggs from these fish were smaller and the color darker than those taken from the wild fish. The fish also differed materially in shape and color, those reared in the reservoir being darker and having long, slender bodies interspersed with black spots, whereas the wild fish in Green Lake are almost similar in color to the sea salmon.

On December 1 the total number of eggs on hand was as follows: Landlocked salmon, 90,400; brook trout, 407,700; Von Behr trout, 149,000; golden trout, 34,000.

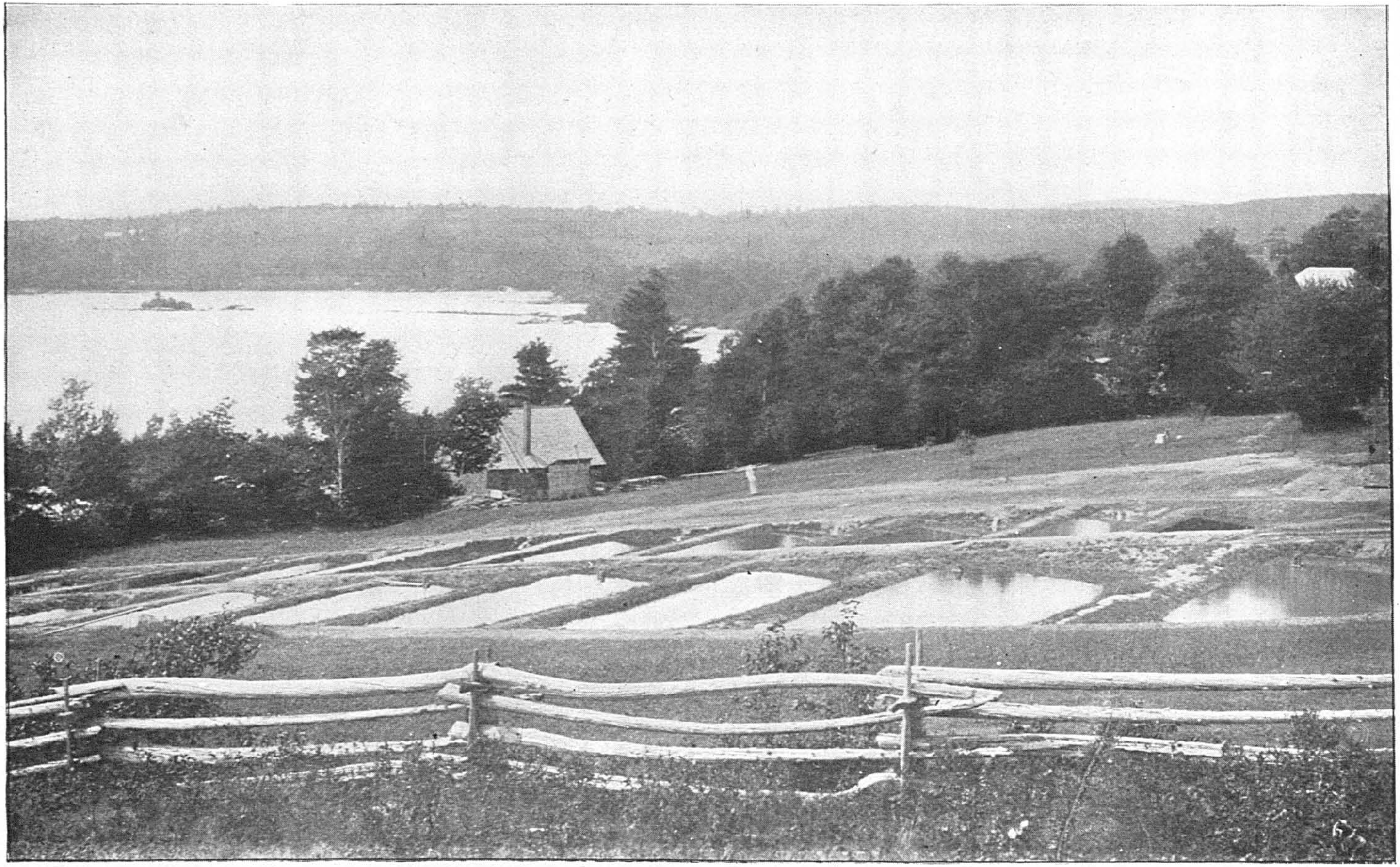
During the fall shipments of eggs were made as follows:

Applicant.	Species.	Number furnished.
Maine Fish Commission, Enfield, Me	Brook trout	40,000
Vermont Fish Commission, Roxbury, Vt	Von Behr trout	10,000
Central Station, Washington, D. C	do	10,000
C. W. Willard, Westerly, R. I	do	10,000
Jno. W. Forbes, Bedford, Ohio	do	15,000
E. C. Kent, Tuxedo Park, N. Y	Landlocked salmon	2,000
Edward Layton, Branchville, N. J	do	2,000
Total		89,000

Large losses of fry occurred in the early part of May, when the air temperature reached a height unprecedented at that season for many years. On May 10 the temperature in the hatchery from 10 a. m. to 5 p. m. ranged from 90° to 92°, and the water temperature rose from 54° to 62½°. The principal losses occurred among the landlocked salmon, being especially heavy among those which had not absorbed the sac. The brook-trout eggs commenced hatching on March 15 and finished on April 1. The balance of the eggs hatched during April, the last of the landlocked salmon and Von Behrs hatching on the 29th.

The losses of brook-trout eggs during the winter were very heavy, due, probably, to imperfect fertilization and to injuries received in transportation to the hatchery. In May, when the fry were all transferred to the troughs outside the hatchery, there remained on hand 85,307 landlocked salmon, 114,174 brook trout, 37,732 Von Behr, and 29,983 golden trout.

In May the architect of the Commission visited the station, and after consultation with the superintendent prepared the necessary plans for improving and increasing the water supply for the hatchery; he also arranged for the acquirement of additional spring water, for the construction of new ponds, and for repairs to Mountainy Pond Dam. These recommendations having been approved, it became necessary to cut off the water supply from the hatchery and ponds and to distribute all of the fry on hand before undertaking the improvements. During the latter part of June 67,817 landlocked salmon, 41,215 brook trout, 19,305 Von Behr trout, and 21,710 golden trout were distributed to applicants in Maine, Vermont, New Hampshire, and Massachusetts. The improvements were then commenced under the direction of the superintendent.



REARING PONDS—LAKE ALAMOOSOOK IN BACKGROUND—CRAIG BROOK STATION, ME.

CRAIG BROOK STATION, MAINE (C. G. ATKINS, SUPERINTENDENT).

During the year ten species of fish were handled at the station. The stock on hand July 1, 1895, was as follows:

Species.	Calendar year in which hatched.				
	1895.	1894.	1893.	1892.	1891 or earlier.
Atlantic salmon	176, 954	624	342	....	....
Atlantic salmon, domesticated	....	216	725	50	....
Landlocked salmon	12, 590	....	....	....	5
Brook trout	39, 331	....	....	....	....
Rainbow trout	11, 506	....	....	....	1
Scotch sea trout	3, 313	....	....	....	22
Swiss lake trout	20	....	....	....	....
Total	243, 714	840	1, 067	50	28

These fish were cared for during the summer in the usual manner, in troughs and ponds, being fed on chopped beef, butchers' offal, and maggots. In the fall the Atlantic salmon were liberated in adjacent waters tributary to the Penobscot, and the landlocked salmon, brook and rainbow trout were shipped to Green Lake for distribution from that point to applicants in Maine and neighboring States.

The total distribution of yearling fish from the station consisted of 151,676 Atlantic salmon, 12,225 landlocked salmon, 27,763 brook trout, 10,000 rainbow trout, and 1,376 Scotch sea trout.

The following table shows the number of eggs from which the fish distributed in the fall were reared, also the percentage of fish distributed as compared with the number of eggs, the fry hatched, and number on hand June 1, when they were placed in the rearing-ponds:

Species.	Number of eggs.	Number of fry hatched.	On hand June 1, 1895.	Remaining at fall count.			
				Number.	Per cent.		
Atlantic salmon	206, 350	206, 109	199, 779	151, 761	74	74	76
Landlocked salmon	14, 867	14, 670	13, 187	12, 228	83	83	93
Brook trout	61, 341	61, 145	45, 959	27, 777	45	45	61
Scotch sea trout	9, 309	8, 150	6, 297	3, 384	36	36	55
Rainbow trout	20, 961	20, 260	12, 290	10, 590	51	52	86
Swiss lake trout	2, 234	541	57	39	2	7	69
Total	315, 062	310, 875	277, 569	205, 779	65	66	78

As in previous years, the United States Commission and the State of Maine operated conjointly in the collection and maintenance of brood salmon from the Penobscot and in the incubation up to the point of shipment of such eggs as were removed to other stations for hatching, and also of those falling to the share of the State. The salmon were confined in an inclosure at Dead Brook, less than 2 miles from the station, and there the spawning operations took place, the impregnated eggs being removed immediately to Craig Brook hatchery. The collection of salmon for the season of 1895 was made during May and June of the previous fiscal year. Arrangements were made as usual for a number of weirs about the mouth of the Penobscot to furnish live fish.

The method of collection was as follows: The fishermen agreeing to furnish live salmon were supplied in advance with large, fine-meshed dip nets, lined with flannel to prevent the chafing of the fish; a car was stationed in every neighborhood, and each fisherman whose weirs were so far from the moorings of the car as to forbid their being brought alongside for the direct receipt of captured fish was provided with a large box in which to transport them short distances. As low water approached and before it became low enough to leave the fish stranded on the floor of the box, the salmon were carefully dipped out and placed in the cars. Once a day the collecting steamer made a tour of the district, taking in tow the cars containing salmon and leaving empty ones in their places. The cars were then towed as far as Orland, arriving there a short time before high water. A dam and lock at this point making it impossible for the steamer to ascend farther, the cars were here taken in tow by oarsmen and carried on nearly 2 miles farther to Dead Brook, where the fish were released in an inclosure of about a third of a mile up and down a sluggish stream, averaging 3 or 4 yards in width and having an extreme depth of about 6 feet.

The first lot was received June 1, and the work proceeded without incident from that time until the 10th. On that date 45 salmon were brought in, but owing to excessive heat 15 of them died in the cars before reaching the inclosure. The following days were also very hot, making the losses so heavy that it was found necessary to suspend operations on the 14th. Work was resumed on the 17th and, with the aid of ice, was continued without interruption until the 26th, when operations ceased. Of 390 salmon purchased, 109 were lost en route. During the season persistent efforts were made to keep the temperature down in the cars by means of ice, and positively favorable results were at last attained by arranging their interiors so that the water, admitted in a greatly reduced volume, should pass through a cooling compartment before reaching the fish. In the application of this method it was necessary to have a separate boat containing a considerable quantity of ice to accompany the fleet.

Notwithstanding the fact that every effort was made to protect the salmon from injury in handling, a great many died in a short time from the effects of bruises and chafing. Thirty per cent may be given as the ordinary ratio of loss out of those liberated in the inclosure, but the loss this year was 6 per cent greater, the number of salmon found in the inclosure in the fall being 179, of which 68 were males and 111 females.

Egg collections commenced October 26 and closed November 7. The total yield was estimated at 992,000, but a later computation based on careful measurement showed a take of 1,027,353. Of these, 106,653 were lost. The United States received as its portion 602,700 and the State of Maine 318,000. Of those belonging to the station, 329,000 were distributed as shown in the accompanying table, and the remainder were reserved for hatching and rearing. Of the 274,158 fry produced from them, 244,405 survived to the close of the year.

BOATS USED IN TRANSPORTING ATLANTIC SALMON FROM PENOBSCOT RIVER TO DEAD BROOK, WHERE THE FISH ARE HELD UNTIL THE FALL.

Atlantic salmon eggs shipped during the year ending June 30, 1896.

Applicant.	Number.	Applicant.	Number.
H. C. Ford, Philadelphia, Pa	100,000	W. S. Hadaway, Plymouth, Mass	25,000
Jas. A. Bill, Bill Hill, Conn	50,000	New Hampshire Fish Commission	50,000
New York Fish Commission	50,000	J. R. Neal & Co., Boston, Mass	4,000
United States Fish Commission	50,000		

The collection of brood salmon for the fall of 1896 was made on the same basis as in 1895. Profiting by the experience of the previous season, a large stock of ice was also provided for use, and the cars were fitted with cooling compartments and cloth partitions. The collections commenced on May 21 and by the 17th of June 678 salmon had been purchased, 677 of which were released alive in the inclosure. The loss on these to the end of June was 87, or less than 13 per cent, and as the great majority of deaths in the inclosure usually occur in June there is every reason to expect that the additional loss before the opening of the spawning season will be very small.

Domesticated salmon.—Of the descendants of salmon that have been retained in the ponds from infancy, and have therefore never visited the sea, there is now a small lot of 55 on hand, reduced from 775 at the beginning of the year by the ravages of mink. These fish were hatched in 1892 and 1893 and produced eggs in October and November of 1896. They were of poor quality, however, and none of them survived the month of January. The fish were recently removed to a larger pond, where it is expected they will be freer from the attacks of enemies. There are also on hand two small lots of salmon hatched in 1893 and 1894, and these will serve to continue the interesting experiment of artificially landlocking the Atlantic salmon.

Landlocked salmon.—Owing to lack of funds no efforts were made to collect eggs of landlocked salmon this season, except from a few spawning fish which were brought to the station from Toddy Pond by interested citizens. These yielded 19,000 eggs, from which 14,670 fry were hatched. Both the eggs and fry appeared to be healthy, but an unusually large percentage of them have died, and only 12,590 of the fish remain at the close of the year. Of the 5 landlocked salmon left on hand at the opening of the year from the hatch of 1888 and 1889, only one survives. These fish were apparently healthy, but no spawn was ever obtained from them.

Scotch sea trout.—Eggs were collected during the fall from the 22 brood fish remaining from the hatch of 1891, but they were of inferior quality, and all the good ones, amounting to 5,100, were furnished to the New York Fish Commission in February. In addition to the 22 fish mentioned there are now on hand 1,337 of the hatch of 1894.

Brook trout.—No attempt was made to collect eggs of this species except from the few fish held at the station, and but 6,364 fry were hatched from these. They proved of very poor quality, however, and only 2,668 survived to the end of the year.

Rainbow trout.—From the fish hatched in 1895, 10,000 were distributed in the fall, and 575 of the 590 retained for rearing purposes remained on hand at the close of the year. In December an invoice of 25,000 eggs was received from Wytheville Station. The fry produced from them suffered heavy losses during the sac stage, and only 12,778 survived to the close of the year.

Quinnat salmon.—A case containing 10,000 eggs of this species arrived from Baird, Cal., on December 26, 1895, in fine condition. Of the 8,248 healthy fry hatched from them, 7,796 remained in stock at the end of the year.

Lake trout.—From 50,000 eggs received from Northville, 42,906 fry were hatched, but by June 30 the number had been reduced to 38,965.

Swiss lake trout.—Another consignment of eggs of this species was shipped from Switzerland in February, and arrived in excellent condition. From the 56,000 received, 51,294 fry were hatched, 46,796 of them surviving to the close of the year. There are also in stock 27 yearlings, left from the 80,000 eggs shipped to the station in 1895.

Von Behr trout.—A shipment of 25,000 eggs of this species sent from Belgium arrived in January in such poor condition that only 9,000 were estimated to be alive, and only 487 of the 6,652 fry hatched from them were alive on June 30.

Steelhead trout.—Three invoices of eggs, amounting in all to 210,000, were received from Fort Gaston station during April and May. Owing to high temperature at the time of shipment and the length of time they were en route, the second and third consignments were in very poor condition when received. The three lots produced 115,537 fry, but there was a heavy loss during the sac stage, so that the net result was but 50,104 distributed and 12,511 remaining at the station on June 30.

The stock on hand at the close of the year is shown by the accompanying table:

Species.	Calendar year in which fish were hatched.				
	1896.	1895.	1894.	1893.	1892 or before.
Atlantic salmon	244,405		451	254	
Atlantic salmon, domesticated				52	3
Landlocked salmon	11,033				1
Quinnat salmon	7,796				
Brook trout	2,668				
Rainbow trout	12,778	575			1
Scotch sea trout		1,337			7
Lake trout	38,965				
Swiss lake trout	46,796	27			
Von Behr trout	487				
Steelhead trout	12,511				
Total	377,439	1,939	451	306	12

During the year 21,610 pounds of butchers' offal, blood, beef, and horse carcasses were used as food, the original cost of which was $282.79. The additional expenses of freight and drayage makes the total cost of fish food at the station for the year $513.88.

Following is a record of the meteorological observations made at the station during the year:

Month.	Mean temperatures.						Rainfall.	Snow.
	Air.		Water.					
			Hatchery, west side.		Head of feed trough, north stand.			
	7 a. m.	2 p. m.	7 a. m.	2 p. m.	7 a. m.	2 p. m.		
1895.							*Inches.*	*Inches.*
July	61.73	72.74	67.71	70.84	62.90	67.42	3.45	....
August	62.32	71.82	68.11	71.18	63.98	68.27	1	....
September	55.55	67.88	62.90	66.65	60.10	64.82	1.1	....
October	39.18	51.48	50.98	54.05	51.02	54.92	1.05	....
November	32.95	43.13	43.37	45.57	44.85	47.65	6.75	1
December	21.89	32.18	36.03	37.43	39.23	41.10	3.15	14
1896.								
January	10.39	23.71	33.34	34.34	36.58	38	....	7
February	13.19	27.81	32.84	33.86	35.45	37.10	2.8	13.5
March	19.72	33.02	33.81	35.71	35.27	38.34	5.15	23.5
April	35.92	52.07	38.95	43.57	39.92	46.45	.25	4
May	50.19	65.37	51.92	56.73	49.47	55.42	2.75	....
June	55.55	72.48	61.03	46.05	56.77	61.72	3.5	....
General means	38.33	51.18	48.45	51.25	50.19	51.80	30.95	63

ST. JOHNSBURY STATION, VERMONT (J. W. TITCOMB, SUPERINTENDENT).

At the beginning of the fiscal year the stock of fish on hand at the station consisted of 6,673 steelhead trout and 22,875 lake trout. The water supply to the hatchery at this time was taken from a small brook on the station property, supplied by springs, and varying in volume from 8 gallons of pure water to 100 of surface water. As it was conducted to the hatchery in an open ditch, it was subject to changes in temperature, and was therefore about the same as the temperature of the water in Sleeper River, from which the supply was taken later in the summer. In July all of the lake trout died, owing to the high temperature, which also caused a heavy mortality among the steelheads. During July and November plants of steelhead trout amounting to 4,777 were made in the tributaries of Lake Champlain, and on May 5 258 were deposited in the Merrimac River at Concord. At the close of of the year 90 yearlings were left on hand.

During the summer preparations were made to obtain spawn of the native brook trout from streams and ponds in various parts of the State, and the following collections were made at the six points selected: Darling Pond, Groton, 106,965; Pico Pond, Shrewsbury, 20,000; Caspian Lake, Greensboro, 602,990; Lakota Lake, Woodstock, 91,100; Lake Mitchell, Norwich, 111,281; Fairbanks Pond, St. Johnsbury, 35,000; total, 967,336.

The first eggs were taken on October 1 at Pico and the last on November 26 at Fairbanks. Owing to the different conditions existing in the various lakes, different methods had to be adopted in capturing the fish. At Pico, Sherburne, and Darling ponds, where the fish enter small tributary streams to spawn, V-shaped slat traps were constructed in the brooks near their outlets, and the fish captured were held in slat pens in the streams above the traps until ripe. At Lakota the feeding streams were so small that the trout could only enter them during a heavy fall of rain. A pound net was placed in the pond near the outlet of the small stream, but the water was so shallow that very few fish were caught. At Lake Mitchell the trap was washed out by a heavy freshet, which undoubtedly reduced the output of that lake. At Fairbanks Pond and Caspian Lake the trout were taken by means of seines, and good results were also obtained at the latter point with dip nets, the spawning-grounds being first surrounded by a fine-meshed gill net. The work of collecting spawn was conducted both by day and by night, the fishermen being guided at night by the use of jack lights attached to the bows of the boats. The largest trout captured was 26 inches long. Those captured at Caspian Lake were larger than the ones taken at the other points, and averaged from 1½ to 2 pounds in weight.

In this lake they locate their spawning-beds in water from 1 to 6 feet deep, and it is not uncommon to see them working on them in water so shallow that their fins and tails are above its surface. Such beds become quickly covered with sediment after a storm, and as they are covered with ice in winter, much of the spawn must be destroyed. The lake is also full of suckers and minnows of large size, which prey upon the spawn and are often taken in the seines with the trout.

The first eggs taken were transferred on canton-flannel trays packed in moss, but later on, for convenience in handling, and in the belief that better results could be obtained, they were placed in tin lard-pails with perforated covers, and these packed in large wooden pails with moss all around them. The latter method is inexpensive, and it does not injure the eggs, as in traveling over rough roads the pails can be held by the messengers, thus breaking the jar of the wagon. It is proposed to try still another method next season, and that is to place the eggs on the wire trays on which they are to be hatched, packing them in light, portable cases with moss.

Of the eggs collected, 25,000 were shipped to A. M. Bigelow, Branchville, N. J., and the balance of the stock and an additional assignment of 20,000 received from Northville, Mich., were retained for hatching. Owing to the very unsatisfactory condition of the water supply, only 13,748 fry were available for distribution, 5,000 of which were shipped to Sherburne, Vt., for deposit in Pico Pond. The heavy loss of eggs and fry is attributed to the muddy condition of the water and to its very low temperature, which averaged 32½° from the middle of November to the middle of April. The water in the troughs would occasionally freeze over and ice form on the bottoms and sides. The eggs during this period developed very slowly, and the time of incubation varied from 176 to 198 days, very few hatching in less than 190 days. Both before and after the eggs were eyed and up to the time of hatching it was necessary to handle them almost daily to free them from mud and sediment, as in some instances enough would collect in one night to entirely bury eggs and trays. It appears from experience gained during the past season that, although eggs may be successfully hatched in pure water of a temperature as low as that recorded at the station, in all instances the eggs should be eyed before subjecting them to it. The loss on the first lots taken was much less than on those which were not eyed at the time the temperature became so low. In addition to collections made in the vicinity of the station, consignments of Atlantic salmon and rainbow and lake trout were received from other stations.

Atlantic salmon.—In January 25,000 of these eggs were shipped from Craig Brook Station. They hatched about three months afterwards, the loss on them being 2,405. Of the fry, 19,000 were planted in Merrimac River at Concord and the balance were retained for rearing.

Rainbow trout.—Three consignments of rainbow-trout eggs, aggregating 75,000, were received from Wytheville Station. Though the first package was overheated, the eggs appeared to be in good condition; the second box had apparently been overturned, but the third showed no signs of rough handling. A very few days after the eggs were received white spots appeared on nearly all of them. The water at Wytheville was about 22° warmer than that at St. Johnsbury, and as the same trouble has been experienced at the Duluth Station under similar conditions of temperature it is inferred that the spots originate from the great difference in the temperature of the water. Of the 75,000 eggs received, there was a loss of only 3,341 after they were laid down in the troughs, but the fry were weak and only 26,700 were saved. These were planted at the following points: 10,000 to East Creek, Rutland County, Vt.; 8,000 to Isinglass River, Strafford County, N. H.; 8,000 to Great Brook, Rockingham County, N. H.; 700 retained at the hatchery.

Lake trout.—From eggs received from Northville, 93,698 fry were produced, most of them hatching during a period of freshets, when the water suddenly became warmer and was so muddy that the fry could not be seen in it for several days. The loss amounted to 39,524, and the remaining 54,174 were distributed to applicants in Massachusetts and Vermont.

During the winter the superintendent made a careful examination of the springs in the vicinity of the station with the view to increasing the water supply. Options were secured on a number of them, but the amount of water they were capable of furnishing was too small as compared with the expense that would have been incurred in their purchase and the piping of the water to the hatchery. The total supply from all the springs in the vicinity, 12 in number, would not have amounted to more than 125 gallons per minute, and even this amount was uncertain, as the investigation was made when the ground was covered several feet deep with snow. An appropriation was secured for the development of the spring water on the station property, and also for the construction of a large settling reservoir and filter to be used in connection with the water taken from Sleepers River. During June plans were prepared with the view to carrying out this work.

The following table shows the stock of fish on hand at the close of the year:

Species.	Fry.	Yearlings.
Brook trout	8,748	
Rainbow trout	700	
Atlantic salmon	1,753	
Steelhead trout		90
Lake trout		5

GLOUCESTER STATION, MASSACHUSETTS (E. F. LOCKE IN CHARGE).

Upon the resignation of Capt. A. C. Adams, E. F. Locke was appointed fish-culturist of the station and took charge on July 1. During the summer necessary repairs were made to the wharf and the steam and water plant, and the hatchery was improved by the addition of four new windows. In July the assistant in charge and I. S. K. Reeves, consulting engineer, visited the station with the view to determining what improvements could be made in the method of hatching cod eggs.

The small output of the previous year, which was less than 13,000,000 fry, or about 16 per cent of the number of eggs collected, was attributed by Captain Adams chiefly to the condition of the water in Gloucester Harbor, which is highly charged with sediment. This attaches itself to the eggs, increasing their specific gravity and causing them to sink to the bottom of the box, where they die. The presence of crustaceans, jelly-fishes, and other animals in the water seriously interferes also with the working of the hatching apparatus. An examination of the harbor failed to show that these conditions could be bettered, and after careful consideration it was decided to continue the work on the same lines as heretofore, and to attempt, in addition, the hatching of cod eggs by means of air circulation, as tried at Central Station during the winter of 1893, and also with closed circulation of water. It had been demonstrated at Chicago that sea water could be kept indefinitely in a practically pure state with large numbers of fish or other animals living in it by means of aeration and circulation, and there appeared to be no reason why cod eggs could not be hatched under similar conditions.

The collection of eggs was directed by Capt. E. E. Hahn, who was stationed at Kittery Point, Maine, with a portion of the crew of the *Grampus*. The season lasted from November 29 to March 23, during which time 70,901,000 eggs were delivered at the station. From these, 24,859,000 fry were produced and liberated in waters in the immediate vicinity. All of the eggs, except those retained for hatching by means of aeration and closed circulation of water, were placed in the

McDonald tidal boxes. Those received previous to December 21 were of excellent quality and yielded fair results, but the shipments coming in after that date were very poor and were apparently imperfectly fertilized.

At the opening of the season the temperature of the water was 44°, but by December 12 it had dropped to 34°, and by January 6 it registered 31°. As this was too cold for hatching with good results, the water was heated artificially, and during the remainder of the season it was kept at from 35° to 37°.

Air circulation.—On the 16th of December 220,000 eggs were placed in two McDonald jars at midnight, the water temperature at the time being 35°; by the morning of the 17th it had risen to 51°, and, although changed frequently, it remained stationary until the 19th, by which time all of the eggs had died. The experiments were continued from time to time, with the view to keeping down the temperature of the water, but without success until the jars had been partially submerged in a packing of crushed ice and salt. On the 31st of January 380,000 cod eggs were placed in two jars and the temperature kept at 40°. On the fifth day it was noticed that minute bubbles had collected on the eggs in sufficient quantity to raise the top layer partly out of the water, where they remained without change. The water also commenced to emit a very offensive odor, notwithstanding the fact that it had been changed every 12 hours. Later on it was changed every 4 hours, but still continued to be offensive. The eggs commenced hatching on the fourteenth day, but the fry were crooked and weak, and of the 25,000 hatched only about 2,000 survived. On February 18 another experiment was tried with 580,000, the water temperature during the entire period of incubation being kept at 40°. The eggs commenced hatching on February 29, and about 10,000 fry were liberated from this lot. Further experiments were tried in March, but the results were practically the same.

Closed circulation.—To test this method of hatching, a cedar tank of 15,000 gallons capacity was placed at the northwest corner of the hatchery, so arranged that the water from the hatching-boxes could flow into it by gravity and from there be pumped to the pressure tank, located at the southwest corner. An air-pump was provided for aerating the water, and sand and gravel filters were placed between the hatching-boxes and the receiving reservoir, through which the water could be filtered each time it was used. It was intended to fill the tank with water comparatively free from sediment and to hold it for use when the water in the harbor became roily, using the reserve supply over and over until the harbor water became clear again. The stormy weather caused numerous delays in setting up the tank and it was not in working order until February 4. A test of this method was at once undertaken, but the experiment had to be discontinued on the 17th, owing to the bursting of some of the pipes by frost.

Another experiment was commenced on the 20th and continued until the 24th, when the fry began to die, owing to the fact that the water was becoming impure. A third attempt was made between February 25 and March 2, but no results were obtained. The experiments were then discontinued.

It would appear that this system can not be used longer than three days at a time with the apparatus now in use.

It is a question whether either of these methods has had a fair trial, as they were not undertaken until late in the season, when not only the quality of the eggs was poor, but the water in the harbor was at its most impure stage, owing to frequent storms. Further efforts in this line will be made next season.

Lobster.—Immediately after the close of the cod season on April 14 arrangements were made for the collection of lobster eggs from points between Boston and York, Me., the commissioners of the States of Massachusetts, Maine, and New Hampshire having granted permission to collect and pen egg-bearing lobsters. An agent was stationed at Kittery Point, Me., for the purpose of collecting eggs from lobsters caught by the fishermen between Rye, N. H., and York Harbor, Me.; he obtained, in addition, a number of egg-bearing lobsters which had been caught at the Isle of Shoals and shipped to Portsmouth, N. H. A small steamer was also chartered for the work and used for a month in visiting the lobstermen between Gloucester and Boston. The first eggs were received on April 22 and the last on July 13, when operations were discontinued. The 14,534,000 eggs obtained were hatched as usual in the McDonald universal hatching jar, and 13,050,000 fry were produced from them. Several shipments were sent to York Harbor, Me., Kittery Point, Me., and Newcastle, N. H., but the bulk of the stock was liberated between Marblehead and Gloucester. The poor results attained with this species were due to the fact that most of the territory was new, and the season was almost over before the fishermen became sufficiently interested in the work to save their egg-bearing lobsters for the Commission. The stormy weather prevailing during the early part of the season also tended to reduce the catch very materially.

Mackerel.—Arrangements were made during the latter part of April to collect eggs of this species from the traps fishing within 15 or 20 miles of Gloucester, also from the drag or drift nets; but the catch proved to be very light, 400 fish being the largest take. The first eggs were collected on June 27, and between that time and July 17, the close of the season, the total number taken was 1,720,000. The eggs were hatched in the McDonald tidal box, and the 897,000 fry produced from them were liberated in the harbor outside of Eastern Point. The results attained in this branch of the work were very discouraging, as operations were pushed energetically and visits were made to the traps in the harbor and to Magnolia and Manchester every morning between June 23 and July 17, when the weather permitted.

WOODS HOLE STATION, MASSACHUSETTS (JOHN MAXWELL AND ALEX. JONES, SUPERINTENDENTS).

The work was under the direction of John Maxwell until June 8, when he was relieved by Alex. Jones, fish-culturist, who acted as superintendent to the close of the year. During the summer the usual repairs were made to the launches, machinery, hatching apparatus, etc., and the pier wall and wharves were repaired under the direction of the Engineer Corps, United States Army, a specific appropriation of $5,000 having been made by Congress for this purpose. The basin used for housing the breeding codfish in winter was repaired and improved so as to protect the cars from being damaged by severe storms during the winter.

The following statement shows the kinds of fish propagated, number of eggs collected, and fry hatched and distributed:

Kind.	Eggs.	Fry.
Cod	70,844,000	41,353,000
Lobsters	90,000,000	83,707,000
Flatfish	11,008,000	8,472,000
Tautog	31,431,000	17,575,000
Mackerel	10,870,000	831,000
Total	214,153,000	151,938,000

Efforts were made at the beginning of the season to increase the production of cod; and with this object in view a larger number of brood fish than usual were obtained and placed in live-cars. Of the total number delivered at the station, 1,350 were collected by the schooner *Grampus*, under the direction of Captain Hahn; the balance, 2,486, were purchased from fishermen. The egg-collecting season commenced November 15 and continued until February 19, 415 brood fish yielding the entire supply. More females were secured, but many of them proved to be barren. The average yield per fish was 170,000, the largest in the history of the station. The number of eggs secured was disappointing in view of the fact that the number of brood fish carried was larger than in past years, but the small take was partly offset by the excellent quality of the eggs and fry, and by the unusual percentage of fry hatched. The apparatus used was the McDonald tidal box, as observations covering a number of years showed its effectiveness over the Chester jar. The fry were planted in the immediate vicinity.

During the time the brood fish were held in confinement an unusually large number of them were lost from disease. The weather at the time they were collected was rough and blustery, consequently those in the wells of the smacks necessarily experienced severe concussion by being forced against the sides of the well. Beyond the removal of the mucous covering, the bad results were not apparent immediately upon their delivery at the station, but subsequent losses showed the effects of such handling. The fish appeared to do well for a time, but many of them developed sores, which apparently resulted from bruises on different parts of the head and body. This was not considered of much importance at the time, as the same thing had occurred before, but these on close examination proved to be of a gangrenous character, and by November 25 an unusual number had died. Even fish that had been hooked in the lip were affected in this way, and many were lost before their eggs could be collected. The water during the time was full of ctenophores, which may have prevented the healing of the affected parts by irritating and inflaming the exposed flesh, thus encouraging the growth of fungus and the formation of ulcers. In many instances on opening the dead fish the air bladder was found to be partially or entirely destroyed by ulcer, which gave off an offensive odor. Some were found with ruptured egg sac, which allowed the eggs to escape from the ovaries into the abdomen, and in other cases internal hemorrhage appeared to be the cause of death.

The quantity and quality of eggs that can be taken at a station of this character depends on the size of the parent fish, the number producing eggs, and the state of the weather. Some seasons there is a scarcity of males and at other times egg-producing females are in the minority, but it is difficult to avoid this, owing to the fact that when the fish are received it is impossible to tell from their condition whether or not they will produce eggs. No fish are received at the station which weigh less than 5 pounds.

The following table shows the number of brood fish from which eggs were collected, the number of ripe fish used, and the yield per fish for a series of years from 1889 to 1896:

Year.	Brood fish.	Eggs taken.	Ripe fish.	Eggs per fish.
1889-90	349	8,500,000	91	93,000
1890-91	3,000	67,600,000	587	115,000
1891-92	1,020	48,600,000	444	102,000
1894-95	3,320	85,500,000	1,107	71,000
1895-96	3,836	70,800,000	415	170,000

Flatfish (winter flounder).—The spawning season of this species varies according to the temperature of the water and the prevailing state of the weather, from February 10 to about the middle of April. This year the first eggs were taken on February 24, and the last on April 18. The fish were obtained from fyke nets set in Great Harbor and Waquoit Bay, and the 44 females stripped yielded 11,008,000 eggs, from which 8,472,000 fry were hatched and planted. The eggs of this species measure 30 to the linear inch, and are very glutinous. Heretofore it has been difficult to separate them, and it was only accomplished by thoroughly washing and stirring for some time, but this season starch was very effectively used in the same manner that it is employed in the fertilization of pike-perch eggs on the Great Lakes. It dissolved quickly and mixed readily with the salt water, coating the eggs and preventing them from sticking together. The hatching was done in the modified McDonald tidal box.

Lobster.—The collection of egg lobsters commenced in the immediate vicinity of Woods Hole about April 10. As the season advanced the territory was extended, and the services of two fishing smacks were utilized, in addition to the launch *Cygnet.* Messengers were also sent to New Bedford, New London, Noank, and other points, where lobsters were held in live-cars by the fishermen. The collections at different points vary from year to year. The grounds on which the best collections were made four years ago yielded less this year than any of the others. The collecting season was continued to July 13, and resulted in a total take of 5,909 lobsters, which yielded 90,000,000 eggs. From these 83,707,000 fry were hatched and planted in the vicinity of New London, Noank, and Nantucket, also in Buzzards Bay, Vineyard Sound, and Great Harbor. The greater part of the lobsters secured after July 1 were from New London and Noank. It is recommended that regular collections be made next year at these two points, also at Westport, R. I., Nantucket, Block Island, and Plymouth. This would enlarge very materially the field of collection, and would probably result in doubling the output of the station.

Early in the season the eggs of the lobsters are hard and stand transportation well, but in advanced stages they are delicate and quickly affected by rough handling or sudden changes in temperature. Experiments were conducted in order to determine how soon after the new eggs are laid they can be taken from the parent lobster and hatched artificially. The observations were continued from the first appearance of the eggs in July until spring, and it was found that those removed before the latter part of October would not live. In November 15,000,000 were placed in jars and carried through the winter, and notwithstanding the many difficulties experienced, 50 per cent of them hatched.

Tautog.—The first eggs were taken on June 8, and by the close of the season (July 1) 31,431,000 had been secured. They were hatched in the McDonald hatching-box, and yielded 17,575,000 fry, which were liberated in Vineyard Sound and Great Harbor one or two days after hatching. The eggs of these fish measure 26 to the linear inch, and the average yield is about 150,000, though one specimen, weighing 9¾ pounds, yielded 1,142,624, and an examination of the fish after death showed this to be only about one-half of what were contained in the ovaries. The eggs develop quickly and hatch in from two to three days in a temperature of about 69°. When the fish are first caught they will not give down their eggs, and experiments were tried in retaining them in the cars for a time. The best results were obtained with eggs taken from two to six hours after capturing. The eggs from fish held longer than that were very hard to fertilize, and those taken from fish held over night proved to be entirely worthless.

Mackerel.—With the view to collecting large numbers of mackerel eggs the schooner *Grampus* was detailed to assist in the work, and reported at Woods Hole early in May. Small numbers of eggs had been collected and hatched at the Gloucester and Woods Hole stations in past years, but the handling of them in quantity was a new departure. Arrangements were made for collecting eggs from the traps and pounds south of the cape, and between May 24 and June 19 there were secured 10,870,000, from which 861,000 fry were produced.

The first eggs were received from the *Grampus* on May 24. They were placed in the McDonald hatching-box on the same day, and development progressed until the forming of the embryo, 5 days after fertilization. The following night a heavy thunderstorm occurred, and immediately afterward all the eggs in the house began to assume a sickly appearance, and in 48 hours all were dead. Whether or not this was due to the thunderstorm can not be definitely determined, but it is well known that eggs of other animals have been killed in this way.

From the 9,936,000 collected by the *Grampus*, which was stationed off Chatham, Mass., only 210,000 fry were produced. The balance of the output was hatched from a lot of 828,000 eggs taken from a trap at Squipnocket on June 3.

During the season various forms of apparatus were tried in hatching eggs, but they failed to produce any better results than the McDonald tidal box. At first it was thought that the poor percentage of fry hatched was due to imperfect fertilization, as the wet method was used, but as the season advanced it became evident that the failure was due not so much to the methods employed, but to the fact that the eggs were not healthy when taken, the parent fish having been held in the nets too long. The pound nets are the only apparatus in the vicinity from which spawning fish can be secured, and it is customary to overhaul these only once in 24 hours. The 828,000 eggs referred to above were transported over 14 miles of rough road, being over 4 hours en route, but, notwithstanding this, 75 per cent of them hatched.

Though the dry method of fertilization was used on them, the good results are attributed to the fact that the fish had been in the nets only a few hours. The eggs of the mackerel are very small and measure 24 to the linear inch. They are kept afloat by a large oil globule for the first 24 hours. After that they leave the top and remain in suspension for a short time, when they sink to the bottom, remaining there until they hatch or die.

Scup and sea bass.—Arrangements were made for collecting scup and sea-bass eggs at Hyannis and other points, but none were secured, owing to the total failure of the fishery on the coast this spring.

The station was visited several times during the spring by Commissioner Brice, who personally directed the lobster and mackerel work and arranged for the collection of scup, sea bass, and tautog eggs.

The following table shows the temperature and density of the water at the station from November 1 to June 30:

Temperature and density of water at Woods Hole Station, 1895–96.

November.			December.			January.			February.		
Date.	Temp.	Density.	Date.	Temp.	Density.	Date.	Temp.	Density.	Date.	Temp	Density.
1	52	....	1	47	1,025.4	1	38	1,025.8	1	32	1,026
2	52	....	2	47	1,025.4	2	38	1,025.8	2	32	1,026
3	51	....	3	46	1,025.4	3	38	1,025.8	3	32	1,026
4	50	....	4	45	1,025.4	4	36	1,026.2	4	32	1,025.8
5	51	....	5	42	1,025.4	5	35	1,026.2	5	32	1,025.8
6	51	....	6	42	1,025.4	6	34	1,026.4	6	33	1,025.4
7	51	....	7	42	1,025.6	7	32	1,026.4	7	34	1,025.2
8	51	....	8	42	1,025.8	8	32	1,026.4	8	34	1,025.8
9	52	....	9	42	1,025.8	9	32	1,026.4	9	34	1,025.8
10	52	....	10	41	1,025.6	10	32	1,026.4	10	33	1,025.8
11	51	....	11	40	1,025.6	11	32	1,026.4	11	32	1,025.8
12	50	....	12	38	1,025.6	12	32	1,026.4	12	32	1,026
13	49	....	13	37	1,025.6	13	32	1,026.2	13	32	1,026
14	49	....	14	37	1,025.6	14	32	1,026.2	14	32	1,025.8
15	49	1,025.4	15	36	1,025.4	15	32	1,026.2	15	32	1,025.8
16	49	1,025.3	16	36	1,025.4	16	31	1,026.2	16	32	1,025.8
17	49	1,025.4	17	36	1,025.4	17	31	1,026	17	30	1,026
18	50	1,025.4	18	37	1,025.4	18	32	1,026	18	30	1,026
19	50	1,025.2	19	38	1,025.4	19	32	1,026	19	32	1,026
20	50	1,025	20	38	1,025.6	20	32	1,026	20	31	1,026
21	49	1,025.2	21	38	1,025.6	21	32	1,026	21	30	1,026
22	46	1,025.4	22	37	1,025.6	22	32	1,026	22	30	1,026
23	48	1,025.4	23	38	1,025.6	23	32	1,026	23	30	1,026
24	48	1,025.4	24	39	1,025.6	24	32	1,026	24	31	1,026
25	47	1,025.4	25	39	1,025.6	25	32	1,026	25	31	1,026
26	48	1,025.8	26	39	1,025.8	26	32	1,026	26	31	1,026
27	48	1,025.4	27	39	1,025.8	27	32	1,026	27	31	1,026
28	48	1,025.4	28	38	1,025.8	28	32	1,026	28	31	1,026
29	47	1,025.4	29	38	1,025.6	29	32	1,026	......	......	....
30	47	1,025.4	30	38	1,025.6	30	32	1,026	......	......	....
......	......	....	31	38	1,025.6	31	32	1,026	......	......	....
......	49.5	1,025.37	......	39.7	1,025.5	......	32.8	1,026.1	......	32.3	1,025.9

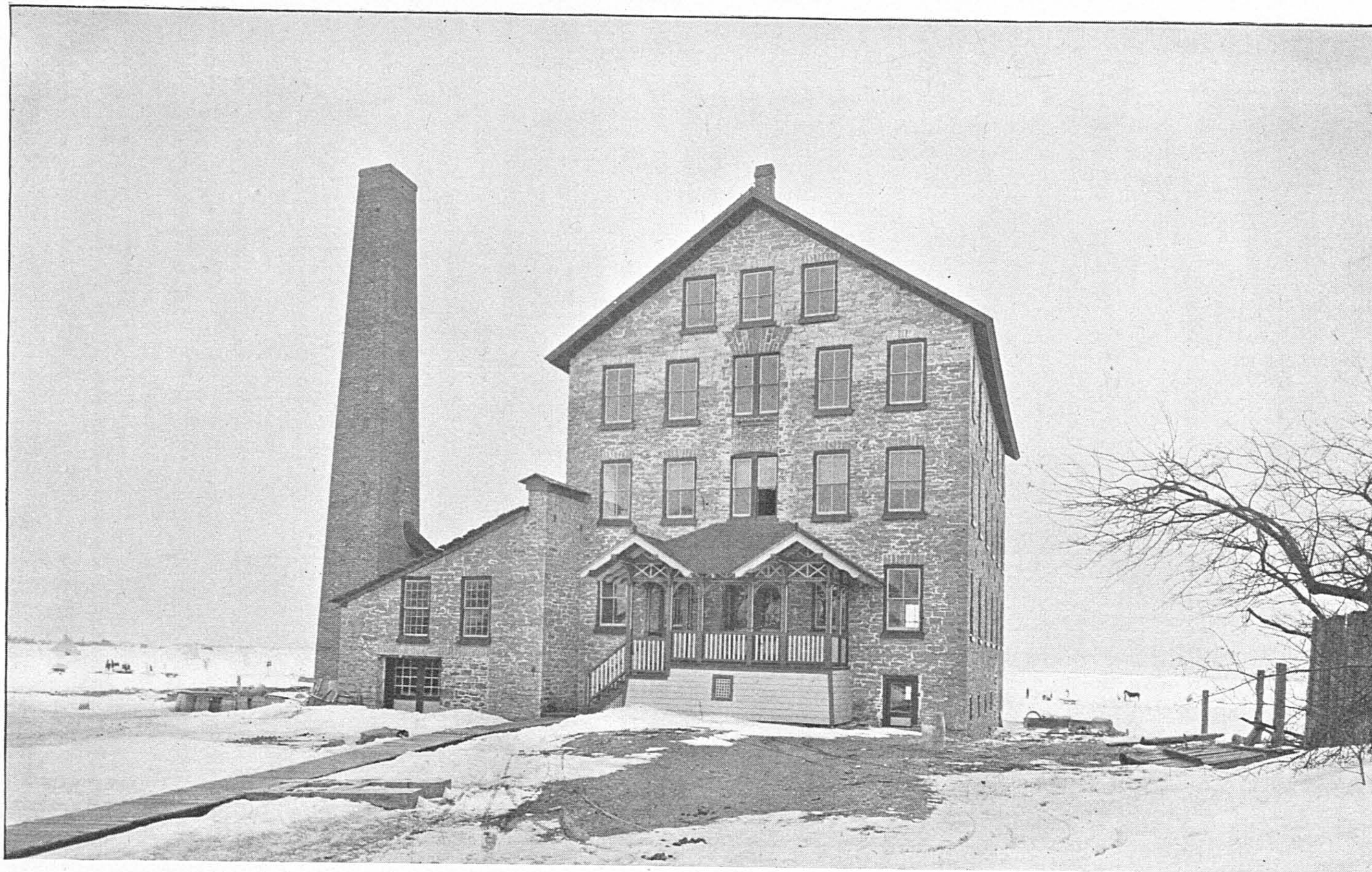
March.			April.			May.			June.		
Date.	Temp.	Density.	Date.	Temp.	Density.	Date.	Temp.	Density.	Date.	Temp.	Density.
1	32	1,026	1	36	1,025.8	1	46	1,025	1	60	1,024.5
2	33	1,026	2	36	1,025.8	2	46	1,025	2	60	1,024.5
3	33	1,026	3	35	1,025.8	3	47	1,025	3	61	1,024.5
4	32	1,026	4	35	1,025.8	4	48	1,025	4	62	1,024.5
5	31	1,026	5	35	1,025.8	5	49	1,025	5	63	1,024.5
6	31	1,026	6	36	1,025.6	6	49	1,025	6	63	1,024.5
7	31	1,026	7	36	1,025.6	7	50	1,025	7	62	1,024.5
8	32	1,026	8	36	1,025.6	8	50	1,025	8	62	1,024.5
9	33	1,026	9	37	1,025.6	9	50	1,025	9	62	1,024.4
10	32	1,026	10	38	1,025.6	10	51	1,025	10	62	1,024.3
11	32	1,026	11	38	1,025.6	11	52	1,025.2	11	62	1,024
12	32	1,026	12	38	1,025.6	12	53	1,025.2	12	61	1,024
13	31	1,026	13	39	1,025.6	13	53	1,025.2	13	62	1,024
14	31	1,026	14	39	1,025.6	14	53	1,025	14	62	1,023.8
15	31	1,026	15	40	1,025.6	15	54	1,024.6	15	60	1,023.8
16	31	1,026	16	42	1,025.6	16	55	1,024.4	16	61	1,023.8
17	31	1,026	17	44	1,025.6	17	56	1,024.4	17	62	1,023.6
18	32	1,026	18	44	1,025.8	18	57	1,024.2	18	64	1,023.6
19	32	1,026	19	44	1,025.8	19	57	1,024.8	19	66	1,024
20	33	1,026	20	44	1,025.8	20	57	1,024.8	20	65	1,024
21	32	1,026	21	44	1,025.8	21	56	1,024.8	21	65	1,024
22	33	1,026	22	44	1,026	22	54	1,024.8	22	66	1,024
23	33	1,026	23	44	1,026	23	55	1,024.8	23	66	1,024
24	33	1,026	24	44	1,026	24	56	1,024.8	24	67	1,024
25	33	1,026	25	44	1,025.8	25	55	1,024.6	25	66	1,024
26	34	1,026	26	44	1,025.8	26	55	1,024.6	26	65	1,024
27	34	1,026	27	45	1,025.6	27	55	1,024.5	27	66	1,024
28	34	1,026	28	46	1,025.6	28	56	1,024.6	28	66	1,024
29	34	1,025.8	29	46	1,025.4	29	58	1,024.6	29	66	1,024
30	34	1,025.8	30	46	1,025.2	30	59	1,024.8	30	66	1,024
31	35	1,025.7	......	......	....	31	59	1,024.5	......	......	....
......	32.5	1,026	......	40.5	1,025.7	......	53.3	1,024.8	......	63.3	1,024

CAPE VINCENT STATION, NEW YORK (H. D. DEAN, SUPERINTENDENT).

H. D. Dean was appointed superintendent of this station on July 1 and shortly afterwards the work of remodeling the old planing-mill and fitting it up as a hatchery was commenced, under the general direction of I. S. K. Reeves, consulting engineer of the Commission, and G. E. David, who directed the installation of the machinery and the carpenter's work. By the latter part of October the hatchery, though not entirely completed, was in readiness to receive whitefish and lake-trout eggs, being equipped as follows: The basement of the building was fitted with 36 troughs for hatching brook trout and salmon, giving a capacity for about 4,000,000 eggs. A battery of 600 jars for hatching whitefish and pike-perch eggs was erected on the second floor, and the third floor was fitted up as offices for the superintendent and bedrooms for the employes.

The question of procuring an adequate supply of eggs for this station is a serious problem, as the laws of the State of New York prohibit fishing with nets within 1 mile of the shores, which practically includes all of the spawning-grounds except Chaumont Bay, where net fishing is allowed all the year round, but where few spawning whitefish or lake trout are ever found. As large numbers of both species are caught in Canadian waters during the close season, it was intended to make an effort to cooperate with the fishermen, but before arrangements could be completed the project was abandoned, as it was intimated that the Canadian authorities would object. Arrangements were then made with the Lake Ontario Fish Company to operate two pound nets by permission of the State Fish Commission on the spawning-grounds between the St. Lawrence and Stony Point, which is within the mile limit. It was proposed to catch the fish in October and November and hold them in pounds until they matured, the Commission furnishing the apparatus and receiving all the ripe fish, while the company was to set the pounds and operate them, receiving as compensation all fish caught after the Commission had stripped them. Owing to delays in securing the necessary apparatus, however, and the difficulty in obtaining a permit to use the company's steamer in American waters, on account of its being a Canadian bottom, this plan also had to be abandoned.

Lake trout.—During the early fall the superintendent visited the fishermen at various points in Lake Ontario on the American and Canadian sides, and arranged for the collection of eggs on Charity Shoals and Pigeon Island, but owing to the very rough weather prevailing during the spawning season, which lasts but a short time in this vicinity, only 54,000 eggs were secured. These were taken during the latter part of October. In November two consignments, aggregating 3,600,000, were transferred from the Northville station. The first arrived in good condition and yielded excellent results, but the last, numbering about 2,600,000, received November 26, were very poor and



HATCHERY AT CAPE VINCENT, NEW YORK, FROM MAIN STREET.

only about 30 per cent of them hatched. This was probably due to the fact that the eggs had been held longer than usual on the shipping trays, and also because they were shipped before the eye-spots appeared. The total output of lake trout fry during the season was 1,650,000. Of these, 53,000 were furnished to applicants in New York and the balance were planted in Lake Ontario and its tributaries.

Whitefish.—Arrangements were made to collect eggs at Chaumont Bay, but the catch of fish at that point was so small that less than 1,000,000 eggs were secured. During the month of November 26,500,000 eggs were sent from the Put-in Bay Station; they arrived in excellent condition, especially one lot of 5,000,000, which had been shipped from Toledo by messenger. The loss on these shipments during the winter amounted to 25 per cent, and in April the 20,000,000 fry resulting from them were deposited in the St. Lawrence River and Lake Ontario in the vicinity of Grenadier Island and Tibbits Point.

Rainbow trout.—The rainbow-trout eggs received from Wytheville arrived in good condition, apparently, but they soon commenced dying and only 6,600 fry were produced from them for distribution. It is probable that the change in temperature proved injurious to them, as the water from which they were taken averaged 54°, whereas the temperature at this station was scarcely above the freezing-point throughout the winter.

Brook trout.—From the 25,000 eggs received from Northville, 22,100 fry were hatched and distributed to applicants in New York.

Atlantic salmon.—The Atlantic salmon eggs received from Craig Brook Station on January 30 were hatched with slight loss, but owing to an accident, whereby the water was turned off the troughs for 12 hours, they were all lost on May 24. During the winter considerable difficulty was experienced with roily water, and at times slush ice was forced around the suction pipe so that no water could be pumped. It is recommended that this pipe be protected by crib-work before next season opens. Owing to the difficulties encountered in procuring an adequate supply of suitable water, it is urged that arrangements be made with the Cape Vincent Waterworks Company to supply the station from the city works.

STEAMER FISH HAWK (LIEUT. FRANKLIN SWIFT IN CHARGE).

The steamer *Fish Hawk* left Washington on April 28, arriving at Gloucester, N. J., on the 30th, where a steam launch, spawning boats, and hatching apparatus, which had been shipped from Woods Hole, Mass., were taken on. Permission having been obtained from Capt. N. H. Farquhar, U. S. N., the vessel then proceeded to League Island navy-yard and moored alongside the wharf in an advantageous position for receiving a good supply of water for hatching purposes. This point was selected as headquarters, as it was believed that the water there was as good if not better than that at Gloucester, where operations had previously been conducted, and because it was nearer to the collecting field. The facilities for shipping the fry were also much better. In addition to the regular crew of the vessel, a number of spawn-takers were transferred from other stations to assist in the work. The hatching apparatus was arranged as usual on the main deck, Mate James A. Smith having charge of it. The collection commenced on May 4th, 697,000 shad eggs being secured on that date from the seine at Howell Cove and from gillers in the vicinity. The work was prosecuted successfully from that time until May 21, by which time 20,930,000 eggs had been collected.

Shortly after the eggs were placed in the jars there appeared to be an undue percentage of loss, and many of the fry in the aquaria settled to the bottom, apparently not having enough vitality to sustain themselves. Since the hatching apparatus was identically the same as in former years, it became evident that the cause of loss must be looked for in the water supply. It was apparently much freer from sediment than that at Gloucester, yet it was suspected to contain oily residue from the petroleum refineries at Point Breeze on the Schuylkill and sulphurous or ammoniacal solution from the gas works on the river. It is also possible that an abnormal condition of the water might have been produced by the stirring of mud by the dredge operating along the water front of a portion of the yard. It was thought advisable to transfer the vessel to Gloucester, and the change was made on May 21. From this point the work of collection was resumed and continued until June 16, resulting in a total collection of 37,874,000 eggs, which produced 22,056,000 fry. In addition to this, 1,183,000 eggs were furnished to car No. 2 for hatching and liberating at Sanford, Fla.

Of the eggs collected, 12,134,000 were obtained from gillers, 580,000 from Gloucester Point, 6,500,000 from the seine at Bennett's shore, and 18,660,000 from the Howell Cove seine. It was impracticable to attend the seines above Philadelphia, owing to their distance from the vessel, and it is recommended than an additional launch be provided next season for the purpose of attending the fishing shores above that city, as many million eggs might be obtained there. The method of collecting was the same as in former years, the steam launch leaving the vessel each afternoon with five spawn-takers and returning during the night or early next morning.

It is recommended that the vessel make its headquarters in Howell Cove, at Washington Point, next season, as it is the center of the spawning-grounds below Gloucester, and more than half the eggs secured this year were collected in its immediate vicinity. In addition to this, the water there is more suitable for hatching purposes than at Gloucester or League Island, as two large fresh-water streams flow into it above and below. It also possesses good railroad facilities and has excellent means of communication with Philadelphia.

During the season 12 Atlantic salmon were taken by the seine at Howell Cove, and the capture of a large number was reported from seines above Philadelphia.

The following table shows the number of shad eggs collected, fry hatched and planted, and temperature of the water:

Date.	Shad.		Number of eggs.	Date of hatching.	Number hatched.	Temperature.	
	Males.	Females.				Air.	Water.
1896.							
May 4	17	17	697,000			68	62
5	50	50	1,876,000			68	63
6	34	34	1,606,000			70	63
7	46	46	2,122,000			60	63
8	30	30	1,340,000			78	64
11	54	54	2,302,000			78	66
12	38	38	1,612,000	May 10-12	2,279,000	80	68
13	14	14	622,000			67	68
14	37	37	1,575,000			70	69
15	49	49	2,036,000			74	70
16	7	7	239,000	May 12-17	5,130,000	74	71
18	67	67	2,584,000			76	72
19	22	22	861,000			73	72
20	26	26	1,468,000			59	70
21	30	30	1,427,000			61	70
22	39	39	1,730,000	May 18-24	2,319,000	68	70
25	42	42	2,048,000			60	69
26	35	35	1,675,000			72	69
27	34	34	1,648,000			71	70
28	8	8	286,000			69	70
29	24	24	1,235,000			69	70
June 1	42	42	1,970,000	May 25, June 1	5,807,000	66	70
2	28	28	1,419,000			68	70
3	14	14	571,000			66	70
4	19	19	966,000			67	70
5	16	16	649,000			74	73
9	11	11	294,000	June 3-8	5,071,000	73	74
11	13	13	550,000			69	74
12	8	8	387,000			69	73
15	2	2	79,000	June 9-15	1,450,000	68	72
	850	856	37,874,000		22,056,000		

At the close of the fishing season on the Delaware the vessel was instructed to proceed as soon as possible to Casco Bay via Woods Hole, to take up the mackerel and lobster work. It left Philadelphia on June 18, and arrived at Woods Hole on the afternoon of the 20th, where it remained long enough to take on the apparatus necessary to conduct operations with those species. Orr Island, in Casco Bay, was selected as headquarters, as it is in easy communication with Portland and Boothbay. It was also the headquarters of a large number of the mackerel drag-net fishermen. Operations were commenced at once, the regular crew being detailed as spawn-takers to go out with the drag-net boats and to attend the traps in the vicinity. The schooner *Grampus*, which had been detailed to assist in the work, was stationed at Small Point, Me., for the purpose of attending the traps in that locality, the steam launch transferring the eggs daily to the *Fish Hawk*.

It was soon found that while the traps about Cape Small took quite a number of spawning mackerel, those in the central part of the bay took scarcely any, and it became necessary for the crew to rely entirely on the drag-netters for eggs. The great majority of spawning mackerel taken in these nets died before the eggs could be secured, and those which were alive produced but few, having no doubt emitted the greater part of the ripe ones on account of worry consequent on capture. The same was found to be true of the fish taken in the traps.

Although the season was quite far advanced when the work was undertaken, it is doubtful whether any better results could have been attained had operations been commenced earlier, as the small number of eggs was not due to the fact that the fish had spawned at an earlier date, but that the fish died before they could be handled by the spawn-takers. As this work was in the nature of an experiment, three forms of apparatus were used in hatching—the McDonald jar, with bottom feed and overflow through cheese-cloth at the top; the McDonald tidal box, and the Chester cod box. The McDonald box gave the best results. The first eggs were taken on June 24, and by the end of the month 6,935,000 had been secured. A few additional collections were made early in July, and operations were discontinued on the 13th, the total number of fry hatched and liberated being only 213,000. At the beginning of the season the eggs were fertilized by the wet method, and as it was thought that the lack of success might be due to this fact, careful experiments were conducted with both the wet and the dry methods, but without affecting the result. Later in the season the dry method was adopted for general use.

As already stated, it seems probable that the poor results were due more to the conditions under which the eggs were collected than to the methods employed in hatching them. When received at the vessel they were apparently all impregnated, and development proceeded normally for two or three days, by which time the embryo would be perfectly formed. In some cases a small proportion of the fish would hatch and live from 6 to 8 hours, but the rate of development was usually as follows: The embryo was first noticeable 48 hours after placing in the jars; after 60 hours it would be well formed, and at the end of 72 hours development stopped, the eggs dying by the end of the 84th hour. In cases where they hatched, the length of time required was 5 days, in an average temperature of 58°. It soon became evident that the fry hatched could not be retained, and they were liberated at once in Merryconeag Sound.

The nets producing the fish from which most of the eggs were secured were set from 5 to 10 miles offshore. They were examined regularly at sunset and again the next morning, the best eggs being obtained from the fish taken at sunset.

It is recommended that the work be undertaken earlier next season, and that Casco Bay be made the headquarters for mackerel operations, as large numbers of pounds and traps are fished there, and because of its facilities for communication with other parts of the State.

Lobster.—Permission having been granted by the Maine Commission of Sea and Shore Fisheries to collect and hold egg-bearing lobsters, Mr. M. B. Spinney, of Small Point, Me., was engaged during the mackerel season to interview the lobster men operating between Portland and Boothbay with the view to arranging for the collection of seed lobsters, he having been in the business for a number of years and being well acquainted along the coast. By the 30th of June 100,000 eggs had been collected at Orr Island. At the close of the mackerel season the vessel left Casco Bay and established headquarters at Boothbay, the *Grampus* being stationed at Rockland, in the vicinity of the large lobster pounds. By this arrangement it was expected to cover the entire coast of Maine. The owners of the large pounds in the vicinity of Vinal Haven, Westport, and Boothbay, and also the dealers in Portland, agreed to notify Lieutenant Swift whenever they received seed lobsters, and permission was obtained to overhaul the lobsters already impounded. Large numbers were examined daily, but only one or two out of a thousand were found with ripe eggs, and it appeared that operations were commenced too late and that the spawning season of the lobster on the Maine coast occurs about the same time as on the Massachusetts coast. Large numbers were brought from Nova Scotia to the various pounds, but no ripe ones were secured, though many of them had young eggs.

Operations were continued till August 3, the season's work resulting in the collection of 654,655 eggs, from which 322,000 fry were hatched. These were liberated in the immediate vicinity of the vessel as soon as hatched. Though the results were poor, it is thought that the work can be made successful next year by establishing the headquarters of the vessel at either Boothbay or Orr Island. The lobster men have been initiated and thoroughly understand the work, and are willing to cooperate with and assist the Commission in its future efforts. It is recommended that arrangements be made next year as early as March or April, and that men be employed to commence the collection of seed lobsters and hold them in suitable pounds along the coast. Large numbers could undoubtedly be obtained from the large pound-owners, who sometimes have from 60,000, to 150,000 on hand.

On August 3 the *Fish Hawk* returned to Woods Hole and the *Grampus* to Gloucester.

BATTERY STATION, MARYLAND (W. P. SAUERHOFF IN CHARGE).

The station was closed and under the charge of the custodian, Mr. Charles Healey, from July 11 to March 23, when J. J. Glennan reported and commenced repairing and fitting up the launches and machinery. On March 31 W. P. Sauerhoff arrived and began fitting up the hatchery and getting the necessary collecting and hatching apparatus in order for the season's work. By April 17 the station was thoroughly equipped and operations were commenced with a force of 36 men. The collection of eggs was continued to June 4, the total receipts for the season being 45,893,000. From these, 36,117,000 fry were hatched and planted and 1,165,000 eyed eggs were shipped. Arrangements were made to collect eggs at all of the floats and shores, but, with the exception of the seine at Carpenter Point, none were received from that source, although spawn-takers attended the haulings regularly from the beginning of the season to the 10th of May. The gillers took more interest than ever before in the work of the Commission and furnished one-fifth of the season's take, for which they were paid at the rate of $20 per 1,000,000.

The following table shows in detail the number of eggs taken and fry hatched and distributed during the season:

Summary of shad eggs taken, fry hatched, and fry and eggs distributed during the season of 1896 at Battery Station, Maryland.

Date.	Eggs taken.	Eggs lost during hatching.	Eggs shipped.	Fry hatched.	Fry distributed.
1896.					
Apr. 17	60,000	40,000	....	20,000	....
18	755,000	392,000	....	363,000	....
19	1,055,000	400,000	....	655,000	....
20	300,000	22,000	....	278,000	....
21	210,000	115,000	....	95,000	....
22	505,000	106,000	....	399,000	....
23	428,000	103,000	....	325,000	....
24	570,000	98,000	....	472,000	....
25	440,000	37,000	....	403,000	20,000
26	2,195,000	327,000	....	1,868,000	....
27	4,390,000	652,000	....	3,738,000	....
28	2,140,000	315,000	....	1,825,000	200,000
29	2,483,000	472,000	....	2,011,000	818,000
30	3,350,000	568,000	....	2,782,000	....
May 1	3,290,000	644,000	....	2,646,000	....
2	1,800,000	160,000	....	1,640,000	823,000
3	1,130,000	125,000	685,000	320,000	....
4	444,000	129,000	315,000	....	900,000
5	1,130,000	134,000	165,000	831,000	450,000
6	1,945,000	219,000	....	1,726,000	450,000
7	2,298,000	223,000	....	2,075,000	3,000,000
8	1,060,000	107,000	....	953,000	2,500,000
9	970,000	248,000	....	722,000	930,000
10	2,138,000	470,000	....	1,668,000	3,000,000
11	1,224,000	301,000	....	923,000	4,150,000
12	835,000	317,000	....	518,000	450,000
13	690,000	138,000	....	552,000	2,759,000
14	805,000	177,000	....	628,000	1,827,000
15	452,000	122,000	....	330,000	1,000,000
16	170,000	30,000	....	140,000	2,900,000
17	820,000	300,000	....	520,000	1,668,000
18	670,000	253,000	....	417,000	450,000
19	403,000	92,000	....	311,000	991,000
20	55,000	7,000	....	48,000	....
21	300,000	23,000	....	277,000	730,000
22	507,000	89,000	....	478,000	450,000
23	690,000	133,000	....	557,000	450,000
24	523,000	112,000	....	411,000	....
25	675,000	80,000	....	595,000	450,000
26	630,000	116,000	....	514,000	500,000
27	580,000	80,000	....	500,000	540,000
28	115,000	15,000	....	100,000	....
29	20,000	2,000	....	18,000	....
30	....	....	....	....	750,000
31	230,000	65,000	....	165,000	688,000
June 1	135,000	10,000	....	125,000	706,000
2	25,000	5,000	....	20,000	1,014,000
3	45,000	5,000	....	40,000	118,000
4	148,000	33,000	....	115,000	....
5	....	....	....	....	290,000
8	....	....	....	....	175,000
Totals	45,893,000	8,611,000	1,165,000	36,117,000	36,117,000

The indications at the opening of the season seemed favorable for a large collection, and the eggs taken up to May 8 were exceptionally good, very small losses occurring. This was probably due to the low and uniform temperature of the water, which ranged from 58 to 63 degrees from April 22 to May 9, also to the absence of sediment, the water being discolored only once or twice, and then but slightly. The catch fell off greatly about May 11, however, and, though the station was kept in operation until June 4, only twice did the night's collections exceed 800,000. The weather as a rule was unfavorable, easterly winds prevailing most of the time, and, although no freshets occurred during the season, frequent and violent thunderstorms at sunset often prevented the gillers from fishing. On May 31 all but six of the spawn-takers were discharged. These were retained until June 6 for the purpose of deciding whether it was advisable to keep the station open after the end of May. For many years past, after the station had been closed, rumors became current regarding the large quantities of shad eggs which might have been secured had the station been in operation. The experience gained this year, however, showed that few gillers fish after that time and that the supply of eggs is not sufficiently large to warrant the expense of keeping the station open.

During the season an effort was made to obtain striped-bass eggs, but without success. Few striped bass were caught in the vicinity during the spring, and it is doubtful if any eggs could have been secured from those taken in trammel nets, as the nets are anchored out during the night and when taken up the next day most of the fish are dead.

During the run of herring in April 10 cases, containing twenty-four 2-pound cans each of roe, were put up and shipped to Craig Brook and Wytheville stations, to be used as trout food.

CENTRAL STATION, WASHINGTON, D. C. (S. G. WORTH, SUPERINTENDENT).

The fish-cultural operations included, as in former years, the distribution of the year's production of the fish ponds in Washington and the hatching of shad eggs collected on the Potomac River. In addition to this, 812,000 yellow-perch fry were produced and distributed, and three consignments of trout eggs (lake, rainbow, and Von Behr), transferred from Northville, Wytheville, and Green Lake stations, were hatched and planted. The following table shows the number of eggs hatched at the station and the number of fish distributed:

Species.	Number received.	Number hatched.	Number distributed.
Shad	44,174,000	36,520,000	36,529,000
Yellow perch	812,000	812,000	812,000
Lake trout	10,000	8,947	8,947
Rainbow trout	15,000	12,640	12,540
Von Behr trout	10,000	8,422	8,422

Yellow perch.—In March 600 adult yellow perch, collected in the Potomac River by Mr. L. G. Harron, were placed in the aquarium and held until the middle of April, when they yielded 812,000 eggs, which were hatched in the McDonald jars without loss. The results attained were disappointing, as the fish handled at the station in 1889 produced a much larger number of eggs. This was probably due to the fact that this season's fish were smaller than those.

Shad.—Consignments of shad eggs from Bryan Point were received daily from April 22 to June 17, with the exception of May 17 and 30 and June 7 and 14. During this period 44,174,000 eggs were handled, from which 36,529,000 fry were hatched and distributed. Though the output was in excess of any previous year's production excepting those of 1887, 1888, and 1895, the results were disappointing, inasmuch as the collections on the Potomac amounted to more than 64,000,000 eggs.

The large loss in hatching, amounting to 17 per cent, was due not only to the poor quality of the eggs when received, but also to the stoppage of the water supply for twelve hours, which caused a loss of about 3,000,000 eggs and fry. This occurred when the station was in full operation. It was apparently caused by a large quantity of material in the water, resembling rotten wood, bark, and leaves, and as the water was received and discharged through closed piping it was impossible to filter it.

Repairs and improvements.—The interior of the station was painted during the summer, and the equipment was enlarged by the addition of a can-cleaning apparatus and a steam air-pump. The can-cleaner consists of a flexible shafting, encased in leather and geared to the machine-shop shafting by belting. A brush attached to the free end revolves rapidly, cleaning and polishing the tin. It fails to remove rust, however, even with the aid of pumice stone. The pump was purchased to provide against losses of fish held at the station in case of stoppage of the water supply, as occurred on December 9, when, by order of the District authorities, the supply was diverted from the building on account of street improvements. The fish were saved on that occasion by using ice and aerating the water by hand.

Aquarium, Central Station (L. G. Harron in charge).

From August 1, 1895, to January 4, 1896, the superintendent was stationed at Atlanta, Ga., having been detailed for duty in connection with the Cotton States and International Exposition. He was again detached from the aquarium on April 1, and assigned to duty in connection with shad propagation on the Potomac River at Bryan Point, Maryland, where he remained until the middle of June.

During the summer the grotto was closed on account of the high temperature and the consequent difficulty of maintaining the supply of fishes. In October collections of marine specimens were transferred to Washington from Old Point, Virginia, and from time to time consignments of sea-anemone, starfish, and lobsters were sent from Woods Hole and Gloucester stations by express.

In addition to these collections, 160 marine specimens that had been exhibited in the Atlanta Aquarium were transferred to Central Station aquarium on January 5. A few of these survived to the close of the year, but the majority died during the spring, owing to high temperature of the water. The salt water for the marine species is about half natural and half artificial, the supply being kept up by shipments from the Chesapeake Bay and by the use of Turks Island salt and fresh water.

Most of the fresh-water fishes exhibited during the year were collected at various points on the Potomac, though several consignments were received from the stations in Washington and Wytheville, Va.

The only marine fish observed to spawn in the aquarium during the year was a flounder. This occurred on April 28. The eggs were placed in a small aquarium fitted with air circulation, but they failed to hatch, probably on account of imperfect fertilization.

The only fresh-water species that spawned were two small yellow perch—on April 1 and 2. The eggs were placed in the McDonald jars and hatched without difficulty.

It is deemed worthy of mention that so few fresh-water fishes have ever spawned in the aquarium. The reason for this is attributed to the use of alum in filtering the water, since the fishes that have spawned had been held in the water only a few months, and though some of them lived for three years afterwards, they never spawned a second time. Apparently there is no filter in the market that will provide a sufficient amount of water for the aquarium except those requiring the use of alum as a coagulator. If a sufficient supply of cool water could be obtained from a well, thus obviating the necessity for a filter, there would be no difficulty in maintaining an excellent exhibit throughout the year. With the present equipment the fishes can be held only from October to the end of June.

Following is a list of marine and fresh-water fishes shown during the year:

List of species of fishes, crustaceans, etc., exhibited at Central Station aquaria during the fiscal year ending June 30, 1895.

Species.	No.	Species.	No.	Species.	No.
Salt-water:		Salt-water—Continued.		Fresh-water—Continued.	
Pinfish	34	Sea raven	2	Mirror carp (adult)	4
Pigfish	43	Sea robin	1	Golden ide (adult)	4
Croaker	30	Sea trout	11	Golden tench (adult)	8
Sea bass	46	Mummichog	30	Common tench (adult)	12
Red drum	7	Sea anemone	100	Yellow perch (adult)	50
Burfish	25	Scup	4	White perch (adult)	12
Spots	31	King crab	4	Sunfish	50
Sheepshead	20	Blue crab	30	Rock bass (adult)	10
Striped mullet	13	Spider crab	10	Rock bass (yearling)	30
Black grouper	4	Lobsters	6	Mill roach (adult)	20
Red grouper	2	Fresh-water:		Fresh water smolt (adult)	30
Red snapper	7	Rainbow trout (adult)	14	Chub sucker (adult)	6
Filefish	6	Rainbow trout (yearling)	40	Yellow catfish (adult)	10
Black drum	1	Brook trout (yearling)	120	Channel catfish	13
Tautog	28	Von Behr trout (yearling)	79	Goldfish	50
Swellfish	3	Black bass (L. M. adult)	19	Lace-fin daco	30
Toadfish	12	Black bass (S. M. yearling)	100	Crappie	3
Rockfish	3	Black bass (L. M. yearling)	100	Paradise fish	20
Flounder	6	Leather carp (adult)	6	Dogfish	13
Pompano	4	Scale carp (adult)	4	Common eel	20
Hog-choker	20			Fresh-water terrapin	6
Stingray	2			Snapping turtle	4
Yellow-tail	20				
Young shad	300				

CARP PONDS, WASHINGTON, D. C. (RUDOLPH HESSEL, SUPERINTENDENT).

Following is a summary of the kinds and number of fish furnished by this station for distribution during the year: Carp, 91,105; goldfish, 2,137; black bass (large-mouth), 5,959; black bass (small-mouth), 1,208; tench, 50,363; golden tench, 44; golden ide, 87; shad, 1,000,000.

The carp furnished were of three varieties, leather, scale, and blue. The Commissioner having decided to discontinue the distribution of this fish, arrangements were made during the spring of 1896 to hatch and rear large numbers of them for food for the young bass, and it is estimated that about 600,000 were used for this purpose during the months of May and June, the ponds west of Seventeenth street producing 300,000 and the tanks 300,000. They were fed to the bass as soon as they had attained a length of from one-fourth to 1 inch.

The distribution of tench and goldfish having been discontinued, efforts were made to rear only a sufficient number for stocking the ponds and fountains in the public parks of Washington.

Rock bass.—The 39 brood fish from Wytheville, which had failed to spawn during the season of 1895, were placed in the new pond between the Monument and west pond early in April, 1896. They spawned in May, and while it is impossible to give the exact number of young fish on hand at the close of the year, it is estimated that there are several thousand in the pond, varying in length from one-half to three-fourths inches.

Large-mouthed black bass.—The north pond, having an area of 4½ acres, was devoted to the rearing of this species. When drawn down in November, 1895, it was found to contain 6,000 fish from 3 to 6 inches long. These were transferred to Central Station for distribution to applicants in the East, and the pond was laid bare for the winter and an effort made to remove the poisonous grasses and insects by scraping the bottom. Early in April, 1896, 23 spawners were placed in the main body of the large pond and 17 in a small portion partitioned off at its southwestern end. Ponds 5 and 6 were were also stocked with 12 spawners each at about the same time. On April 25 the bass were observed preparing nests, and by the 26th a few were completed. These continued to increase in numbers, and the first eggs were discovered on the 28th.

In order to simplify the handling of the young fish 24 artificial nests were constructed and placed in the ponds. They were circular in form, 2 feet in diameter and 3 inches deep, made of cement, and covered while fresh with a layer of fine gravel. Although they resembled the natural nests very closely and were placed in favorable locations, no results were obtained from them. The experiment will be tried again next year, however, as the failure is thought to have been due to the fact that they were placed in the ponds late in the season. As the bass spawn late in the afternoon or very early in the morning, the process was observed only once.

On May 12, the first young fish were noticed, and from that time the number increased daily. Up to the age of eight days the ponds afforded them an abundance of natural food, consisting principally of species of *Rotatoria*, *Hydatina*, and *Euchlanis*. These constituted the first food of the young fish, as disclosed by microscopic examination of the contents of the enlarged pharynx. After the eighth day that class of food apparently proved to be insufficient, as they appeared to be looking for more substantial matter. At the age of two weeks carp, from 8 to 11 days old, were supplied and were eagerly eaten by the young bass. The carp were fed them until some time in June, when finely chopped fish were substituted.

Owing to the fact that the young fish attain different sizes and prey upon each other, the output from the ponds heretofore has been very small, and it was determined this season to attempt the rearing of them in small ponds and tanks located on the terrace in front of the cottage. Between the 1st and 12th of June 5,000 were transferred to the tanks and held for a few days, when they were assorted according to size and placed in small rectangular ponds. They were fed regularly on chopped fish, and as the ponds were well stocked with plants they also obtained a certain amount of natural food.

During the first two weeks the losses in the tanks were heavy, but this was accounted for by the high water-temperature, which ranged from 92° to 95°, and by its muddy condition. The sudden change from the comparatively clear water of the ponds to the hydrant water greatly impaired the health of the young fish, as the organs of respiration were visibly affected, even after a very short stay in the tanks. The epithelium of the lamellæ of the gills would become covered with a slimy, veil-like scum, and those so affected usually died during the second or third night. As many as 30 or 40 dead ones were frequently taken from tanks containing 500, and at one time the death rate reached nearly 60 per cent. Thus from lots of 500 each from 150 to 200 or more perished in a few days after being transferred from the ponds, and the total loss amounted to about 2,000. The transfer of the second lot was made under more favorable conditions, the temperature being lower and the hydrant water clearer. Only about 12 per cent of this lot were lost, and the loss on the third lot amounted to only 3 per cent. At the close of the year 12,270 had been transferred from the north pond to the tanks and small ponds, and indications point to successful results. No difficulty was experienced in keeping from 2,000 to 3,000 in ponds varying from 2,000 to 3,000 square feet in area. They soon learned to take the chopped fish from the feeding boards, and apparently thrived on the food. It is difficult to give even an idea of the number of young bass left in the north pond, on account of the dense vegetation.

Small-mouthed black bass.—When the south pond, containing the small-mouthed bass, was drawn down it was found to contain only about 1,200 yearling fish, which were distributed as usual during the month of December. At the same time the large-mouthed bass were placed in the north pond 30 breeders were put in a small section of the south pond, which had been partitioned off as a spawning-bed. They commenced building nests on April 25, and young bass were noticed on May 13. Although every effort was made to secure good results from this species, the indications are that the total output will not exceed two or three thousand. Attempts were made to remove the young fish from the ponds by the same method employed with the large-mouthed species, that is, with fine-meshed seines, but up to the close of the year only a few specimens had been caught. It is thought that the poor success with this species was due to the high temperature of the water. They were fed on the same material as the large-mouthed bass, namely, natural food in the ponds during the first stages, then young carp, and afterwards finely chopped fish.

Shad.—During the latter part of October the shad fry which had been placed in the west pond in April, 1895, were liberated. It is impracticable to count these fish, but the number liberated was estimated at 1,000,000. They had attained a length of from 3 to 5 inches and were apparently strong, healthy fish, having had an abundance of food throughout the summer. In liberating them in the Potomac they were permitted to pass out the gates gradually at night, as it is believed that they would be destroyed by the immense schools of white and yellow perch lying outside the gate if liberated during the day. The pond was left bare during the winter in order to destroy noxious weeds and plants.

Between April 25 and 28, 1896, 2,333,000 fry were introduced into the pond. At the cl se of the year large numbers could be seen, though they had not attained as large size as in past seasons.

BRYAN POINT STATION, MARYLAND (S. G. WORTH, SUPERINTENDENT).

With the view to increasing the output of shad fry, the allotment for the propagation of that species on the Potomac was increased from $4,000 to $6,000, and arrangements were made to push the work to its utmost capacity. L. G. Harron, superintendent of the aquarium, was detailed to assist in the work, and reported for duty on April 1.

In addition to the launch *Petrel*, which was utilized between Bryan Point and Alexandria, a steam tug was chartered, which, with a large force of spawn-takers, attended the gillers and seines between Gunston and Freestone Point, commencing April 20, and covering daily about 15 miles, until May 23, when the vessel was released and the spawn-takers attached to it discharged.

The returns from this section of the river were disappointing in view of the fact that more than a third of the funds available were expended here, while the collections amounted to only 15½ per cent of the total take. A like result may be experienced any season, however, as the spawning-grounds of the shad vary with the condition of the river and the lateness of the season. This year, owing to absence of rain, the fresh water diminished and the salt water backed far up the river.

The collection of eggs commenced in April and ended on June 17, resulting in the procurement of 64,362,000. This exceeded the take of any previous year excepting 1888 and 1895, when the collections amounted to 81,179,000 and 66,055,000, respectively. The quality of the eggs was exceedingly poor, however, probably because of the high temperature of the water which prevailed throughout the season. They were derived from 5 haul seines and 121 gill nets, the seines producing 8,477,000. Of eggs collected from shad caught in gill nets, 33,234,000 were taken by 8 gillers, an average of 4,154,000 to each man. The other gillers employed averaged only about 204,000. These men operated within sight of the station and within a radius of 2 miles.

The eggs were held at Bryan Point from 12 to 36 hours and then packed on wire trays overlaid with wet cloths and shipped to Central Station by the Washington and Mount Vernon boat. Transfers were made daily from April 22 to June 17, except on May 17 and 30 and June 7 and 14. The shipments in April amounted to 19,817,000; in May 31,572,000, and in June 13,399,000, an average of 2,202,000 per day in April, 1,018,000 in May, and 788,000 in June.

The force was reduced on May 23, when the services of the tug were discontinued, and again on the 29th, only a sufficient number of men being retained to store the property and attend the gillers operating within easy distance of the station; that is, between Mount Vernon Pier and River View.

The cost of making collections this season amounted to only $47 per 1,000,000, whereas the average cost in previous seasons has been about $80 per 1,000,000.

The eggs during the entire season were poor in quality, and were inferior to any taken in previous years. Only 44,000,000 of those collected were delivered at Central Station, and the total loss, amounting to 43 per cent, was increased by the accidental destruction of 3,000,000 eggs and fry in Central Station. From 1885 to 1892 the difference between the eggs collected and the output from Central Station ranged from 11.44 to 41 per cent, the average loss being 25.47 per cent. Of this, 14.94 per cent represented the loss from time of collection to delivery at Central Station, and 10.53 per cent the subsequent loss in hatching. The bulk of the run of shad appeared on a rapidly ascending temperature, and it is probable that the eggs were of poor vitality when taken, as the rise in temperature was greater than had been recorded in 11 years preceding. The temperature of the water at the station registered 46° on April 10, 48° on the 12th, and on the 21st, when large collections were being made, it reached 71°, a rise of 25° in ten days. Though the catch of shad was enormous up to and including April 21, after which it commenced falling off, the total catch probably fell short 50 per cent, the season being one of the most unprofitable ever known on the upper river to the fishermen. Seines which took 150,000 shad in 1895 took only 30,000 in 1896.

During the season an examination was made for a new site for a shad station, but no place was found to possess superior advantages over Bryan Point.

For the successful operation of this station in future it is recommended that two suitable launches be provided in order that all of the seines and gill nets fishing between Alexandria and Freestone Point may be attended; also that the daily shipments of eggs to Washington be made by launch instead of by steamboat, as heretofore.

Following is a record of the air and water temperatures at Bryan Point during the months of April, May, and June:

Record of air and water temperatures at Bryan Point.

Date.	Air.				Water.			
	6 a.m.	Noon.	6 p.m.	Mean.	6 a.m.	Noon.	6 p.m.	Mean.
April 1	55	58	48	53⅔	46	46	46	46
2	46	51	45	47	46	47	47	46⅔
3	33	41	39	37⅔	46	46	46	46
4	38	45	40	41	45	45	45	45
5	37	50	46	44	44	45	45	44⅔
6	42	56	46	48	45	46	46	45⅔
7	35	45	39	39⅔	46	46	45	45⅔
8	34	49	42	41	46	46	47	46
9	34	50	48	44	46	46	47	46⅓
10	42	45	45	44	46	46	46	46
11	45	50	50	48	46	46	47	46⅓
12	45	62	67	58	47	48	49	48
13	55	86	72	71	48	50	52	50
14	62	82	79	74	51	54	55	53
15	60	82	80	74	52	55	56	54
16	59	84	82	75	55	57	58	56⅔
17	63	83	85	77	59	61	64	61
18	62	85	85	77	62	63	66	63⅔
19	69	91	81	80	64	68	68	66⅔
20	68	81	81	77	66	68	68	67⅓
21	71	79	75	75	68	71	71	70
22	54	70	66	63	66	68	69	67⅔
23	45	61	60	55	66	68	69	67⅔
24	56	63	61	60	67	69	69	68⅓
25	56	58	58	56⅔	66	66	67	66⅓
26	52	58	60	56⅔	64	66	66	65⅓
27	46	68	62	58⅔	64	65	66	65
28	55	69	71	65	64	65	66	65
29	58	70	74	67	64	67	67	66
30	61	66	56	61	64	67	67	66
May 1	57	58	58	57⅔	63	64	64	63⅔
2	63	68	67	66	63	64	65	64
3	64	72	68	68	64	65	66	65
4	63	71	75	69⅔	64	66	67	65⅔
5	63	88	78	76	64	68	68	66⅔
6	62	74	70	68⅔	64	68	68	66⅔
7	55	67	62	68	64	66	66	65⅓
8	45	63	64	57	63	66	66	65
9	56	72	87	71⅔	67	68	69	68
10	64	80	87	77	68	69	71	69⅓
11	64	87	86	79	69	71	72	70⅓
12	67	86	77	76⅔	69	73	72	71
13	69	86	78	77	70	73	74	72
14	68	80	78	75	71	73	74	72⅔
15	72	80	80	77	72	74	74	73⅓
16	55	74	80	69⅔	72	74	75	73⅔
17	68	89	86	81	74	75	76	75
18	63	90	84	79	74	75	77	75⅓
19	66	92	82	80	75	76	77	76
20	65	60	60	61⅔	75	74	75	74⅔
21	60	65	70	65	74	74	75	74⅓
22	69	82	70	76⅔	74	75	76	75
23	68	76	74	72⅔	74	75	75	74⅔
24	65	68	70	67⅔	74	74	74	74
25	64	74	68	68⅔	72	73	73	72⅔
26	70	82	74	75⅓	73	74	74	73⅔
27	68	85	84	79	73	74	75	74
28	67	85	73	75	74	74	74	74
29	61	75	78	71	72	73	74	73
30	60	84	77	73⅔	72	74	74	72⅔
31	74	88	78	80	73	74	75	74

Record of air and water temperatures at Bryan Point—Continued.

Year.	Air.				Water.			
	6 a. m.	Noon.	6 p. m.	Mean.	6 a. m.	Noon.	6 p. m.	Mean.
June 1	64	83	74	73⅔	72	74	74	73⅓
2	62	80	75	72⅓	73	74	74	73⅔
3	60	82	74	72	73	74	73	73⅓
4	64	70	66	66⅔	73	73	73	73
5	66	88	76	76⅔	73	74	74	73⅔
6	68	84	76	76	73	75	75	74⅓
7	68	85	79	77⅓	75	76	76	75⅔
8	68	87	75	76⅔	76	77	77	76⅔
9	70	81	74	75	77	78	78	77⅔
10	69	79	68	72	77	77	78	77⅓
11	62	74	80	72	77	77	77	77
12	70	76	78	74⅔	77	78	78	77⅔
13	72	86	66	74⅔	77	77	76	76⅔
14	60	68	73	67	75	75	76	75⅓
15	62	79	69	70	75	75	75	75
16	65	79	68	70⅔	74	74	74	74
17	70	86	72	76	74	74	74	74
18	68	86	71	75	74	75	75	74⅔
19	70	92	82	81⅓	74	75	76	75
20	76	92	86	84⅔	75	76	77	76
21	76	94	81	83⅔	76	77	78	77
22	76	82	81	79⅔	77	78	79	78
23	76	86	76	79⅓	78	79	79	78⅔
24	72	78	76	75⅓	78	78	78	78
25	70	71	72	71	77	77	77	77
26	74	90	75	79⅔	77	78	78	77⅔
27	68	90	76	78	77	78	79	78
28	75	89	76	80	78	79	79	78⅔
29	75	88	82	81⅔	78	79	79	78⅔
30	68	81	70	73	78	78	78	78

WYTHEVILLE STATION, VIRGINIA (GEORGE A. SEAGLE, SUPERINTENDENT).

The following table shows the number of fishes of various species on hand at the beginning of the fiscal year:

Species.	Calendar year in which hatched.				
	1895.	1894.	1893.	1892.	1891.
Rainbow trout	82,950	700	890	1,965	600
Black-spotted trout			120		62
Carp	5,000				50
Goldfish	1,000				10
Tench	3,000		45		
Black bass	5,000			24	
Rock bass	20,000				142

The work of distributing the year's production of fish was commenced October 9 and continued until December 28, the total output consisting of 74,695 rainbow trout, 13,205 rock bass, and 1,460 large-mouthed black bass.

Rainbow trout.—The rainbow trout were held in troughs and in the five rearing-ponds below the hatchery until fall, being fed as usual on mush and liver. The season's supply of eggs, amounting to 980,700, were obtained from 1,156 females, 660 male fish being used to fertilize them. The trout commenced spawning on November 10, and eggs were obtained from that time to the end of February, the collections by months being as follows: November, 67,000; December, 647,500; January, 246,500; February, 19,700. The increased number and the unusually fine quality of eggs obtained this season were attributed to the changes made in the spawning-ponds. Of the 980,000 collected, 380,000 were retained at the station and produced strong healthy fry, but owing to the muddy condition of the water in March, when the fish were very small, the losses were heavy, amounting in all to about 75,000. As the facilities at the station were inadequate for carrying over 125,000 to the yearling stage, 112,000 were distributed as fingerlings during the month of April to applicants in Virginia and Tennessee, and at the close of the year there remained on hand 117,300.

The following table shows the shipments of eggs made to other stations of the Commission, State fish commissions, and foreign applicants:

Applicant.	Number.	Applicant.	Number.
Dr. E. G. Shortlidge, Wilmington, Del	10,000	J. T. Newton, New Haven, Conn	25,000
U. S. F. C. Station, East Orland, Me	25,000	U. S. F. C. Station, Cape Vincent, N. Y	25,000
Société Nat. d'Acclimatation, Paris, France	50,000	U. S. F. C. Station, Washington, D. C	15,000
Maj. J. W. Turner, Bertrix, Belgium	50,000	New Hampshire Fish Commission, Manchester, N. H	25,000
M. Raveret-Wattel, Fécamp, France	25,000	U. S. F. C. Station, Northville, Mich	25,000
U. S. F. C. Station, St. Johnsbury, Vt	75,000		

Black bass and rock bass.—Early in the spring the adult bass were placed in the breeding-ponds and artificial nests were introduced. These consisted of wooden boxes, 20 inches square by 2 inches deep, with flaring sides, filled with gravel. Chestnut was selected for the boxes, as that wood quickly changes when wet to a color which closely resembles the bottom of the pond. The nests were marked by stakes extending a foot or more above the surface of the water, and with the object of protecting the parent fish from the sun and also from enemies, a wooden hood, 15 inches by 20 inches, was attached to each of these stakes below the water surface. The nests were examined once a week and those containing eggs were transferred to the rearing-ponds. Very satisfactory results were attained with the rock bass, but they were only partially successful with the black bass. The nests for the rock bass were the same as those for the black bass except that they were 15 inches by 15 inches in size.

With suitable ponds and with the experience gained this season in making these nests, there is little doubt but that they can be successfully used with the black bass next year. At the close of the year indications point to a large crop of rock bass and a fairly good output of black bass, though it is doubtful whether the final results will be any better than in past years, owing to the condition of the ponds, which leak so badly that it is difficult to keep them even half filled with water.

Black-spotted trout.—As these fish had been held at the station for a number of years without producing eggs, they were transferred to Atlanta in December for exposition purposes.

Other fishes.—The propagation of carp, goldfish, and tench for distribution having been discontinued, the ponds heretofore devoted to that

PLATE 6.

HATCHERY, WITH STEAMER SHEARWATER AT DOCK, PUT-IN BAY STATION, OHIO.

purpose will be repaired and utilized in future for rearing the basses. Most of the young goldfish and tench and a number of the carp on hand at the beginning of the year were transferred to Atlanta for exposition purposes. The adult goldfish were liberated in Tate Run, and the brood carp and tench were retained at the station.

During the year the commissioners of the State of Virginia expended, under the direction of the superintendent, $250 of the rent paid by the Government for this station in making the most necessary repairs.

PUT-IN BAY STATION, OHIO (J. J. STRANAHAN, SUPERINTENDENT).

During the summer hatching batteries similar to those in use at the Duluth and Detroit stations were installed, thereby increasing the capacity of the hatchery from 700 to 1,000 jars. By this system of batteries the water is used over eight times, which results in the saving of about one-half in the amount of coal consumed, as it requires only 300 gallons of water per minute for 1,000 jars, whereas under the old system 800 gallons per minute were required for 700 jars.

Whitefish.—The usual arrangements were made during the month of October for the collection of eggs from all of the pound and gill net fishermen at the western end of Lake Erie. The first eggs were taken on November 4, one day earlier than ever before at this station, and by the 25th of November 188,163,000 had been secured from the following points: Port Clinton, Ohio, 92,403,000; Toledo, Ohio, 25,029,000; Put-in Bay Island, 15,615,000; North Bass Island, 27,540,000; Middle Bass Island, 13,284,000; Kelley Island, 9,441,000; Catawba Island, 4,104,000; West Sister Island, 333,000; other sources, 414,000.

The usual system was employed in making the collections. The spawn-takers stationed at the different points visited the pound and gill nets of the fishermen every day when fished and the eggs obtained were brought to the station in wooden kegs or transportation cans by the steamer *Shearwater*. Eggs collected at Toledo and other distant points were packed on canton-flannel trays, inclosed in wooden boxes, and shipped to Port Clinton by rail, thence by the *Shearwater* to the station. These boxes are provided with hinged doors, and each of them is capable of carrying about 750,000 eggs.

The take this season was not only the largest ever secured, but the eggs were of excellent quality. This was partly due to the fine weather prevailing during November, but the good results are to be mainly attributed to the fact that trained spawn-takers were hired, whereas in past years the fishermen collected most of the eggs.

Shipments of eggs were made during the months of November and December as follows: Cape Vincent, N. Y., 26,540,000; Duluth, Minn., 10,000,000; Alpena, Mich., 5,000,000.

Car No. 3 also transported 3,000,000 to Bear Lake, Idaho, where 2,940,000 fry were hatched from them and liberated in the lake.

The eggs retained at the station commenced hatching early in April, and 120,950,000 fry, produced from them, were liberated at the following points:

Point of deposit.	Number.	Point of deposit.	Number.
Peach Point Reef, Ohio	1,400,000	Middle Bass Island, Ohio	5,670,000
Rattlesnake Island Reef, Ohio	22,620,000	Niagara Reef, Ohio	11,080,000
Ballast Island Reef, Ohio	7,300,000	Buckeye Island	5,670,000
North Bass Island Reef, Ohio	23,460,000	West Sister Island	4,200,000
Green Island Reef, Ohio	6,400,000	Toledo Field, Ohio	3,300,000
Starve Island Reef, Ohio	5,600,000	Monroe Field, Mich	3,300,000
Port Clinton Field, Ohio	13,280,000	Turkey Lake, Syracuse, Ind	2,000,000
Kelley Island, Ohio	5,670,000		

During the period of incubation the water in the lake became so low, on account of a southwest gale, that the suction pipe was above the surface of the water, and the supply to the hatchery was cut off for six hours. The closed circulation was used without apparent detriment to the eggs during this period.

The use of air jets in keeping the screens in the fry tanks clean and free from shells has proved a success. The screens now require little or no attention, whereas, under the old plan, it took the services of several men to keep them clear when the fry were coming out rapidly. It is also believed that under the old system the fry suffered more or less from coming in contact with the screens. As now arranged, the jets coming up from the bottom on the inside produce active currents of water, which prevent the fry and shells from touching the screens. The fry are also kept from collecting in large numbers at the bottom and smothering, and they are undoubtedly made active and healthy by the thorough aeration of the water.

Lake herring.—The collection of eggs of this species, although pushed earnestly, was almost a complete failure, as very few herring were captured this season. From the 1,200,000 eggs secured, 696,000 fry were hatched and liberated at North Bass Island Reef.

Lake trout.—During December 1,000,000 lake-trout eggs were received from Northville, from which 685,400 fry were hatched and planted on Rattlesnake and Ballast Island reefs.

Black bass.—During the spring attempts were made to hatch the eggs of the small-mouthed black bass by artificial fertilization. Male and female fishes, apparently in the act of spawning, were taken from their beds, but in only one instance were fry hatched from eggs collected in this way. The eggs were forced from the female with great difficulty, and in no instance could milt be obtained from the male; hence it became necessary to open the fish and remove the spermaries, which were then cut up and mixed with the eggs, a little corn starch being added to prevent adhesion. The eggs were then placed in the McDonald jar and worked as usual. They showed little tendency to adhere to each other or to the jar any more than is usual with whitefish or pike-perch eggs. On the following day they were taken from the jar, counted, and examined under the microscope, when it was found that 85 per cent of them were impregnated, the form of the embryo showing plainly. The water temperature at the time was 63°, and the eggs developed rapidly, hatching on the 12th, four days after being taken. A dram of the eggs were counted and they were found to measure 100,096 to the fluid quart. The ovaries of one female, weighing 1½ pounds, were removed and found to contain 4,011 nearly mature eggs, or 2,674 to a pound of fish. Eggs collected from fish caught at the Put-in Bay dock and at North Bass Island were impregnated as described above. Apparently these were as good as the first ones taken, but fungus set in within twenty-four hours and all of them died, notwithstanding they had received careful handling.

As it is believed that a large proportion of bass eggs are destroyed by storms, it was determined to experiment with artificial nests, the object being to remove the eggs to the station as soon as practicable after the fish deposited them. Two hundred nests were made of Portland cement and sand, 14 inches across the face, one-half inch thick, and slightly dished in the center. While the cement was still plastic small-sized gravel was imbedded therein so that it would resemble the natural nests. About half the nests were placed in depressions in the gravel and rock in the bay adjacent to the station and the rest of them on mud and sand bottom, being slightly sunk below the natural surface and covered about an inch deep with selected gravel of the size of chestnuts. On the morning of the 7th many bass were observed on the natural nests, but only one of the artificial nests was occupied. In many instances the bass first selected the artificial ones, but after fanning them off with their tails, according to their habit, they deposited the spawn on larger gravel in the immediate vicinity. As soon as this was noticed the nests were covered with gravel as large as hens' eggs and more or less angular in shape. This remedied the difficulty, and although most of them had already selected their beds, thirteen established themselves on the artificial nests. Four of the nests left in the lake in front of the hatchery after the black-bass season closed were afterwards found to be occupied by rock bass.

Owing to the high temperature prevailing the experiments were unsuccessful. On May 10 the water temperature rose from 64° to 69°, and on the morning of the 12th it was found that every nest in the bay, both natural and artificial, contained fungussed eggs. The artificial nests containing eggs were at once removed to the fry tanks at the station, running water turned on, and the temperature was lowered gradually to 65° by means of ice. This stopped the death rate and a few hundred fry were hatched; they were very weak, however, and survived only a few days. It is believed that very successful work can be done with artificial nests in future, and it is recommended that arrangements be made with this object in view.

NORTHVILLE STATION, MICHIGAN (F. N. CLARK, SUPERINTENDENT).

As in past years, the fish-cultural work at the Michigan stations was directed by Mr. F. N. Clark, the Northville Station being utilized for hatching trout eggs and Alpena for whitefish. In August the superintendent, accompanied by the foreman at Alpena, visited the important fisheries on Lakes Huron and Michigan and arranged for collecting lake-trout and whitefish eggs. He also made preparations to establish a field station for collecting brook trout on Au Sable River at Stephan Point, about 8 miles from Grayling.

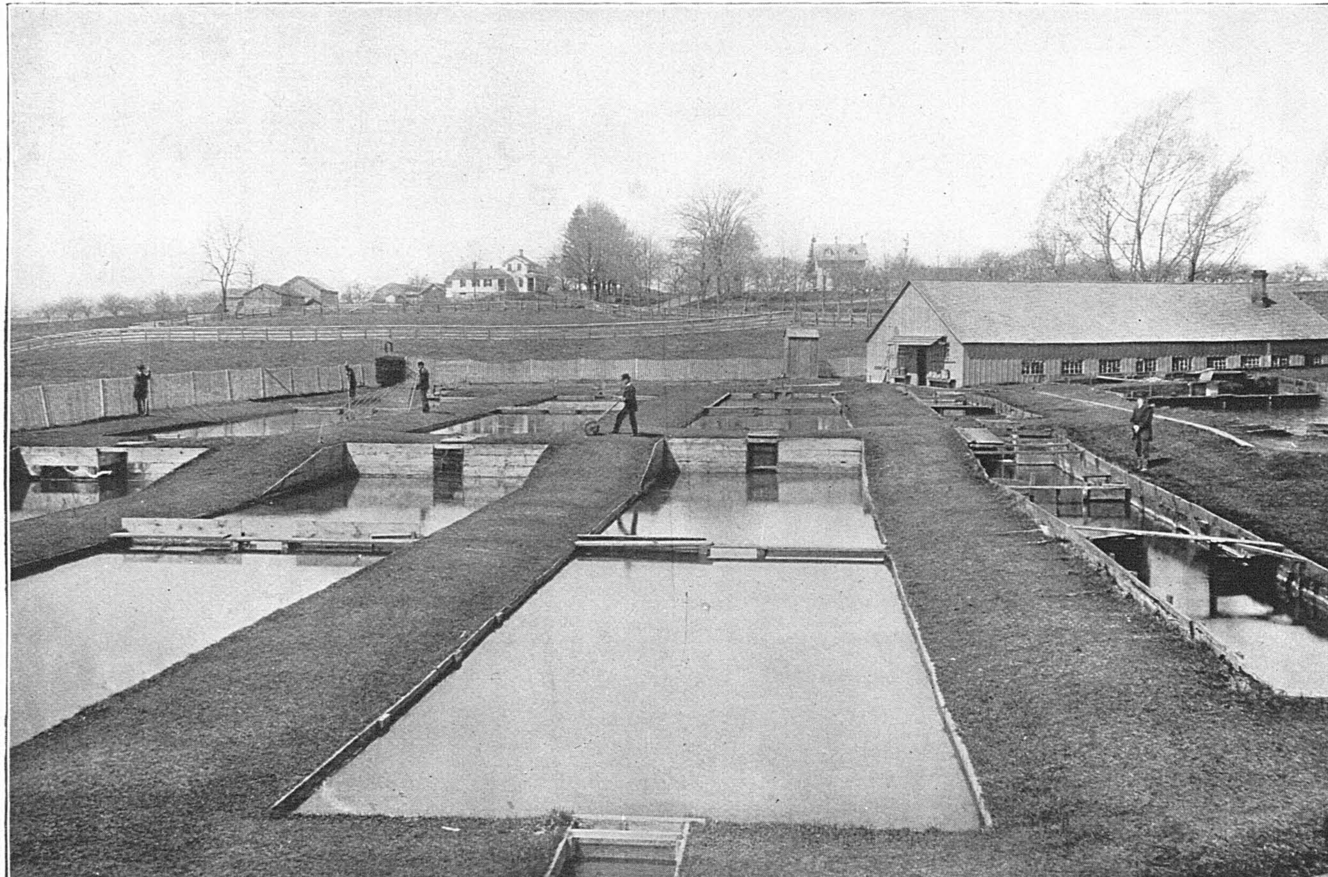
During the months of July and August the station force was employed as usual in repairing the ponds, improving the grounds, and overhauling and repairing the hatching apparatus. The spring furnishing the main portion of the water for hatching operations has been failing for two years, and owing to protracted drought the water was lower this summer than ever known before. As a result of this the losses of fish held at the station were very heavy, the wild trout collected from the Au Sable suffering most severely.

Lake trout.—The first consignment of lake-trout eggs was received from Alpena on October 27 and the last on December 5, the total collections amounting to 11,122,000, over 3,000,000 in excess of any previous year's take. Owing to the limited capacity of the hatching-house it became necessary to ship 5,750,000 of them, and they were consigned as follows:

Consignee.	Number.	Consignee.	Number.
U. S. F. C. Exhibit, Atlanta, Ga	35,000	Ed. Jefferson, Mammoth Springs, Ark.	5,000
U. S. F. C. Station, Cape Vincent, N. Y.	3,600,000	Swiss Department of Agriculture, Berne, Switzerland	50,000
U. S. F. C. Station, Washington, D. C.	10,000	Henry Studor, White Lake Corners, N. Y	200,000
U. S. F. C. Station, Put-in Bay, Ohio	1,000,000	Nebraska Fish Commission, South Bend, Nebr	200,000
U. S. F. C. Station, St. Johnsbury, Vt.	100,000	Vermont Fish Commission	300,000
U. S. F. C. Station, Bucksport, Me	50,000		
Wyoming Fish Commission, Laramie, Wyo	200,000		

Of these eggs, 4,600,000 were shipped in the green stage and 1,150,000 after the eye-spots appeared. From those remaining at the station, 1,295,000 fry were hatched and distributed during the months of April and May, plants amounting to 400,000 being made in Lake Huron, 750,000 in Lake Michigan, and 100,000 in the Straits of Mackinac. The remaining 45,000 were distributed to private individuals for stocking inland lakes.

Brook trout.—Arrangements having been made with Mr. H. Stephan for the lease of 4 acres of land on a brook flowing into the Au Sable, a field station was established and the collection of fish commenced on August 26. Operations were continued until November 10, during which time 6,453 trout were caught and confined in a pond prepared for them. During the early part of the season the collections were made with rod and line, but after October 1 a seine was used with



TROUT PONDS, NORTHVILLE, MICH.

excellent results, a 20-foot minnow net bringing in at each haul from 5 to 75 trout. The largest catch in any one day was over 600. The first ripe fish were found on October 3, and by the close of the season 386,807 eggs had been secured. From the experience gained this year, there is no doubt that much better results can be secured, and at reduced cost, as it is unnecessary to establish the station before the end of September.

A number of experiments were made during the season in transferring eggs before they were eyed from the field stations to Northville. Fourteen shipments of eggs were made, varying in age from 1 to 22 days, and it was found that they could be moved successfully up to and including the eighth day; between the eighth and the eighteenth days the losses were much heavier, in some cases being as high as 50 per cent.

The mortality among the wild brook trout taken from the Au Sable early in the summer was very heavy, and only 233,928 eggs were secured from them. From the domesticated stock 46,710 eggs were taken from 78 spawners. Of 667,445 brook-trout eggs obtained from all sources during the season, 75,000 were transferred to the U. S. Fish Commission stations at St. Johnsbury, Cape Vincent, and Duluth; 20,000 were furnished to the Minnesota Fish Commission, and 20,000 to applicants in Ohio. From the remaining stock, 210,000 fry were hatched and furnished in March and May to applicants in Michigan. Iowa, Wisconsin, and Ohio, for planting in public waters.

Von Behr trout.—Of the brood stock on hand, 132 females spawned during the season, producing 60,400 eggs. The first were taken on November 6 and the last on January 7. They commenced hatching in February and the 30,000 fry resulting from them were distributed with the brook and lake trout during the month of May.

Loch Leven trout.—Most of the eggs secured from this species were taken from 3-year-old fish, as only 23 females of the older brood stock spawned. The total number of ripe fish used was 262, and the number of eggs obtained from them was 132,000. Of these, 20,000 were assigned to the Nebraska and Minnesota Fish Commissions, and 17,000 fry were hatched from the balance and distributed to applicants in Michigan and Indiana.

Steelhead and rainbow trout.—On April 5 a consignment of 75,352 steelhead trout eggs was received from Fort Gaston Station. The eggs were en route twelve days and only 3,363 dead ones were picked out on arrival. The 55,000 fry resulting from them were planted early in May, deposits being made in Tawas and Pine rivers, emptying into Lake Huron, and Maple River, Straits of Mackinac. From a consignment of 25,000 rainbow trout eggs shipped from Wytheville Station, 20,000 fry were hatched and distributed during the spring.

Black bass—The small-mouthed black bass transferred from Put-in Bay showed no inclination to spawn this season. This was probably due to the fact that they were confined in small shallow ponds, and it is recommended that a pond at least an acre in area, with the necessary spawning-beds, be built south of the reservoir. With the view to increasing the supply of water for the hatchery a 3-inch artesian well was sunk during the month of April. At a depth of 96½ feet a flow of 14 gallons per minute was obtained, the temperature being 50°. There has been no opportunity to test the value of this water for hatching purposes, but it was tried on a trough containing 23 brook trout for one week. During this time the fish did not thrive. Their gills became affected and they refused to take food. Whether this was due to the fact that the temperature of the water was much lower than that of the spring water, or to the presence of injurious foreign matter, can not be determined. The water had a slight taste of iron, but a chemical analysis developed the fact that it was not in sufficient quantities to prove injurious. By mingling it with spring or creek water good results were secured.

An appropriation of $13,000 having been made by Congress for the construction of a new hatchery, a dwelling for the superintendent, and the increase of the spring-water supply, the superintendent was instructed in June to submit the necessary plans and specifications.

At the close of the year the stock of fish on hand was as follows:

Species.	Calendar year in which hatched.				
	1896.	1895.	1894.	1893.	1892.
Brook trout	17,000	90		675	215
Wild brook trout					230
Von Behr trout				512	85
Loch Leven trout					20
Black bass					
Total	17,000	90		1,187	550

ALPENA STATION, MICHIGAN (F. N. CLARK, SUPERINTENDENT).

The foreman of the station, Mr. H. D. Dean, having been appointed superintendent of the station at Cape Vincent, N. Y., the position thus made vacant was filled by the promotion of S. W. Downing, fish-culturist. Arrangements were perfected during the month of August for the collection of lake-trout and whitefish eggs, and in October a large force of spawn-takers was employed and stationed at all of the important fishing-grounds in the upper waters of lakes Huron and Michigan.

Lake trout.—Favorable weather and an unusually large run of trout permitted the collection of over 7,000,000 eggs at Charlevoix and Beaver Island, an excess of 4,000,000 over the previous year's take at these points. On account of the frequent storms prevailing at the Caribou Islands and Detour, where collections in the past have usually been large, the nets could not be lifted regularly, consequently most of the fish taken from them were unfit for use. The eggs secured from the fish caught in Lake Michigan were forwarded to the field foreman at Charlevoix, and from there they were shipped by rail to Northville.

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PLATE 8.

SELECTING AND STRIPPING RIPE TROUT, NORTHVILLE, MICH.

They were transported as usual on canton-flannel trays packed in boxes, and the majority of them arrived in excellent condition. The season closed on December 5 with a total collection of 11,122,000 from the following points: Caribou Islands, Lake Superior, 450,000; Manistique, Lake Michigan, 1,500,000; Beaver Islands, Lake Michigan, 4,634,000; Charlevoix, Lake Michigan, 2,552,000; Detour, Lake Huron, 468,000; Alpena, Lake Huron, 1,518,000.

Whitefish.—The collection of whitefish eggs commenced November 2 and continued until December 17, during which time 44,420,000 were secured from the following points:

Lake Huron: Alpena, Mich., 15,070,000; Hammond Bay, 5,000,000; Oscoda, Mich., 1,200,000.

Lake Michigan: Manistique, Mich., 14,500,000; Beaver Island, 4,500,000; Naubinway, Mich., 2,500,000; Warehouse Point, Michigan, 1,200,000; Epoufette, Mich., 450,000.

In addition to these, a consignment of 5,000,000 was transferred from Put-in Bay hatchery. Two lots of eggs were shipped, one consignment of 50,000 being sent to the Japanese Imperial Government, and another of 800,000 to Atlanta for exhibition purposes; the balance were retained for hatching and 35,850,000 fry were produced from them. The percentage of fry hatched this year was much better than that of the previous year, owing to the fact that most of the eggs were obtained from fish captured in pound nets. The experiment of penning whitefish was made at North Point, near Alpena, and although it was not so successful as anticipated, 4,000,000 eggs were secured from the 500 fish confined, and it is believed that from 20,000,000 to 25,000,000 can be secured next season in this manner, at an expense of $1,000. The fish were transferred from the pounds to the live-cars and thence to the crates without injury, though a few of them hardened afterwards and produced no eggs. This was attributed to the fact that the crates were located in very shallow water, the most difficult part of the undertaking being to find a place where they could be anchored securely in deep water.

Duluth Station, Minnesota (S. P. Wires, Superintendent).

During the summer the force of the station was employed in repairing the hatching apparatus and painting the buildings. The main flume which supplies the hatchery with water was repaired and painted and the boiler and pump overhauled, preparatory to the opening of the spawning season.

Lake trout.—Early in September arrangements were made with the fishermen on Lake Superior for collecting lake-trout eggs. The season opened September 18 and continued to November 5, eggs being obtained at the following points: Port Arthur, Ontario, 1,675,000; Grand Portage, Minnesota, 250,000; Bayfield, Wisconsin, 1,998,000; Isle Royale, Michigan, 1,392,000; total, 5,315,000.

The eggs were forwarded to Duluth by steamer and arrived in excellent condition, considering the fact that it was frequently necessary to hold them on trays in the transportation boxes from 10 to 12 days before shipping, and in one instance they were held as long as 30 days, though it is not usually considered safe to hold them longer than 20 days. The fish from which these eggs were collected were caught in small gill nets set in shallow water on reefs near the shore.

As soon as the eggs were fertilized they were placed on canton-flannel trays 18 inches square, about three layers deep, and then packed in cases holding 20 trays each. Early in the season, when the weather was warm, the bottoms of the cases were covered with wet moss and crushed ice, and a tray filled with wet moss was placed on top of that. The trays containing eggs were then packed one above the other, and at the top was placed another tray filled with wet moss and crushed ice. As the weather became colder the ice was omitted. The eggs were removed from the cases every 24 hours, thoroughly sprinkled with cold water by means of a sprinkling pot or whisk broom, and after being well drained were returned to the cases. A consignment of 50,000 was shipped to Mr. G. F. Mills for the Nevada Fish Commission. From the balance, 4,400,000 fry were hatched and distributed during May and June, 130,000 being furnished to applicants in the States of Minnesota and North Dakota. The remainder were deposited in the vicinity of the fishing-grounds from which the eggs were obtained. The total loss of eggs and fry amounted to 867,000.

Whitefish.—The fishing operations at Basswood Lake, Minn., and Whitefish Lake, Ontario, were seriously interfered with by severe storms and cold weather early in the season; hence the collections at those two points amounted to only 7,000,000. As this number was inadequate for stocking public waters, a consignment of 10,000,000 was transferred to Duluth from Put-in Bay Station. The eggs commenced hatching about the middle of April and fry resulting from them were liberated in Lake Superior between April 20 and May 8 at the following points: Iron River, Wis., Isle Royale, Mich., Bayfield and Raspberry, Wis. The loss of eggs and fry to the time of planting amounted to 7,000,000.

Steelhead trout.—In order to test the adaptability of steelhead trout to the waters of the Great Lakes, a consignment of 150,000 eggs was forwarded from the Fort Gaston, Cal., station during the month of April, and the 135,000 fry resulting from them were planted, between June 4 and 15, at the following points: Washington River, Isle Royale, Mich., 30,000; French River, Minn., 20,000; Brule River, Wis., 20,000; Split Rock River, Minn., 20,000; Poplar River, Minn., 20,000; Baptism River, Minn., 10,000; Sucker River, Minn., 15,000.

Consignments of brook and rainbow trout were also received from Neosho and Northville stations, from which 16,000 rainbow trout and 3,200 brook trout were hatched and distributed to applicants in Minnesota and North Dakota during the month of May.

UNITED STATES FISH COMMISSION PONDS, MEREDOSIA, ILL.

QUINCY STATION, ILLINOIS (S. P. BARTLETT, SUPERINTENDENT).

At the beginning of the year the prospects for a good season's work were poor, as the lakes and sloughs from which supplies of fish were ordinarily secured dried up during the preceding year and the usual spring rise occurred too late to permit of their being used for spawning-grounds. The station was thus left dependent on a few large flat lakes connected with the river, which had become thoroughly stocked with bass. From these a number of young fish were collected for immediate distribution, and 50,000 additional were transferred to a pond near Meredosia, leased from Mr. F. H. Ray, who had constructed it for the purpose of storing temporarily the fish caught for market by his men. A number of breeding bass had also been introduced into this pond, and the number of fry resulting from them was estimated to be about 50,000.

The distribution made early in the year was fair, but about the end of July a series of unprecedented storms occurred. A cloud-burst caused the river to rise 6 feet in a few hours, overflowing the dam and permitting the escape of all but 2,000 of the 100,000 fish in the pond. About 26,000 young bass were gathered from overflowed points near Quincy, and as it was thought to be unsafe to keep them in live-boxes, arrangements were made with the city authorities for the use of a fountain basin, 50 feet in diameter and 3½ feet deep, supplied with water from the city reservoir. The fish were held for six weeks, during which time a quantity of ground liver and 300,000 river minnows were fed them, but notwithstanding the efforts made to feed them to their fullest capacity, the larger fish devoured the smaller ones to such an extent that when the basin was drawn down only 2,482 were found.

Late in August collections were again undertaken, and, although many fish were secured, the greatest difficulty was experienced in transporting them from the places of collection to the live-boxes at Meredosia and Quincy. They seemed to be in a diseased condition when taken, and frequently the entire catch was lost en route. All along the Mississippi and Illinois rivers the fish died by thousands, and even in the deeper, larger lakes, where they live in an ordinary season until there is scarcely enough water left to cover them, the bottoms were covered with dead ones. In Spring Lake, which covers several thousand acres and is fed mostly by springs, fish of all kinds and sizes floated dead on the surface several times during the season. Various theories were advanced to account for this unusual occurrence, the most probable one attributing it to the poisoning of the waters by decayed vegetation, which had sprung up during the preceding season, when the lakes were dry, or partially so. The refuse from the cities above also polluted the waters greatly. Taken altogether, the season was without a precedent. Squatters planted turnip patches in many places where carloads of fish had been taken without difficulty two seasons before, and in several of the large flat lakes good crops of corn were raised and harvested. In September a carload of bass, crappie, and other fishes indigenous to the Mississippi River were collected and shipped to Atlanta for exhibition in the United States Fish Commission aquarium. The other cars engaged in the distribution from Quincy were ordered to Neosho and Leadville, and the work of collection was discontinued until the following spring.

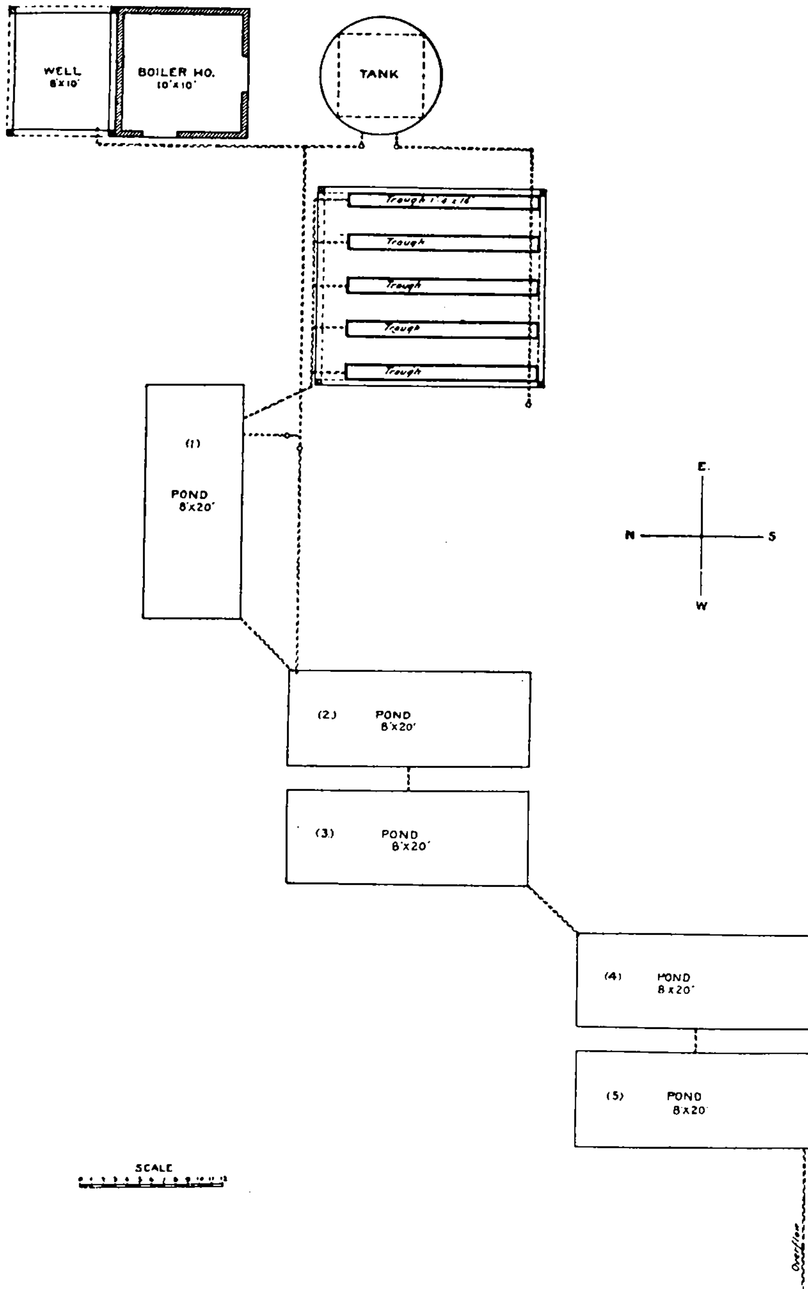
During the month of June, 1896, 7,750 black bass were collected and distributed to applicants in Wisconsin and Michigan. During the fiscal year the station furnished for distribution the following:

Species.	Fry.	Yearlings.
Black bass		18,637
Crappie		51
Warmouth bass		200
White bass	20,000	
Yellow perch		3,100
Pickerel		1,550
Carp		7,008
Total	20,000	30,546

In addition to these, large numbers of carp, buffalo, sunfish, perch, etc., were taken from the drying ponds and liberated in the river near the points where the men were working. During the very hot weather, when it was impracticable to carry the bass to the live-boxes, entire days were devoted to the saving of these coarser fishes.

From experience gained in past years it has been demonstrated that to conduct work successfully at this station it is necessary to provide a number of ponds not liable to overflow, in order that collections of bass and crappie may be made early in the spring, as soon as the water begins to recede, and held therein for distribution during the summer and fall. The fish, particularly the bass, should be carefully assorted as to size, as the sizes vary greatly, and when kept together in a limited space the smaller ones invariably fall a prey to the larger ones.

In August the superintendent was authorized to construct five ponds at Meredosia, on land leased from Mr. Ray. The site selected was on a hill about 40 feet above the level of the river, its base being 500 feet distant from Meredosia Bay. The excavations were made 2 feet greater than the dimensions of the finished ponds, which were 20 by 8 by 6 feet deep. The sides were lined with well-dressed cypress 2 inches thick, and filled in with black dirt from an Indian mound near by. The dirt was deposited in layers 4 inches thick, being well puddled and tamped; the bottom was treated in the same manner to a depth of 8 inches, and on this 2 inches of clear sand and 6 inches of screened gravel were spread. The sides and ends of the lining were securely fastened to posts which had been coated with coal tar. Evidently the dirt from the mound had originally been taken from the lake, as it resembled cement in its action, becoming so hard when wet and tamped that it was difficult to cut. The water for the ponds was obtained at a depth of 35 feet in pure sand, being forced into the tanks 8 feet above



PUMPING STATION, UNITED STATES FISH COMMISSION, MEREDOSIA, ILL.

The fall from pond 1 to 2 is 18 inches, and about the same from 2 to 3; from 3 to 4 the fall is about 14 inches, and from 4 to 5 it is 18 inches. These are about 2 feet of earth between ponds 2 and 3 and also between ponds 4 and 5.

the ground by means of a pump driven in a well 16 feet deep. Connected with the pump is a 10-horsepower boiler, which is covered, together with the well, by a neat shed. A small shed was also erected and a number of troughs constructed for holding bass intended for immediate shipment and for assorting bass before putting them in the ponds. The pumping plant is so arranged that the water can be forced into the ponds direct, or into the tanks, the ponds being supplied by gravity, or it can be introduced into the ponds and tanks at the same time. The pumping apparatus and the buildings were erected during May.

With the present facilities the chief difficulty in holding fish for distribution is eliminated, as there is little danger of their dying from fungus with the new water supply, it being as clear as spring water and almost chemically pure. If the fish reach the station in good condition, the percentage of loss from any cause will be slight. As already stated, they are first carefully assorted as to size, and those showing any injury are placed by themselves; twenty-four hours determines which ones are unfit for transportation, and these are returned to the river. The fish seem to harden by keeping, and when taken from warm water their color becomes much darker in a few days. In past seasons the greatest losses occurred in the live-boxes, where the temperature of the water frequently ranged from 90° to 100°, but since completing the ponds and obtaining the new water supply the loss in holding has decreased perceptibly.

The cost of constructing the ponds, including the purchase of the pumping plant and erection of sheds and troughs, was less than $700, exclusive of services of regular employees, who were utilized in this work when not otherwise engaged.

NEOSHO STATION, MISSOURI (W. F. PAGE, SUPERINTENDENT).

During the year considerable work was done at the station in the way of painting and repairs to buildings and fences; various improvements were also made to the ponds and the conduits; outlets and inlets of the trout pools, originally made of oak, were replaced by terra-cotta gutter pipe.

The following tables show the total precipitation during the year and the maximum, minimum, and mean air temperatures by months:

Month.	Mean.	Maximum.	Minimum.	Precipitation.	Snow.
1895-July	82.1	104	59	7.52	....
August	82.3	104	62	4.76	....
September	76.4	95	32	11.24	....
October	54.3	81	20	.41	....
November	44.4	75	11	4.16	4.50
December	38.3	66	2	*a* 11.21	1.25
1896—January	36	64	3	1.11	3.50
February	39.7	73	10	1.08	1.50
March	43.5	81	10	2.37	2.50
April	64.8	91	20	3.62	....
May	69	96	32	11.91	....
June	73.5	96	48	7.18	....
	58.7	....	....	66.57	13.25

a Rain gauge overran in the storm of December, and the amount was calculated from other data.

The year was marked by four unusually severe storms, occurring on July 7, September 8, December 17, and May 30, all of which did much damage to the station. The storms of December and May washed over the north end of grounds, damaging walks, fences, roads, and pond banks.

The theory set forth in a previous report that crawfish would not enter or live in a pond the banks of which were planted with mint, was proved this year to be untrue, as the experiment was tried and it was found that the crawfish were not affected by the mint.

The following list shows the number of enemies of fish killed during the year: Kingfishers, 19; ducks, 25; grebes, 2; water hens, 10; bitterns, 18; fishhawks, 4; herons, 2; terns, 12; owls, 4; turtles, 20; snakes, 22; frogs, 3; muskrats, 20; water rats, 6; crawfish (pounds), 1,385.

Black bass.—The output of black bass for the year was 9,338, which was 50 per cent in excess of the number distributed in any previous year. As in preceding seasons, the ponds were drawn frequently and the fish carefully assorted according to size. The increased output is attributed in a large measure to the fact that most of the fry were transferred to hatching-troughs during the summer and fed on grated crawfish, it having been found after a few days' trial that young bass could be taught to take this food readily.

In the spring of 1896 ponds Nos. 10 and 11 were, as usual, selected as breeding-ponds, 15 brood fish being put in No. 10 and 29 in No. 11 on April 3. On April 16 the first nest was observed, and the first young fish were noted on the 25th. Several thousand of them were at once transferred to the troughs and an effort made to raise them, but it resulted in failure. About the middle of May 12,000 fry were taken out of pond No. 11 to troughs in the hatching-house, and no difficulty was experienced in training them to take artificial food. About the middle of June both ponds were drawn down and the remainder of the crop, amounting to 9,761, transferred to the troughs. At the close of the year the average loss of fry from the time of their transfer to troughs was about 2 per cent a month. At this rate the total loss to the time of general distribution will be 10 per cent. Under the old system of rearing in ponds the total loss frequently ran as high as 50 per cent, and sometimes higher. It appears from this season's experience that the fry of the black bass should not be transferred to the troughs until two or three weeks old.

An effort was made this season to artificially spawn the black bass, and with this object in view a number of wild adults were taken from Shoal Creek in April and confined in the east pool. They were held until the close of the season, but failed to produce any eggs. This can only be accounted for on the supposition that the water in the pond selected was too cold. Its temperature averaged 57°, 3° lower than that in which the regular brood stock spawned. Efforts were also made to collect young bass from the natural nests in Shoal and Hickory creeks, but the roiling of the streams from excessive rains made the experiment unsuccessful.

Strawberry bass.—On December 1, 1895, 51 strawberry bass (*Pomoxis sparoides*) were received from Quincy station. These were wintered with a loss of only 5, and early in the spring were transferred to one of the breeding-ponds. Although no nests or spawning were observed at any time, a number of fry have been seen in the pond. A number of them accidentally caught in the net early in June died before they could be removed. It seems doubtful if the young of this species can be handled in midsummer like the rock bass and black bass.

Rock bass.—The total output of yearling rock bass, amounting to 25,248, was less than half the output of the previous year. The cause of this decrease is unknown. It was found to be an easy matter to carry the fry in troughs for several weeks by feeding on coriza and grated crawfish. In the spring the usual arrangements were made for breeding and rearing the new crop, and judging from indications at the close of the fiscal year the output will be very fair.

Tench.—The work with this species was a failure, owing partly to the accidental introduction of black bass into the pond, and partly to the fact that the ponds containing the fry were flooded on May 30. After the water subsided it was observed that nearly all of these fish had escaped.

Goldfish.—The total distribution of goldfish during the year was 994. During the winter the Commissioner decided to discontinue the propagation of this species, and the brood stock on hand were liberated in Hickory Creek.

Rainbow trout.—During the fall 81,507 yearlings were distributed from eggs taken at the station and 7,426 yearlings from eggs shipped from California. In July and August two severe epidemics prevailed among the 16-months red-banded rainbows. When the first one appeared it was thought to be due to the feed water being overtaxed by passing over 21,000 rock bass in the hatching-house and 32,000 trout in the east pool, but at the time of the August epidemic these conditions did not exist. The fish remaining after the second loss were placed in the pond with the old brood stock, and at the close of the year only 487 survived of the 1,450 on hand at the beginning of the season.

The spawning season commenced December 17 and lasted until February 20, during which time 614,887 eggs were collected; 74 per cent, or 456,110, proved to be impregnated. Shipments amounting to 313,851 were made during the fall to other hatcheries, 12,732 of the balance died in incubation, and 11,139 fry were lost in the troughs, leaving on hand 118,388 fry. Of this number, 30,940 were distributed and 87,448 were retained for rearing to the yearling stage. The eggs shipped from the station this year were packed in sphagnum moss collected in Maine, and the results so far reported are more satisfactory than in any previous season.

The early distribution of the trout in the fall of 1895 made it possible to use the old series of trout pools for holding brood stock during the spawning period. By this arrangement it became much easier to handle the fish and to segregate the sexes and the spent from the unripe fish.

The following tables show the loss of eggs and fry in the hatchery, the percentage of fry transferred to the rearing-ponds, and the maximum and minimum temperatures of water to which the various species were subjected during the year:

Number of eggs retained.	Eggs lost in incubation.	Fry lost in troughs.	Fry counted out into pools.	Per cent of loss.
13, 120	1, 450	1, 574	10, 105	23
8, 016	810	776	6, 430	19
6, 302	555	422	5, 325	15
11, 044	915	760	9, 369	15
14, 021	1, 380	745	11, 946	14
13, 298	1, 280	1, 124	10, 894	18
13, 147	1, 828	595	10, 724	18
9, 602	824	718	8, 060	16
16, 560	1, 360	815	14, 385	13
15, 695	1, 245	1, 240	13, 210	16
21, 445	1, 135	2, 370	17, 940	16
142, 250	12, 732	11, 130	118, 388	16

1644
2258
451
4353

Summary of temperatures to which the various species were subjected.

Species.	Maximum.	Minimum.
Trout, rainbows, fry to 6 years old	67	48
Black bass, fry to 6 years	79	33
Rock bass, fry to 6 years	76	36
Strawberry bass, fry to adults	67	39
Tench, fry to 6 years	77	34
Goldfish, fry to adults	75	47

In view of the success attained in the rearing of black bass and rock bass in the troughs and hatching-house, it is recommended that the hatching facilities be doubled. At present there are only eleven troughs, which are entirely inadequate for the needs of the station.

LEADVILLE STATION, COLORADO (E. A. TULIAN, SUPERINTENDENT).

The Government having acquired the right to use the water of Rock Creek and Evergreen Lakes, operations were commenced in June, 1895, with the view to increasing the water supply to the hatchery. A solid riprap dam was built in Rock Creek above the head of Evergreen Lakes ditch, and a wooden pipe was laid at an elevation of 9,918.66 feet, to connect the intake crib with an intermediate crib 1,644 feet distant. The intermediate crib was connected with Evergreen Lakes by a 16-inch overflow flume, and an 8-inch outlet pipe was laid to a lower crib, 2,258 feet distant. This lower crib was provided with an 8-inch outlet pipe and an overflow flume 10 by 16 inches, the elevation at the overflow being 9,706.85 feet. The 8-inch pipe conveys the water to the hatchery reservoir, 451 feet distant; it also supplies the house and stables, and has hydrant connections at other points.

On August 9 the water was turned into the pipe, and the flow into the intermediate crib was found to be 2,350 gallons per minute, and

1,500 per minute into the hatchery reservoir. Of this amount 500 gallons are required for the hatchery, and the balance is fed into the ponds. The temperature of the new water supply is 10° colder in midsummer and 1° warmer in winter than that which flows through the lakes to the hatchery.

Brook trout.—At the beginning of the year 112,000 were reported to be on hand, but this estimate proved erroneous, as the total output in the fall numbered 47,800, and the losses to the time of distribution amounted to only 16,000. Arrangements were made to collect eggs from various points in the vicinity of Leadville, and at the close of the season 360,900 had been secured at Wellington Lake, 179,900 at Uneva, 43,100 at Gales, 65,200 at Nasts, 47,000 at Twin Lakes, and 404,800 from brood stock at the station and in Evergreen Lakes, making a total of 1,100,900.

With the view to simplifying the work of capturing ripe fish in Evergreen Lakes, a spawning-race, 100 feet long, 4 feet wide, and 3 feet deep, was placed at the head of the lake early in the season, and a flow of water 2 feet deep turned through it. The result was disappointing, as very few fish were captured by means of it. This may have been because the flume was new, but it has since been observed that very few brook trout enter the cold mountain streams emptying into lakes in Colorado for the purpose of spawning.

The work at Wellington Lake extended from November 12 to December 14, being conducted under very unfavorable circumstances, owing to severe weather and lack of suitable facilities for capturing fish and taking spawn. The lake was frozen over solid, and as the fish entered the inlets in very small numbers, it became necessary to catch them by seines fished through holes in the ice. This work, ordinarily tedious, was rendered more so from the fact that the thermometer ranged from zero to 10° below every night, making it necessary to cut the ice out each day. The fish had to be stripped in the open air, and several lots of eggs were taken with the temperature ranging from zero to 16° above. As a result of the severe weather 160,000 of the 360,900 died in incubation. That the mortality was due to the intense cold is made evident by the fact that the loss on eggs taken when the temperature was above 32° ranged from 9 per cent to 16 per cent; of those taken in a temperature of 15° to 20° below freezing point, about 42 per cent succumbed, and on two lots taken at a temperature of zero over 80 per cent died, notwithstanding the fact that the fish from which they were taken were in better condition than those on which the smaller losses occurred. Arrangements have been made to erect a spawning-house at this point before the next season opens.

The Uneva Lake collections were not as large as anticipated, and owing to scarcity of male fish the loss of eggs from imperfect fertilization was considerable. The season lasted from October 29 to December 2, and on May 1 there were 143,740 fry on hand as a result of the collections made at that point. The collections at Gale's Pond were also very poor, owing to the fact that the fish were too fat. Several of them were opened and the vent was found to be so nearly closed that the eggs could not be forced out. Operations were discontinued on January 17, although there were on hand 80 large ripe females. The work at Nast's Lake, though small, was satisfactory. Half of the eggs collected at that point were turned over to the owner of the lake, and from the balance 26,000 healthy fry were produced, the loss in incubation being a little over 20 per cent. The result at Twin Lakes was discouraging, as it was not only an expensive field to operate, but 27,000 of the eggs secured were lost, owing to low temperature and rough handling in transportation.

The brood stock commenced spawning on October 5, the collections continuing until January 3. These eggs were of excellent quality, the loss in hatching being only 22 per cent, and in May, when the distribution of fry was undertaken, there were 314,000 in stock.

The first fry were hatched on January 5, 91 days after the spawning season commenced, and began taking food on February 20, at the age of 47 days. In May 332,000 of the fry on hand were distributed to applicants in Colorado, Wyoming, and South Dakota, and 170,520 were turned over to the owners of Wellington and Uneva lakes and Gale's Pond; the balance were retained to be reared and distributed as yearlings.

Loch Leven trout.—The first eggs of this species were obtained on October 24, and by January 18, the close of the season, 81,260 had been secured from brood stock at the station and wild fish in Uneva and Twin lakes. Three consignments of 10,000 each were shipped to Hon. G. Schnitger, fish commissioner of Wyoming, Hon. Lewis Miller, Laramie, Wyo., and Austin C. Tubbs, of California. From the balance 23,000 fry were hatched, 11,780 of which were on hand at the close of the year.

Rainbow trout.—As a result of eggs collected the preceding spring, there were 4,260 rainbow trout available for distribution in October. Of these, 900 were deposited in Evergreen Lakes and the balance were liberated in other waters. In February, 55,000 eggs were received from the Neosho, Mo., Station, and later in the spring collections aggregating 85,500 were secured at Uneva and Twin lakes. The eggs received from Neosho commenced hatching February 20 and finished March 16, yielding 52,800 fry. Of these, 32,300 were lost; the balance were distributed in May. From the collections made in the vicinity of the station there remained on hand at the close of the year 24,500 fry and 44,900 eggs.

Native trout.—From the 11,300 eggs of the yellow-finned trout on hand at the beginning of the fiscal year, 7,700 fingerlings were planted in Evergreen and Twin lakes in October. The following spring the first eggs were taken on May 12, at Twin Lakes, and the collection for the season amounted to 21,200. The loss to July 1 was 6,100, about 29 per cent.

The collection of black-spotted trout eggs commenced at Twin Lakes on May 14 and continued until June 24, the total number secured being only 207,000. The results were very discouraging, as operations had been conducted not only with the Government trap constructed the previous year, but the State trap and hatchery, which had been turned over to the Commission, were also used. It is believed that the presence of large numbers of suckers was the main cause of failure. They entered Lake Creek in such numbers that they crowded each other partly out of the water, and each morning from 500 to 1,000 pounds of dead ones were taken from the Government trap, and a ton or more of live fish were turned loose. But few suckers were caught at the State trap, and the results there would undoubtedly have been much better, but the trap was destroyed on the night of May 27 by persons in the neighborhood, who objected to its being operated, as it prevented the trout from running out of the lower lake into Lake Creek and thence into the Arkansas River.

At the time the trap was destroyed 600 native trout had been taken and the spawning season had not commenced. From the eggs obtained 25,000 were shipped to the Michigan Fish Commission; the balance were hatched at the station and at the close of the year there remained on hand 44,900. The large loss in incubation was no doubt due to the poor quality of the males used.

Under ordinary conditions the eye-spots appeared in the rainbow, yellow-finned, and black-spotted trout eggs collected during the spring in about 20 days, and the eggs commenced hatching in 45 days, though the last ones taken frequently hatched in 30 days or less, according to the temperature of the water. Feeding commenced after the absorption of the sac, which required from 20 to 30 days.

At the beginning of the fiscal year there were on hand 36,580 black-spotted trout eggs; 10,000 of these were shipped to the Michigan Commission and arrived in excellent condition, notwithstanding the fact that the temperature was over 100° in the shade during the four days the consignment was en route. From the balance, 6,000 yearlings were reared and distributed in the month of October to applicants in Colorado and Wyoming, and 5,600 were deposited in Evergreen and Twin Lakes.

The stock of fish remaining on hand at the close of the season was as follows:

Species.	Calendar year in which fish were hatched.		Eggs.
	1896.	1802.	
Brook trout	137,000	566	....
Loch Leven trout	11,780	118	....
Rainbow trout	24,600	....	44,900
Black-spotted trout	20,000	40	57,900
Yellow-finned trout	....	....	15,100

BAIRD STATION, CALIFORNIA (LIVINGSTON STONE, SUPERINTENDENT).

At the beginning of the year a rack was constructed across McCloud River to prevent the ascent of salmon. Several additional piers were rendered necessary by the constant widening of the river. After the completion of this work the old wornout flatboats supporting the current wheel were removed, and two substantial piers were erected in place of them. Seining operations for the summer run of salmon were commenced August 26, and the first eggs were collected the following day. The season lasted a month, and the results attained were unusually large, the yield of eggs amounting to 7,747,600. Operations were resumed on October 30, when the fall run of salmon appeared, but owing to low water in the river very few fish were captured, and only 1,915,400 eggs were secured, making a total of 9,663,000 for the season.

As in past years the bulk of the season's collection was transferred to the California State Fish Commission, to be hatched at the Sisson Hatchery and planted in the public waters of the State. Of the stock remaining 2,674,000 were transferred to Clackamas Station; 10,000 were sent to Craig Brook Station, and 40,000 to Atlanta for hatching in the United States Fish Commission exhibit. In addition to these shipments the following assignments were sent to applicants in foreign countries:

Consignee.	Number assigned.
S. Jaffé, Sandfort, Osnabruck, Germany	25,000
Gen. Reuben Alonzo, Leon, Nicaragua	20,000
R. L. Moore, Belleek, Ireland	50,000

The balance of the eggs, amounting to 768,200, were retained at the station, and of the 650,000 fry resulting from them 400,000 were deposited in McCloud River in February and March. The remaining 250,000 were kept in troughs at the hatchery, being fed on chopped liver, venison, and such other fresh meat as could be secured. When they were liberated in the Sacramento River, on May 12, they were strong, healthy fish, ranging in length from 1½ to 2½ inches. These fish were kept during the winter without expense, except the cost of the food, as the water used was supplied by gravity through the aqueduct from Wiley Creek, which was completed during the summer. The hatching apparatus used was the Williamson trough and the Stone salmon basket, a full description of which is given in the report for 1895.

During the year the superintendent visited Battle Creek and made a report on the advisability of either acquiring the salmon-hatching station recently established there by the California Fish Commission, or opening an auxiliary station in connection with Baird, since the conditions existing on the creek indicated that immense numbers of eggs could be collected annually, the California Commission having taken over 10,000,000 during a period of less than one month.

Table of temperatures at Baird Station.

Month.	Air.			Water.			Month.	Air.			Water.		
	Min.	Max.	Mean.	Min	Max.	Mean.		Min.	Max.	Mean.	Min.	Max.	Mean.
1895.							1896.						
July	69	94	85	56	58	57	January	44	72	56	42	49	46
August	78	99	87	58	60	58	February	49	78	63	45	50	47
September	60	90	75	49	57	51	March	34	78	70	41	52	48
October	67	90	79	49	54	52	April	42	72	55	45	52	49
November	42	87	65	41	50	45	May	46	92	67	48	56	51
December	36	70	51	39	47	43	June	58	92	82	52	58	56

Table showing the catch of salmon and number of eggs collected at Baird Station.

Date.	Salmon caught.			Eggs collected.	Date.	Salmon caught.			Eggs collected.
	Male.	Fem.	Ripe.			Male.	Fem.	Ripe.	
1896.					1896.				
Aug. 26	343	171	19	....	Oct. 21	13	13	9	....
27	619	288	19	79,900	22	8	4	4	....
28	303	270	16	65,500	23	7	2	2	....
29	201	151	12	93,600	28	23	31	16	....
30	283	171	21	57,500	29	35	24	34	....
31	310	139	28	83,400	30	15	9	7	178,500
Sept. 1	97	53	15	137,000	31	33	27	10	....
2	433	240	56	221,000	Nov. 1	33	29	11	189,100
3	308	181	56	283,800	2	22	39	21	....
4	403	178	66	278,800	3	29	31	12	....
5	270	143	50	277,900	4	27	20	12	148,200
6	386	153	47	294,100	6	22	14	10	....
7	368	196	82	265,500	7	25	27	15	95,200
8	329	169	63	335,700	9	6	6	3	....
9	357	154	84	517,000	11	46	37	14	....
10	695	357	113	345,800	12	51	41	23	168,300
11	565	364	86	542,000	13	22	25	19	120,700
12	270	122	33	....	15	14	21	10	....
13	362	311	64	709,800	16	12	22	12	192,100
14	467	243	37	308,500	19	......	......	......	125,800
16	395	183	116	657,000	21	......	......	......	126,600
17	186	105	65	....	25	2	5	5	54,400
18	89	45	26	503,800	26	2	3	2	....
19	115	87	57	....	27	7	5	4	....
20	157	105	79	545,400	29	36	39	28	68,800
21	56	46	22	240,800	30	8	9	6	91,800
23	44	29	23	....	Dec. 2	8	19	12	85,000
24	46	57	47	329,400	3	3	6	4	....
25	25	44	36	....	4	6	......	......	85,500
26	15	30	28	307,600	5	6	5	5	....
27	77	24	20	200,000	6	16	8	7	....
28	2	2	2	....	7	4	4	4	131,400
30	3	4	2	66,800	11	2	......	......	....
Oct. 18	11	13	10	....	14	......	......	......	54,000
19	17	14	8	....					
20	13	11	9	....	Total	9,320	5,512	1,951	9,663,000

FORT GASTON AND SUBSTATIONS (CAPT. W. E. DOUGHERTY IN CHARGE).

The allotment for the fiscal year being only $1,000 it was decided to close the substation at Korbel and confine operations to the collection of steelhead-trout and quinnat-salmon eggs at the substation on Redwood Creek, and of Von Behr and rainbow trout eggs at Fort Gaston. The difficulty experienced heretofore in constructing a rack that would withstand the force of the water during a freshet was overcome this year by a plan devised by Mr. Dayton Barnhardt. The bed of the river, 135 feet wide, was paved with heavy timbers 30 feet long. Timber piers were then constructed 30 feet apart, which extended up through the platform to high water, and the rack was built across the river 5 feet high, so as to permit the water at its highest stages to pass over the top.

During the months of December and January 73,000 quinnat-salmon eggs were taken from the 49 females captured. These eggs were hatched at the station and the 65,700 fry resulting from them were liberated in adjacent streams. Only about 50 per cent of the steelhead trout below the rack were used, as the means for impounding them were inadequate, but 795,000 eggs were secured from the 257 females stripped. The bulk of these eggs were shipped, as shown by the accompanying table, but from those retained at the station 107,808 fry were deposited in waters in the immediate vicinity.

Shipments of steelhead-trout eggs.

Consignee.	Number.
New York Fish Commission, Caledonia, N. Y	75,000
U. S. F. C. Station, Northville, Mich	100,000
U. S. F. C. Station, Duluth, Minn	150,000
U. S. F. C. Station, Cape Vincent, N. Y	50,000
U. S. F. C. Station, East Orland, Me	160,000
Japanese Minister of Agriculture and Commerce, Niigata Ken, Japan	75,000
New York Fish Commission, Cold Spring Harbor, N. Y	25,000
Total	635,000

From brood fish at Fort Gaston 17,000 Von Behr and 87,000 rainbow-trout eggs were taken; 10,000 Von Behr eggs were consigned to the California Fish Commission and 30,000 of the rainbows to the Country Club, Marin County, Cal. The balance were hatched at the station. At the close of the fiscal year the stock on hand was as follows:

Species.	Calendar year in which hatched.		
	1896.	1895.	1894.
Rainbow trout	40,000	3,000	100
Von Behr trout	1,500	200	....
Brook trout	....	200	....

In view of the increased run of salmon in Redwood Creek and Mad River, due to plants made in previous years, it is recommended by the superintendent that both of the substations be operated to their fullest capacity during the next fiscal year. The hatchery at Redwood is located in a building 18 by 42 feet, and is equipped with 14 troughs, fitted with trays and salmon baskets. The water supply is taken from Minor Creek, 650 feet distant, and is conducted to the hatchery through an open ditch and flume. The Fort Gaston hatchery is 30 by 38 feet, and is equipped with 36 troughs 12 feet long, 12 inches wide, and 5 inches deep, fitted with trays 10 by 22 inches. The water for the hatchery is obtained from two sources, Supply Creek and Hospital Creek.

CLACKAMAS.

Acting on information contained in the report of Prof. Barton W. Evermann, on his investigation of the headwaters of Columbia River Basin, the superintendent was instructed not to attempt collections on the Clackamas River, but to arrange for the operation of a field station at some point on Snake River in Idaho. Accordingly, a survey of the grounds was made during the early summer, and it was decided to locate the station near Weiser, as a larger number of fishermen operated in that vicinity than at any other point on the river. On August 12 the superintendent transferred the regular force from Clackamas, together with the necessary supplies and apparatus, and arranged for establishing the station on an island in the river 7 miles below Weiser. This island was owned by Mr. T. L. Westlake, who permitted the use of the land without charge. A small channel which divided the island was inclosed in wire netting for the purpose of penning the fish taken, and a current wheel was erected in order to supply water for hatching operations. Considerable difficulty was experienced in procuring the necessary lumber and other material for erecting the wheel and troughs, owing to the isolated situation of the island, but by August 28 ten troughs 12 feet long had been constructed and a flume provided for conducting the water furnished by the wheel. It was the original intention to use the wheel simply as motive power for operating a Chinese pump, but, as this plan proved to be impracticable, the pump was discarded and the water was raised from the river by buckets attached to the paddles of the wheel.

Arrangements were made with the fishermen in the vicinity to purchase all of the female salmon and an equal number of males at 40 cents each, the fish to be delivered at the station. From the reported catch of the previous year it was thought that no difficulty would be experienced in obtaining all of the brood fish desired, but as the season advanced it became apparent that, owing to low water in the river, very few fish would be caught. Mr. William O'Brien, whose fishery is on the Oregon side about 2½ miles above the station, and who expected to furnish at least 2,000, delivered by September 12 only 50. These were transported to the station in live-boxes, and though in good condition apparently when received, they soon developed sores and fungus, and many of them became blind. They commenced dying shortly afterwards, and by October 1 forty-one of them had been lost. The water in the river at this time was very warm, its temperature at noon ranging from 70° to 80° It was then arranged with Mr. O'Brien to pen the fish at his fishery, and although they did better at first than those transferred to the station, they also became fungussed in a short time and many died. Most of the quinnat salmon were taken during September, the catch being at its best about the middle of the month. The total number furnished by Mr. O'Brien was 161, and the majority of them were males. During the month of October 64,000 eggs were secured from the fish surviving at the pound and those at the O'Brien fishery, the last lot being taken on the 1st of November. After that date arrangements were made to close the field station, and the eggs were packed in moss and ice and shipped by express to Clackamas.

As only a few of the eggs were eyed at the time of shipment, a large number were lost in transit, and but 19,000 fry were hatched from them, 17,000 of which survived and were liberated in Clear Creek on February 14. On October 16 a shipment of 1,534,000 quinnat salmon eggs was received from Baird Station. The fry resulting from them were held until the sac was absorbed, when plants aggregating 1,236,072 were made in Clackamas River and Clear Creek. The balance of the fry hatched from the consignment, amounting to 79,746, were retained in the troughs and fed until May 21. These fish when liberated averaged 2⅝ inches in length, and the loss amounted to only 2,147. The adipose fins of 5,000 of them were cut off before planting, with the view to identifying them later on if practicable. On December 18 another shipment of 1,000,000 eggs arrived from Battle Creek, Cal., and a third consignment of 1,140,000, transferred from Baird Station, was received January 22, making a total of 3,674,000 transferred to Clackamas from California stations. The loss on these shipments was very small, and the fry resulting from them were also liberated in Clackamas River and Clear Creek as soon as the sac was absorbed, with the exception of 481,635, which were retained in the hatchery until May 21.

The following table shows the number of fry liberated at the various points, and dates of deposit:

Waters stocked.	Date of deposit.	Number deposited.
	1895.	
Clackamas River, at Clackamas, Oreg	Dec. 19	239,240
Do	Dec. 20	239,240
Do	Dec. 26	239,240
Clear Creek, at Clackamas, Oreg	Dec. 28	358,860
Clackamas River, at Clackamas	Dec. 31	159,492
	1896.	
Clear Creek, Clackamas	Feb. 14	17,000
Clackamas River and Clear Creek, Clackamas	Mar. 9	600,000
Clear Creek, Clackamas	Mar. 24	379,078
Clackamas River and Clear Creek, Clackamas	Mar. 27	400,000
Do	Mar. 28	200,000
Clear Creek, Clackamas	May 21	278,575
Do	May 22	278,575
Total		3,389,300

Repairs and improvements.—During the year a new barn, 34 by 30, was constructed by station employees, and a new suction pipe was laid to Clear Creek. A flume was constructed to convey water by gravity from a small brook, 80 rods distant, to the hatchery, thus making it unnecessary to operate the pump during the winter months. The hatchery was supplied with water from Clear Creek until December 6, when the gravity supply was utilized to the end of the season. The gravity supply is available only during the winter and spring months, as the brook dries up in summer.

DISTRIBUTION.

During the year the cars were occupied as usual in making the distribution of trout, salmon, whitefish, shad, black bass, rock bass, carp, and tench, traveling 93,436 miles. In addition to this, 93,591 miles were traveled by detached messengers. The total number of fish handled by the cars and messengers was as follows:

Species.	Fry.	Fingerlings and yearlings.
Trout	1,864,000	319,334
Landlocked salmon	67,000	37,382
Whitefish	39,000,000	....
Shad	78,000,000	....
Black bass	....	35,931
Rock bass	....	35,581
Carp and tench	....	131,152
Total	118,931,000	559,380

Two distributions of trout were made during the year, one in the fall when the yearling fish—that is, fish resulting from the previous year's product—were distributed, and again in the spring, when the lake-trout fry were planted, and part of the brook and rainbow trout fry from some of the stations where the stock was too large to be carried through the summer.

The distribution of yearlings commenced in September and continued until December 15, and, with the exception of the loss of two carloads of yearling rainbow trout from Neosho Station, it was very successfully accomplished. The losses referred to occurred during the month of September, when the temperature of the air inside the car registered 101° and 106° F., respectively. Efforts were made to keep the water temperature down to 50° by the liberal use of ice, but this did not apparently reduce the death rate. Large losses have occurred heretofore under somewhat similar conditions, but it was thought they killed themselves by jumping, attributed to fright. In this instance they did not jump.

The landlocked salmon at Green Lake, Maine, were distributed with the trout in September and October, and in June.

The water used in the transportation of salmon and trout varied in temperature from 34° to 69°, its average being 43°. They were carried in square galvanized iron tanks of 50 gallons capacity, and in the regular round-shouldered cans of 10 gallons, both air and water circulation being used, except in the case of car No. 4, which had been fitted for the transportation of marine fishes, with air circulation alone. Most successful results were attained in carrying rainbow trout on this car, the fish being transported in round-shouldered cans, which were connected with the air pump by means of half-inch rubber tubing. The air passed into the cans through air-liberators attached to this tubing.

In March 3,000,000 whitefish eggs were shipped from Put-in Bay Station on car No. 3 to Bear Lake, Idaho, where they were hatched and liberated; 34,000,000 fry were also deposited in Lakes Huron, Superior, Michigan, and in Turkey Lake, Indiana, during the months of April and May, with a loss of only 50,000. The average temperature of the water in which they were transported was 37°. Air circulation was used in the distribution of whitefish and resulted in doubling the capacity of the cars, over 4,000,000 being taken on some trips.

The black bass and rock bass produced at Neosho and Wytheville and the Washington Fish Ponds were distributed at the same time as the yearling rainbow trout. The distribution from Quincy was made during summer. Little difficulty was experienced in transporting these species (the losses not exceeding 6 per cent); they were carried as usual in square galvanized-iron tanks with a temperature ranging from 55° to 60°. Large numbers of rock bass were shipped with satisfactory results in carp pails, about 30 to each pail, on trips not requiring more than 24 hours' time. This method of shipment reduced very materially the expense of distribution and also saved much time. It was tried with the black bass for short shipments, but with only moderate success.

During the fall carp and tench numbering 131,152 were distributed, the cars engaged in the work traveling 9,836 miles, with a loss of only 8,459 fish. In the spring two of the cars, with the aid of three additional messengers, planted 78,000,000 shad fry in rivers along the Atlantic coast from Florida to Massachusetts. They were transported in the regulation round-shouldered cans, in water of a temperature ranging from 62° to 68°.

In addition to the regular work the car and messenger service was called upon to transport the fish exhibited by the Commission at the Cotton States and International Exposition, Atlanta, Ga. Car No. 4 was specially fitted for the transportation of marine fishes with an air-circulating plant similar to that used in transporting salt-water fishes to Chicago for the World's Columbian Exposition, rectangular tanks with submerged covers being used instead of the circular ones, as it was found that the fish carried much better in them.

As many of the railroads refused to haul the cars unless fitted with quick-action air brakes, Nos. 1 and 2 were equipped during the year as required, but, owing to its construction, No. 3 could not be equipped in this manner.

In January when No. 2 was sent to the railroad shops at Altoona, to have the quick-action air brake put on, it was discovered that the main timbers were much decayed, and further examination showed the car to be so unsafe that arrangements were at once made to rebuild it, using as much of the old material as practicable. It was completed in March, at an expense of about $4,000, and was then taken to Central Station, where the boilers, pumps, hatching apparatus and circulating pipes were replaced by the engineer force of the Commission.

Résumé by States and Territories of the distribution and assignment of fish and eggs.

State or Territory.	Species.	Eggs.	Fry.	Adults and yearlings.
Alabama	Carp			599
	Tench			554
	Goldfish			12
	Rainbow trout			3,600
	Black bass (large mouth)			400
	Rock bass			900
Arizona	Tench			95
	Rock bass			93
Arkansas	Goldfish			10
	Carp			258
	Tench			650
	Rainbow trout	17,550	9,940	16,620
	Von Behr trout			1,000
	Brook trout			350
	Lake trout	5,000		
	Black bass (large mouth)			275
	Rock bass			500
California	Quinnat salmon	6,075,800	465,700	250,000
	Steelhead trout		107,808	
	Loch Leven trout	10,000		
	Rainbow trout	30,000		
	Von Behr trout	10,000		
Colorado	Rainbow trout		5,900	4,530
	Black-spotted trout		8,600	
	Yellow-finned trout		7,700	
	Brook trout		250,500	19,800
	Rock bass			100
	Black bass (large mouth)			150
Connecticut	Goldfish			24
	Shad		6,362,000	
	Atlantic salmon	50,000		
	Rainbow trout	25,000		2,870
	Brook trout			7,130
	Black bass (large mouth)			300
	Lobster		10,138,000	
Delaware	Carp			1,000
	Tench			224
	Golden tench			12
	Shad	1,165,000	8,881,000	
	Rainbow trout	10,000		
District of Columbia	Carp			5,646
	Tench			1,524
	Goldfish			113
	Golden tench			24
	Golden ide			8
	Rainbow trout		3,500	298
	Shad		9,390,000	1,000,000
	Black bass (large mouth)			100
Florida	Carp			2,070
	Tench			505
	Shad		4,674,000	
Georgia	Carp			14,101
	Tench			11,426
	Goldfish			330
	Golden tench			9
	Shad		4,593,000	
	Landlocked salmon			69
	Rainbow trout			1,533
	Black-spotted trout			17
	Brook trout			38
	Lake trout		9,000	
	Yellow perch			60
	Black bass (large mouth)			1,007
	Black bass (small mouth)			100
	Sunfish			35
	Rock bass			1,549
Idaho	Carp			496
	Tench			758
	Brook trout			1,475
	Whitefish		2,940,000	
	Yellow perch			400
	Black bass (large mouth)			270
Illinois	Carp			50
	Tench			680
	Goldfish			20
	Black bass (large mouth)			950
	Rock bass			600
Indiana	Carp			90
	Tench			185
	Loch Leven trout		4,000	
	Rainbow trout		7,500	3,761
	Brook trout		7,000	
	Whitefish		2,000,000	
	Black bass (large mouth)			1,800
	Rock bass			885

Résumé of the distribution and assignment of fish and eggs—Continued.

State or Territory.	Species.	Eggs.	Fry.	Adults and yearlings.
Indian Territory	Carp			700
	Rainbow trout			2,400
	Black bass (large mouth)			75
	Rock bass			300
Iowa	Carp			2,371
	Tench			500
	Rainbow trout		1,000	1,500
	Brook trout		20,000	
	Yellow perch			550
	Pickerel			50
	Black bass (large mouth)			1,625
	White bass		19,500	
	Rock bass			900
Kansas	Carp			2,290
	Tench			2,321
	Goldfish			20
	Rainbow trout			8,361
	Black bass (large mouth)			750
	Rock bass			4,935
Kentucky	Carp			300
	Tench			300
	Rainbow trout			1,250
	Black bass (large mouth)			1,910
	Rock bass			2,075
Louisiana	Carp			161
	Tench			30
	Goldfish			727
	Rainbow trout			1,000
	Black bass (large mouth)			300
	Rock bass			63
Maine	Carp			30
	Atlantic salmon			151,676
	Landlocked salmon		59,525	34,482
	Steelhead trout		43,907	
	Rainbow trout			48
	Brook trout	40,000	24,565	10,913
	Lake trout			1,000
	Golden trout		21,700	10
	Scotch sea trout			1,376
	Lobster		759,000	
	Mackerel		213,500	
Maryland	Carp			5,500
	Tench			512
	Shad		26,653,000	
	Rainbow trout		4,600	5,150
	Von Behr trout		8,422	
	Yellow perch		812,000	
	Black bass (large mouth)			315
	Black bass (small mouth)			400
	Rock bass			600
Massachusetts	Carp			671
	Tench			115
	Shad		1,490,000	
	Atlantic salmon	20,000		
	Rainbow trout			1,000
	Brook trout		3,000	2,800
	Lake trout		14,000	
	Black bass (large mouth)			333
	Cod	846,000	65,366,000	
	Flatfish		8,472,000	
	Lobster		86,032,000	
	Tautog		17,575,000	
	Mackerel		1,728,000	
Michigan	Carp			420
	Goldfish			12
	Steelhead trout		85,000	
	Loch Leven trout		13,000	
	Rainbow trout		5,000	
	Von Behr trout		20,000	
	Black-spotted trout	35,000		
	Brook trout		158,000	300
	Lake trout		2,490,000	
	Whitefish		43,100,000	
	Black bass (large mouth)			2,650
Minnesota	Carp			3,100
	Steelhead trout		85,000	
	Loch Leven trout	10,000		
	Rainbow trout		13,000	
	Brook trout	20,000	3,100	
	Lake trout		1,240,000	
	Whitefish		250,000	
	Black bass (large mouth)			200
Mississippi	Carp			145
	Tench			235
	Goldfish			12

Résumé of the distribution and assignment of fish and eggs—Continued.

State or Territory.	Species.	Eggs.	Fry.	Adults and yearlings.
Mississippi	Black bass (large mouth)			1,250
Missouri	Rock bass			1,150
	Carp			179
	Tench			1,204
	Goldfish			968
	Rainbow trout	20,475	21,000	21,624
	Black bass (large mouth)			489
Montana	Rock bass			1,400
	Carp			705
	Brook trout			2,205
	Yellow perch			500
Nebraska	Black bass (large mouth)			650
	Carp			541
	Tench			1,100
	Goldfish			312
	Loch Leven trout	10,000		
	Rainbow trout	65,740	900	1,500
	Brook trout			750
	Lake trout	200,000		
Nevada	Rock bass			590
	Rainbow trout	61,739		
New Hampshire	Lake trout	50,000		
	Atlantic salmon	50,000	19,000	
	Landlocked salmon		3,000	
	Steelhead trout			258
	Rainbow trout	25,000	15,890	2,000
	Brook trout	25,000	9,750	2,300
	Black bass (large mouth)			100
New Jersey	Lobster		150,000	
	Carp			120
	Goldfish			12
	Shad	63,000	8,608,000	
	Landlocked salmon	2,000		
	Rainbow trout			3,000
	Brook trout	25,000		405
	Black bass (large mouth)			685
New Mexico	Rock bass			400
	Carp			600
	Tench			1,040
	Rainbow trout			2,420
	Black bass (large mouth)			650
New York	Rock bass			700
	Carp			650
	Shad		5,495,000	
	Atlantic salmon	50,000		
	Landlocked salmon	2,000	2,000	14,300
	Steelhead trout	100,000		
	Rainbow trout		2,200	475
	Von Behr trout		2,000	
	Brook trout		22,100	3,665
	Lake trout	200,000	1,642,000	
	Scotch sea trout	5,100		
	Whitefish		20,000,000	
	Black bass (large mouth)			350
	Black bass (small mouth)			358
North Carolina	Rock bass			550
	Carp			1,405
	Tench			1,178
	Shad		1,744,500	
	Rainbow trout			7,665
	Black bass (large mouth)			350
North Dakota	Rock bass			1,550
	Carp			610
	Rainbow trout		8,000	
	Brook trout			1,830
	Lake trout		30,000	
	Yellow perch			200
Ohio	Black bass (large mouth)			400
	Carp			60
	Tench			892
	Goldfish			70
	Rainbow trout		6,500	660
	Von Behr trout	15,000	10,000	
	Brook trout	20,000	5,000	
	Lake trout		685,400	
	Whitefish		115,650,000	
	Lake herring		690,000	
	Black bass (large mouth)			1,365
Oklahoma	Rock bass			1,550
	Carp			9,744
	Tench			2,307
	Goldfish			16
	Rainbow trout			700
	Black bass (large mouth)			300
	Rock bass			1,500

Résumé of the distribution and assignment of fish and eggs—Continued.

State or Territory.	Species.	Eggs.	Fry.	Adults and yearlings.
Oregon	Carp			60
	Tench			50
	Quinnat salmon		2,832,150	557,150
	Black bass (large mouth)			175
Pennsylvania	Carp			380
	Tench			3,680
	Goldfish			121
	Shad		7,125,000	
	Atlantic salmon	100,000		
	Rainbow trout		18,000	25,415
	Lake trout		16,947	
	Black bass (large mouth)			1,120
Rhode Island	Von Behr trout	10,000	3,705	
	Brook trout			498
	Landlocked salmon		3,000	
South Carolina	Carp			12,872
	Tench			1,700
	Goldfish			42
	Shad		400,000	
	Black bass (large mouth)			268
	Black bass (small mouth)			57
	Rock bass			510
South Dakota	Carp			1,978
	Rainbow trout		11,000	
	Brook trout		51,000	7,955
	Yellow perch			75
	Black bass (large mouth)			1,524
Tennessee	Carp			6,530
	Tench			2,823
	Goldfish			30
	Rainbow trout		46,000	11,407
	Black bass (large mouth)			2,050
	Rock bass			1,899
Texas	Carp			1,715
	Tench			6,188
	Goldfish			24
	Rainbow trout			1,400
	Black bass (large mouth)			3,000
	Rock bass			5,900
Utah	Carp			90
	Tench			90
	Rainbow trout		10,000	
	Brook trout		20,000	4,050
	Rock bass			190
Vermont	Steelhead trout		4,000	777
	Rainbow trout		9,950	2,000
	Von Behr trout	10,000	13,590	
	Brook trout		4,965	5,400
	Lake trout	800,000	38,671	1,000
Virginia	Carp			4,514
	Tench			570
	Shad	1,000,000	9,748,000	
	Rainbow trout		38,968	9,077
	Black bass (large mouth)			900
	Rock bass			2,000
Washington	Tench			850
	Yellow perch			450
	Black bass (large mouth)			625
West Virginia	Carp			240
	Tench			123
	Rainbow trout			2,670
	Rock bass			200
Wisconsin	Carp			10,320
	Tench			90
	Steelhead trout		20,000	
	Brook trout		12,000	
	Lake trout		1,625,000	
	Whitefish		5,750,000	
	Pickerel			1,350
	Black bass (large mouth)			3,585
Wyoming	Carp			400
	Loch Leven trout	20,000		
	Rainbow trout	57,190	1,000	
	Black-spotted trout		3,000	
	Brook trout		10,000	4,225
	Lake trout	200,000		
	Black bass (large mouth)			500
Foreign countries	Quinnat salmon	95,000		
	Steelhead trout	75,000		
	Rainbow trout	125,000		
	Lake trout	50,000	198,000	
	Whitefish	50,000		
	Totals	**11,460,594**	**484,579,058**	**2,448,621**

Details of distribution.

Species and disposition.	Eggs.	Fry and fingerlings.	Adults and yearlings.
Carp:			
Applicants in Alabama			599
Arkansas			258
Delaware State Fish Commission			1,000
Ponds in Zoological Park, District of Columbia			500
Potomac River near Washington, D. C			4,990
Applicants in District of Columbia			156
Florida			2,079
Georgia			1,274
Etowah River near Canton, Ga			1,000
Flint River near La Grange, Ga			3,000
Savannah River near Augusta, Ga			5,830
Satilla River near Waycross, Ga			3,000
Applicants in Idaho			496
Illinois			50
Indiana			90
Indian Territory			700
Iowa			371
Iowa State Fish Commission			2,000
Applicants in Kansas			2,290
Kentucky			360
Louisiana			161
Maine			30
Maryland			560
Maryland State Fish Commission			2,000
Susquehanna River near Havre de Grace, Md			1,000
Perryville, Md			2,000
Applicants in Massachusetts			671
Michigan			420
Minnesota			100
Minnesota State Fish Commission			3,000
Applicants in Mississippi			145
Missouri			57
Hickory Creek near Neosho, Mo			122
Applicants in Montana			705
Nebraska			541
New Jersey			60
Musconetcong River near Rahway, N. J			60
Applicants in New Mexico			900
New York			650
North Carolina			1,405
North Dakota			610
Ohio			60
Applicants in Oklahoma			2,744
Oregon			60
Pennsylvania			380
South Carolina			1,872
Cape Fear River near Fayetteville, S. C			3,000
Pee Dee River near Pee Dee, S. C			3,000
Edisto River near Pon Pon, S. C			3,000
Ashepo River near Ashepo, S. C			2,000
Applicants in South Dakota			1,078
Tennessee River near Loudon, Tenn			2,500
Knoxville, Tenn			300
East and west fork of Stone River near Murfreesboro, Tenn			500
Boone and Cherokee creeks near Jonesboro, Tenn			3,000
Applicants in Tennessee			230
Texas			1,715
Utah			90
Virginia			1,852
Cripple Creek near Ivanhoe, Va			100
Rappahannock River near Elkwood, Va			500
James River near Richmond, Va			2,000
Tate Run near Wytheville, Va			62
Applicants in West Virginia			240
Wisconsin			320
Wisconsin State Fish Commission			10,000
Applicants in Wyoming			400
Tench:			
Applicants in Alabama			554
Arizona			95
Arkansas			650
Delaware			24
Appoquinnick River near Middletown, Del			200
Pond in Zoological Park, District of Columbia			500
Potomac River, Washington, D. C			1,024
Applicants in Florida			505
Etowah River near Jasper, Ga			1,000
Long Swamp Creek near Jasper, Ga			1,000
Tate Pond near Jasper, Ga			1,000
Flint River near La Grange, Ga			4,000
Savannah River near Augusta, Ga			60

Details of distribution—Continued.

Species and disposition.	Eggs.	Fry and fingerlings.	Adults and yearlings.
Tench—Continued.			
Applicants in Georgia			4,366
Diamond Lake near Newport, Idaho			500
Applicants in Idaho			258
Des Plains River near Des Plains, Ill			500
Applicants in Illinois			180
Indiana			185
Upper Iowa River near Chester, Iowa			500
Brickner River near Jetmore, Kans			100
Applicants in Kansas			2,221
Kentucky			360
Louisiana			30
Youghiogheny River near Oakland, Md			150
Applicants in Maryland			302
Massachusetts			115
Mississippi			235
Flat Creek near Verona, Mo			200
Hickory Creek near Neosho			64
Applicants in Missouri			940
Nebraska			100
Nebraska State Fish Commission			1,000
Applicants in New Mexico			1,040
North Carolina			1,178
Ohio			692
Tinker Creek near Bedford, Ohio			200
Eastern Branch of Kingfisher Creek near El Reno, Okla			100
Applicants in Oklahoma			2,297
Alden Springs near Laurel, Oreg			50
Brandywine Stream near Reading, Pa			3,000
Jacobs Creek near Mount Pleasant, Pa			150
Mendenhall Lake near Mendenhall, Pa			30
Conodoquinnette Creek near Carlisle, Pa			150
Tributary of Susquehanna River near Selinsgrove, Pa			200
Applicants in Pennsylvania			150
Broad River near Blacksburg, S. C			500
Applicants in South Carolina			1,200
Cove, Hickory, Dairs, and Indian creeks in Campbell County, Tenn			300
Tennessee River near Loudon, Tenn			300
Knoxville, Tenn			200
Lamberton and Cherokee creeks near Jonesboro, Tenn			300
East and West Fork of Stone River near Murfreesboro, Tenn			200
Harpeth River near Newsom, Tenn			200
North Fork of Forked Deer River near Trenton, Tenn			300
Jellico Creek near Gumfork, Tenn			300
Applicants in Tennessee			723
Palestine Fishing Club Lake near Palestine, Tex			1,800
Trinity River near Fort Worth, Tex			1,800
Applicants in Texas			2,588
Utah			90
Crab Creek near Wytheville, Va			150
Applicants in Virginia			420
Washington			150
Fourth of July Lake near Sprague, Wash			200
Applicants in West Virginia			123
Wisconsin			90
Goldfish.			
Applicants in Alabama			12
Arkansas			10
Connecticut			24
Ponds in Zoological Park, D. C			56
Fountain in front of Treasury Department, D. C			25
Applicants in District of Columbia			82
Georgia			330
Illinois			20
Kansas			20
Louisiana			112
Fountains in city parks, New Orleans, La			615
Applicants in Michigan			12
Mississippi			12
Hickory Creek, near Neosho, Mo			8
Lakes in Forest Hill Cemetery, Kansas City, Mo			960
Applicants in Nebraska			12
Nebraska State Fish Commission, South Bend, Nebr			300
Pond in City Park, Paterson, N. J			12
Applicants in Ohio			20
University Lake, Columbus, Ohio			50
Applicants in Oklahoma			16
Pennsylvania			121
South Carolina			42
Tennessee			30
Texas			24

Details of distribution—Continued.

Species and disposition.	Eggs.	Fry and fingerlings.	Adults and yearlings.
Golden tench:			
Delaware State Fish Commission			12
Applicants in District of Columbia			24
Georgia			9
Golden ide:			
Fountain in front of Treasury Department, D. C			8
*Shad:**			
Connecticut State Fish Commission ponds, Joshuatown, Conn		6,302,000	
Delaware State Fish Commission	1,165,000		
Mispillion River near Milford, Del		625,000	
Smyrna River near Smyrna, Del		575,000	
Jones Creek near Dover, Del		575,000	
Murderkill Creek near Felton, Del		625,000	
Nanticoke River near Seaford, Del		375,000	
Leipsic River near Leipsic, Del		250,000	
Broadkiln River near Milton, Del		100,000	
Indian River near Millsboro, Del		750,000	
Potomac River near Washington, D. C		5,027,000	1,000,000
Eastern Branch of Potomac River near Benning, D. C		4,363,000	
St. Johns River near Sanford, Fla		4,224,000	
Crane Creek, tributary of St. Lucie River, near Stuart, Fla		450,000	
Savannah River near Augusta, Ga		1,703,000	
Ogeechee River near Midville, Ga		400,000	
Ocmulgee River near Macon, Ga		400,000	
Altamaha River near Doctortown, Ga		545,000	
Satilla River near Waycross, Ga		545,000	
Withlacoochee River near Quitman, Ga		500,000	
Allapaha River near Stockton, Ga		500,000	
Chesapeake Bay near Battery Island, Md		15,142,000	
Patapsco River near Relay Station, Md		894,000	
Patuxent River near Laurel, Md		1,281,000	
Bush River near Bush River Station, Md		2,250,000	
Gunpowder River near Gunpowder Station, Md		2,250,000	
Potomac River near Point of Rocks, Md		2,952,000	
Tuckahoe River near Queen Anne, Md		875,000	
Chester River near Chestertown, Md		375,000	
Monocacy River near Dickerson Station, Md		759,000	
Wicomico River near Salisbury, Md		375,000	
Waukinquoi River near Wareham, Mass		200,000	
Connecticut River near Springfield, Mass		1,290,000	
Delaware River near Woodbury, N. J		450,000	
Milford, N. J		1,350,000	
Lambertville, N. J	63,000	5,011,000	
Gloucester, N. J		547,000	
Timber Creek near Woodbury, N. J		440,000	
Little Egg Harbor near Egg Harbor, N. J		450,000	
Dividing Creek near Dividing Creek Station, N. J		450,000	
Hudson River near Newburg, N. Y		2,167,500	
Albany, N. Y		427,500	
Delaware River near Callicoon, N. Y		450,000	
Port Jervis, N. Y		450,000	
New York State Fish Commission		2,000,000	
Yadkin River near Salisbury, N. C		400,000	
Pasquotank River near Elizabeth City, N. C		438,500	
Rockfish River near Wallace, N. C		452,000	
Neuse River near Goldsboro, N. C		454,000	
Susquehanna River near Peach Bottom, Pa		1,725,000	
Fites Eddy, Pa		1,800,000	
Columbia, Pa		450,000	
Delaware River near Delaware Water Gap, Pa		2,700,000	
Lackawaxen, Pa		450,000	
Catawba River near Catawba, S. C		400,000	
Mattaponi River near Milford, Va		857,000	
Chappawansie River near Quantico, Va		867,000	
Rappahannock River near Fredericksburg, Va		911,000	
Rockfish River near Rockfish Station, Va		894,000	
Little River near Taylorsville, Va		1,009,000	
Cedar Run near Catletts, Va		898,000	
Meherrin River near Belfield, Va		457,000	
Rapidan River near Rapidan, Va		450,000	
Occoquan River near Woodbridge, Va		912,000	
Otter River near Evington, Va		446,000	
Tye River near Tye River Station, Va		450,000	
Nansemond River near Suffolk, Va		445,000	
Potomac River near Widewater, Va		612,000	
Roslyn, Va		540,000	
Dan River near Danville, Va	1,000,000		
Quinnat salmon:			
McCloud River near Baird, Cal		400,000	250,000

* 2,333,000 fry were released for rearing in fish ponds, Washington, D. C., but these figures are not to be included in the summations.

Details of distribution—Continued.

Species and disposition.	Eggs.	Fry and fingerlings.	Adults and yearlings.
Quinnat salmon—Continued.			
Bair Ranch Creek, tributary to Redwood Creek in Humboldt County, Cal		65,700	
Clackamas River near Clackamas, Oreg		1,477,212	
Clear Creek, tributary to Clackamas River, near Clackamas, Oreg		1,354,938	557,150
California State Fish Commission	6,075,000		
S. Jaffé, Sandfort, Osnabruch, Germany	25,000		
General Reuben Alonzo, Leon, Nicaragua	20,000		
R. L. Moore, Cliff Belleek, Ireland	50,000		
Atlantic salmon:			
Connecticut State Fish Commission	50,000		
W. L. Hadaway, Chiltonville, Mass	25,000		
Joseph R. Neal, Boston, Mass	4,000		
New Hampshire Fish Commission	50,000		
New York Fish Commission	50,000		
Pennsylvania Fish Commission	100,000		
Merrimac River near Concord, N. H		19,000	
Toddy Pond near Orland, Me			134,306
Alamoosook Lake near Orland, Me			12,307
Heart Pond near Orland, Me			3,063
Little Tunk Pond near Orland, Me			2,000
Landlocked salmon:			
E. M. Robinson, Bevans, N. J	2,000		
Tuxedo Club, Tuxedo Park, N. Y	2,000		
George Pond near Liberty, Me		2,760	
Donnells Pond near Franklin, Me		3,000	
Lake George near Skowhegan, Me		2,760	
Long, Flanders, and Little Tunk Pond near Sorrento, Me		3,000	
Moose Pond near Hartland, Me		5,520	
Great Embden Pond near North Anson, Me		2,760	
Swan Lake near Belfast, Me		2,760	
Clearwater and Varnum Pond near Farmington, Me		2,760	
Great Brook near Green Lake, Me		2,500	
Webb Pond near Ellsworth, Me		3,000	
Patten Pond near Ellsworth, Me		2,965	
Great Brook near Otis, Me		10,000	
Branch Pond near Dedham, Me		4,000	
Floods Pond near Otis, Me		3,000	
Cathance Lake and Dennys River near Calais, Me		3,000	
Green Lake near Green Lake, Me		2,740	
Long Pond near Bar Harbor Me		3,000	
Penacook Lake near Concord, N. H		3,000	
Lake in Tuxedo Park, N. Y		2,000	
Applicants in Rhode Island		3,000	
Applicants in Georgia			69
Embden Pond near North Anson, Me			2,000
Swan Lake near Belfast, Me			2,000
Woods Pond near Blue Hill, Me			3,000
China Lake near East Vassalboro, Me			2,500
Hadlock Pond near North East Harbor, Me			1,000
Waterworks Pond near Belfast, Me			2,000
Moose Pond near Hartland, Me			4,000
Varnum Pond near Farmington, Me			1,500
Clearwater Pond near Farmington, Me			1,500
Whites Pond near Penobscot, Me			2,000
Green Lake near Dedham, Me			6,000
Duck Lake near Winn, Me			1,250
Junior Lake near Winn, Me			1,250
Toddy Pond near Orland, Me			4,225
Green Lake near Green Lake, Me			257
Lake Ozonia near St. Regis Falls, N. Y			1,300
Owasco Lake near Union Springs, N. Y			1,000
Lakes in Tuxedo Park, N. Y			2,000
Lake George near Caldwell, N. Y			5,000
Polfershire Brook, tributary Lake Champlain, near Port Henry, N. Y			1,250
Senteen Brook, tributary Lake Champlain, near Port Henry, N. Y			1,250
Mullen Brook, tributary Lake Champlain, near Port Henry, N. Y			1,250
Grove Brook, tributary Lake Champlain, near Port Henry, N. Y			1,250
Steelhead trout:			
Bair Ranch Creek near Bair Ranch, Cal		107,808	
Pleasant River near Brownsville, Me		6,433	
Todd Brook near Brownsville, Me		4,800	
Salmon Brook near Sebec, Me		5,200	
Baber Brook near Milford, Me		2,000	
Brick Stream near Milford, Me		2,000	
Sunkhazo Stream near Greenfield, Me		1,951	
Burnt Bridge Brook near Enfield, Me		1,600	
Darling Pond near Enfield, Me		1,000	

Details of distribution—Continued.

Species and disposition.	Eggs.	Fry and fingerlings.	Adults and yearlings.
Steelhead trout—Continued.			
Webb Brook near Lowell, Me		10,000	
Mooselhorn Stream near Bucksport, Me		1,600	
Smith Brook in Hancock County, Me		1,600	
Brook near New Boston, Hancock County, Me		3,747	
Comstock and Meduxnikeag Rivers near Caribou, Me		1,976	
Silver Creek near East Tawas, Mich		20,000	
Pine River near East Tawas, Mich		15,000	
Boardman River near Mayfield, Mich		10,000	
Maple River near Pellston, Mich		10,000	
Washington River, off Washington Harbor, Mich		30,000	
French River near Duluth, Minn		20,000	
Sucker River in St. Louis County, Minn		15,000	
Split Rock River near Two Harbors, Minn		20,000	
Poplar River near Grand Marais, Minn		20,000	
Baptism River near Grand Marais, Minn		10,000	
Merrimac River near Concord, N. H			258
New York Fish Commission	100,000		
Browns River near Jericho and Essex, Vt		2,500	
Pond Brook near Walcott, Vt		500	
Lee River, near Jericho, Vt		1,000	
Lake Champlain off Burlington, Vt			777
Rule River near Rule, Wis		20,000	
Minister of Agriculture, Japan	75,000		
Loch Leven trout:			
Country Club, San Francisco, Cal	10,000		
Tributaries of Sylvan Lake near Rome City, Ind		4,000	
Sanborn Creek near Baldwin, Mich		10,000	
Little Rocky Run near Marcellus, Mich		3,000	
Minnesota Fish Commission	10,000		
Nebraska State Fish Commission	10,000		
Wyoming State Fish Commission	10,000		
Louis Miller, Laramie, Wyo	10,000		
Rainbow trout:			
Dog River and tributaries near Venitia, Ala			2,900
Little Cahawba River near Brierfield, Ala			500
Lookout Pond near Gadsden, Ala			200
Mammoth Springs, Mammoth Springs, Ark			200
Sulphur Springs Lake near Sulphur Springs, Ark			3,000
Flint Creek near Gentry, Ark			700
Illinois River near Siloam Springs, Ark			3,000
Barren Fork Creek near Siloam Springs, Ark			3,000
Spavinaw River near Gravett, Ark			5,120
Applicants in Arkansas			1,000
Flint Creek, near Siloam Springs, Ark		9,940	
Applicants in Arkansas	17,550		
Country Club, San Francisco, Cal	30,000		
Eagle River and tributaries near Berry Station, Colo			3,330
Middle Evergreen Lake near Leadville, Colo			900
Applicants in Colorado			300
Rock Creek near Glenwood Springs, Colo		900	
Applicants in Colorado		5,000	
Fillows Brook near South Norwalk, Conn			300
Norwalk River near South Norwalk, Conn			300
Norwalk River and tributaries near Norwalk, Conn			1,100
Barnum Brook near Norwalk, Conn			300
Stony Brook near Norwalk, Conn			370
Whitlock Branch, Norwalk, Conn			250
Lockwood Branch, Norwalk, Conn			250
J. T. Newton, New Haven, Conn	25,000		
Delaware State Fish Commission	10,000		
Applicants in District of Columbia	3,500		
Taccoa River near Mineral Bluff, Georgia			298
Tallulah River near Tallulah Falls, Georgia			500
Cartecay Creek near Ellijay, Ga			498
Applicants in Georgia			500
Spring Brook near La Porte, Ind			35
Allison Creek near La Porte, Ind			982
Upper Lost River near Orleans, Ind			982
Applicants in Indiana			1,497
Johnson Creek near Westville, Ind			800
Lake Renner near Renner, Ind		5,000	
Applicants in Indiana		1,000	
Ballard Creek near Stilwell, Ind. Ter		1,500	
Applicants in Indian Territory			2,000
Spitznoggle Lake near Wapello, Iowa			400
Applicants in Iowa			1,000
Turkey Pond near Baxter, Iowa			500
Walnut Creek near Great Bend, Kans		1,000	
Smoky River near Presley, Kans			900
Applicants in Kansas			980
Kentucky			6,475
			1,250

Details of distribution—Continued.

Species and disposition.	Eggs.	Fry and fingerlings.	Adults and yearlings.
Rainbow trout—Continued.			
Applicants in Louisiana			1,000
Great Brook near Green Lake, Me			48
Western Run near Glyndon, Md			1,000
Hamilton and Bellevue Brooks near Hagerstown, Md			1,000
Spring Branch near Reisterstown, Md			1,000
Streams near Finksburg, Md			700
Indian Springs near Frederick, Md			150
Applicants in Maryland		4,000	1,300
Michaels Pond near Barnstable, Mass			1,000
Sturgeon River near Gaylord, Mich		3,000	
Sturgeon River near Vanderbilt, Mich		2,000	
Wiscoi Creek near Winona, Minn		3,000	
Spring Creek near Northfield, Minn		5,000	
Applicants in Minnesota		5,000	
Five Mile Creek near Hornet, Mo		2,000	
Crane Creek near Crane, Mo		6,000	
Flat Creek near McDowell, Mo		9,000	
Applicants in Missouri		4,000	
Zoo Park Lake, Springfield, Mo			1,000
Mahaska Creek near Bourbon, Mo			1,000
Spring River near Aurora, Mo			2,000
Verona, Mo			2,000
Grove Creek near Webb City, Mo			2,000
Indian Creek near Lanagan, Mo			1,000
Elk (or Cowskin) River near Noel, Mo			2,000
James River near Turner, Mo			2,000
Piney Creek near Cabool, Mo			1,000
Potter Creek near Cabool, Mo			1,000
Jacks Fork of Current River near Mountain View, Mo			4,000
Grove Creek, Jasper County, Mo			135
Barbers Lake near Ritchie, Mo			113
Applicants in Missouri			500
State Fish Commission, Missouri	10,400		1,876
Applicants in Missouri	10,075		
Nebraska State Fish Commission	65,740		
White Clay Creek near Rushville, Nebr		900	
Spring Brook Ponds near Omaha, Nebr			1,500
Nevada State Fish Commission	61,739		
New Hampshire State Fish Commission	25,000		
Great Brook near Greenland, N. H		7,950	
Isinglass River near Dover, N. H		7,940	
Green Hill Brook near Dover, N. H			1,000
Isinglass River near Dover, N. H			1,000
Musconetcong River near Washington, N. J			1,000
Paulins Kill River near Blairstown, N. J			500
Pequest Creek near Belvidere, N. J			500
Cedar Lake near Blairstown, N. J			500
Applicants in New Jersey			500
Eagle Creek near White Oaks, N. Mex			470
Bluewater Creek near Fort Wingate, N. Mex			500
Applicants in New Mexico			1,450
Black River reservoir near Honnedaga, N. Y			175
Applicants in New York			300
Page Brook near Chenango Forks, N. Y		2,200	
Cullowhee Creek near Hillsboro, N. C			637
Linville River near Linville, N. C			800
Big Buck Creek near Marion, N. C			425
Little Buck Creek near Marion, N. C			425
Licklog Creek near Marion, N. C			425
Mill Creek near Marion, N. C			425
Little River near Brevard, N. C			765
North Fork of Swannanoa River near Black Mountain, N. C			850
Applicants in North Carolina			2,913
Forest River near Inkster, N. Dak		3,000	
Blue Ditch near Richmond, Ohio		2,000	
Applicants in Ohio		4,500	660
Applicants in Oklahoma			700
Half Mile Run near Gaines, Pa			300
Letort Stream near Carlisle, Pa			900
Big Wapwallopen Creek near Nanticoke, Pa			800
Bengully Run near Gaines, Pa			300
Gall Run near Gaines, Pa			300
Lamb Creek near Mansfield, Pa			300
Piney Creek near Altoona, Pa			255
Middle Branch near Nanticoke, Pa			300
Cotter Creek near Nicholson, Pa			300
Benscoter Run near Nanticoke, Pa			300
Mill Run near Gaines, Pa			600
Roaring Brook near Nanticoke, Pa			300
Blue Run near Gaines, Pa			300
Calin Run near Mansfield, Pa			300

Details of distribution—Continued.

Species and disposition.	Eggs.	Fry and fingerlings.	Adults and yearlings.
Rainbow trout—Continued.			
Cedar Run near Gaines, Pa			600
Crooked Creek near Mansfield, Pa			300
Pog Hunter Creek near Nanticoke, Pa			300
Thompson Run near Gaines, Pa			300
Fades Creek near Nanticoke, Pa			300
Martin's Mill Pond near Wayne, Pa		4,800	
Creeks near Crossroads, Pa		4,700	
Stevens Run near Nicholson, Pa		2,200	
Tunkhannock Creek near Nicholson, Pa		2,200	
Applicants in Pennsylvania		4,700	
Laurel Run near Nicholson, Pa			300
Trout Run near Tobyhanna, Pa			300
Tobyhanna Creek near Tobyhanna, Pa			300
Middle Creek near Hawley, Pa			300
Two Mile Run near Wetmore, Pa			300
Tributary of Tobyhanna Creek near Tobyhanna, Pa			300
Delawanna Lake near Thornhurst, Pa			300
Maplecraft Run near Charlestown, Pa			300
Tobyhanna Creek near Tobyhanna, Pa			300
Clover Creek near Williamsburg, Pa			300
Montgomery Creek near Clearfield, Pa			340
French Creek near Kimberton, Pa			510
Roaring Springs near Altoona, Pa			800
Painter Run near Gaines, Pa			340
Elk Run near Mansfield, Pa			300
Hickson Run near Mansfield, Pa			300
Mountain Run near Nanticoke, Pa			300
Lines Creek near Carlisle, Pa			300
Little Sandy Creek near Punxsutawney, Pa			300
Muddy Run near Greencastle, Pa			335
Toms River near Lockhaven, Pa			300
Sugar Run near Lockhaven, Pa			900
Cedar Run near Lockhaven, Pa			900
Plum Run near Lockhaven, Pa			900
Chatham Run near Lockhaven, Pa			900
Sugar Creek near Troy, Pa			1,200
Leonard Creek near Troy, Pa			400
Spring Brook near Pittston, Pa			600
Tributaries to Tioga River near Farmington, Pa			750
Roaring Creek near Shamokin, Pa			300
Eagle Run near Shamokin, Pa			300
Brush Valley Creek near Shamokin, Pa			300
Taylor Run near Nicholson, Pa			300
Applicants in Pennsylvania			300
Streams on Indian reservation, Pine Ridge Agency, S. Dak			3,685
Spring Creek near Whitewood, S. Dak		900	
Applicants in South Dakota		5,000	
Duck River near Normandy, Tenn		6,000	
Tellico River near Athens, Tenn		5,000	
Flint River near Fayetteville, Tenn		6,000	
East Fork of Stone River near Murfreesboro, Tenn		7,900	
Smith Fork near Brushcreek, Tenn		6,000	
Conasauga River near Cleveland, Tenn		4,000	
Mossy Creek near Mossycreek, Tenn		8,000	
Applicants in Tennessee		8,000	
Cane Creek near Hohenwald, Tenn		2,000	
Big Creek and French Broad River near Delrio, Tenn			464
Big Pigeon River near Newport, Tenn			500
Roaring Creek and Hampton Creek near Elizabethton, Tenn			500
Clark Creek near Jonesboro, Tenn			1,000
Jack River near Cleveland, Tenn			1,000
Horsey Creek near Hickory Ridge, Tenn			2,000
Pigeon River near Sevierville, Tenn			500
Ellejoy Creek near Maryville, Tenn			2,000
White Oak Creek near Sunbright, Tenn			500
Lake Watausee near Johnson City, Tenn			493
Tellico River near Mount Verd, Tenn			300
Applicants in Tennessee			500
Amarillo Creek near Amarillo, Tex			1,050
Paluxy Creek near Glenrose, Tex			800
Applicants in Texas			400
Utah			200
East Creek near Rutland, Vt		10,000	
Onpompanoosuc River near Ely, Vt		9,950	
Applicants in Vermont			1,000
Robinson River near Somerset, Va			1,000
North Fork of Shenandoah River near Staunton, Va		5,000	
Calvin Run near Hunters Mills, Va		4,990	
Mud Run near Hot Springs, Va		4,000	
Cowardin Run near Hot Springs, Va		5,000	
Rubins Healing Stream near Hot Springs, Va		5,000	
		9,978	

Details of distribution—Continued.

Species and disposition.	Eggs.	Fry and fingerlings.	Adults and yearlings.
Rainbow trout—Continued.			
Reed Creek near Wytheville, Va		5,000	
Travis Mill Pond near New London, Va			500
South Fork of Powell River near Big Stonegap, Va			1,275
Dry River near Mount Clinton, Va			850
Broad Run near Thoroughfare, Va			940
St. Clair Creek near St. Clair Bottom, Va			500
North Fork of Holston River near Ceres, Va			200
Big Cedar Creek near Honaker, Va			850
St. Clair Creek near Grosses, Va			500
Buck Creek near Springwood, Va			500
Tate Run near Wytheville, Va			787
Cripple Creek above Pierce's mill-dam near Cripple Creek, Va			370
Applicants in Virginia			1,805
Lake Terra Alta near Terra Alta, W. Va			425
Cold Run near Berkeley Springs, W. Va			425
Willow Springs near Shenandoah Junction, W. Va			300
Cat-tail Run near Millville, W. Va			425
Applicants in West Virginia			1,095
Wyoming State Fish Commission	57,190		
De Lacey Lake near Mammoth Hot Springs, Wyo		1,000	
Société d'Acclimatation, Paris, France	50,000		
M. Raveret-Wattel, Fécamp, France	25,000		
Major W. Turner, Bertrix, Belgium	50,000		
Von Behr trout:			
Mammoth Springs near Mammoth Springs, Ark			1,000
California State Fish Commission	10,000		
Streams near Brooklandville, Md		8,422	
Pine River near West Harrisonville, Mich		10,000	
South Branch of Tobacco River near Farwell, Mich		5,000	
Sanborn Creek near Nirvana, Mich		5,000	
Ellerslie Lake near Rhinecliff, N. Y		2,000	
King Creek near King Creek, Ohio		4,000	
Cedar Run near Bowlusville, Ohio		4,000	
Taylor Run near Bowlusville, Ohio		2,000	
Applicants at Bedford, Ohio	15,000		
Queen and Beaver rivers near Usquepaugh, R. I		3,705	
Rhode Island State Fish Commission	10,000		
Beaver Pond near Proctor, Vt		4,300	
Big Fish Pond near St. Johnsbury, Vt		4,290	
Haystack Pond near Wilmington, Vt		5,000	
Vermont State Fish Commission	10,000		
Black-spotted trout:			
Twin Lakes in Lake County, Colo		5,000	
Middle Evergreen Lake in Lake County, Colo		3,000	
Applicants in Georgia			17
Michigan State Fish Commission	35,000		
Spring Creek near Laramie, Wyo		2,000	
Sweetwater Creek near Newcastle, Wyo		1,000	
Yellow-fin trout:			
Twin Lakes near Twin Lakes, Colo		4,700	
Middle Evergreen Lake near Leadville, Colo		3,000	
Brook trout:			
Mammoth Springs near Mammoth Springs, Ark			350
Spring Brook near Iowa Gulch, Colo			2,000
North Branch of St. Vrain River near Lyons, Colo			2,000
Eagle River near Wolcott, Colo			7,000
Tributary of Black Squirrel Creek near Eastonville, Colo			2,000
Upper Evergreen Lakes in Lake County, Colo			5,000
Applicants in Colorado			1,800
Twin Lakes in Lake County, Colo		5,000	
Box Creek near Leadville, Colo		5,000	
Eagle River near Minturn, Colo		10,000	
Headwaters of Arkansas River in Lake County, Colo		10,000	
Mountain Lake near Granite, Colo		5,000	
North Fork of South Platte River near Estabrook, Colo		10,000	
Brush Creek near Eagle, Colo		10,000	
Naylor Lake near Georgetown, Colo		10,000	
Frying Pan River between Novice and Castle, Colo		40,000	
North Fork of South Platte River near Chaseville, Colo		3,000	
Slaghts, Colo		3,000	
Bailey, Colo		3,000	
Pine Grove, Colo		3,000	
Dawson, Colo		3,000	
Chalk Creek near Northrop, Colo		5,000	
Silver Creek near Shirley, Colo		4,917	
East River near Crested Butte, Colo		4,917	
Elk River near Cebolla, Colo		4,917	
Soap Creek near Sapinero, Colo		4,917	
Alder Creek near Alder, Colo		4,915	
Goose Creek near Wagonwheel Gap, Colo		4,917	
Eagle River near Mitchell, Colo		5,000	

Details of distribution—Continued.

Species and disposition.	Eggs.	Fry and fingerlings.	Adults and yearlings.
Brook trout—Continued.			
Jennie Creek near Central City, Colo		5,000	
Mammoth Creek near Central City, Colo		5,000	
North Boulder Creek near Central City, Colo		10,000	
South Boulder Creek near Central City, Colo		10,000	
Tributaries of Twin Lakes in Lake County, Colo		25,000	
Applicants in Colorado		36,000	
Duchess Brook near Pomfret, Conn			300
Eastern Branch of Farmington River near New Hartford, Conn			600
Lawson Brook near Wilton, Conn			300
West Norwalk Stream near South Norwalk, Conn			300
Blackberry River near Canaan, Conn			300
Comstock Brook near Wilton, Conn			300
Pennel Stream near Norwalk, Conn			300
Five Mile River near South Norwalk, Conn			300
Wheeler Stream near South Norwalk, Conn			300
Poorhouse Brook near New Canaan, Conn			300
Mill River near Southport, Conn			300
Barnum Brook near Norwalk, Conn			300
Stony Brook near Norwalk, Conn			30
Guthrie Brook near Norwalk, Conn			300
Whitlock Brook near Norwalk, Conn			300
Norwalk River near Norwalk, Conn			600
Comstock Hill Brook near Norwalk, Conn			300
Five Mile River near Norwalk, Conn			300
West Branch of Norwalk River near Norwalk, Conn			300
Gregory Brook near Norwalk, Conn			800
Silver River near Norwalk, Conn			200
Barratt Brook near Wilton, Conn			300
Applicants in Connecticut			300
Georgia			38
Spring Creek near Beaver Canyon, Idaho			1,475
Little Kankakee Creek near Laporte, Ind		5,000	
Applicants in Indiana		2,000	
Spring Creek near Osage, Iowa		10,000	
Riceville, Iowa		5,000	
Canoe Creek near Decorah, Iowa		5,000	
Megunticook Lake near Camden, Me		1,500	
Long Pond near Sorrento, Me		1,000	
Little Tunk Pond near Sorrento, Me		1,000	
Flanders Pond near Sorrento, Me		1,000	
Anasagunticook Lake near Canton, Me		2,000	
Cathaua Stream near Topsham, Me		1,950	
Swan Lake near Belfast, Me		2,000	
Reservoir at Belfast, Me		2,000	
Great Brook at Green Lake, Me		4,500	
Webb Pond near Ellsworth Falls, Me		3,000	
Green Lake at Dedham, Me		115	
Applicants in Maine		4,500	
Maine State Fish Commission	40,000		
Swan Lake near Swanville, Me			2,000
Studly Pond near Waldoboro, Me			1,000
Goose River near Waldoboro, Me			1,000
Belfast Waterworks Pond near Belfast, Me			2,000
Clearwater Pond near Farmington, Me			1,500
Varnin Pond near Farmington, Me			1,500
Jordan Pond near Bar Harbor, Me			1,000
Moose Lake near Hartland, Me			1,000
Craig Pond near Orland, Me			2,913
Eagle Lake near Bar Harbor, Me			3,000
Lake Pearl and Archer Pond near North Attleboro, Mass		1,950	
Baker Brook near Pembroke, Mass		1,950	500
Spring Brook near Marion, Mass			500
Rehoboth Creek near Attleboro, Mass			300
Cobb Brook near Princeton, Mass			1,000
Brook near Lowell, Mass			500
Applicants in Michigan			300
Tributary of Traverse Bay near Traverse, Mich		5,000	
Au Sable River near Grayling, Mich		100,000	
Schimnemous Creek near Coldwater, Mich		3,000	
West Branch of Big Creek near Grayling, Mich		5,000	
Bruce Brook near St. Johns, Mich		5,000	
Swan Creek near Coldwater, Mich		5,000	
Beitner Creek near Beitner, Mich		5,000	
Dodd, Clifford, and Sherwood creeks near Allegan, Mich		5,000	
Norris Creek near Cloverville, Mich		5,000	
Paint Creek near Ypsilanti, Mich		5,000	
Little South Branch of Baldwin Creek near Baldwin, Mich		10,000	
Cedar River near Harrison, Mich		5,000	
Minnesota State Fish Commission	20,000		
Pickwick Creek near Winona, Minn		200	
Burnside Lake near Ely, Minn		2,900	

Details of distribution—Continued.

Species and disposition.	Eggs.	Fry and fingerlings.	Adults and yearlings.
Brook trout—Continued.			
Box-elder Creek near Havre, Mont			735
Sullivan Creek near Cascade, Mont			735
Rock Creek Lake near Deer Lodge, Mont			735
Spring Brook Ponds near Omaha, Nebr			750
New Hampshire State Fish Commission	25,000		
Streams near Grafton, N. H		1,950	
Concord, N. H		1,950	
Ammonoosuc River near Faybans, N. H		1,950	
Bicknell Brook near Enfield, N. H		1,950	
Mascoma River near Lebanon, N. H		1,950	
Crystal Lake near East Enfield, N. H			800
Hurricane Brook near Harrisonville, N. H			1,500
Applicants in New Jersey	25,000		495
Godfrey Run near De Ruyter, N. Y		4,500	
Page Brook near Chenango Forks, N. Y		4,100	
Oriskany Creek near Utica, N. Y		4,500	
Moyer Creek near Frankfort, N. Y		4,500	
Oquaga Creek near Deposit, N. Y		4,500	
Peterskill Creek near St. Josen, N. Y			500
Tioughnioga River near De Ruyter, N. Y			1,000
Otego and Charlotte creeks near Oneonta, N. Y			818
Perkinsville Creek near Perkinsville, N. Y			409
Hansome Brook near Sherburne, N. Y			500
Madison Square Garden Aquarium, New York			30
Applicants in New York			408
Turtle Lake near Bismarck, N. Dak			1,830
Cold Creek near Castalia, Ohio		5,000	
Applicants in Castalia, Ohio	20,000		
Rhode Island			498
North Branch of Little Rapid Creek near Deadwood, S. Dak			720
Medary Creek near Brookings, S. Dak			1,200
Little Spearfish Creek near Spearfish, S. Dak			5,750
Applicants in South Dakota			285
Rapid Creek near Rapid City, S. Dak		15,000	
Evans Lake near Hot Springs, S. Dak		5,000	
False Bottom Creek near St. Onge, S. Dak		20,000	
Applicants in South Dakota		11,000	
Utah		20,000	
Ice Pond near Pleasant Valley, Utah			1,800
Ogden River near Ogden, Utah			1,125
Big Cottonwood Creek near Salt Lake City, Utah			1,125
Forest and Stream Club Pond near Wilmington, Vt			1,000
Caspian Lake near Greensboro, Vt			1,500
Beaner Pond near Proctor, Vt			1,450
Pico Pond near Proctor, Vt			1,450
Lake Pico near Sherburne, Vt		4,965	
Wausaukee River near Amberg, Wis		7,000	
Lake Junior near Necedah, Wis		5,000	
Labonte Creek near Douglass, Wyo		10,000	
Spring Creek near Laramie, Wyo			1,475
Dome Lake near Sheridan, Wyo			2,100
Beaver Creek near Newcastle, Wyo			650
Lake trout:			
Troutdale Fish Farm, Mammoth Springs, Ark	5,000		
Applicants in Georgia		9,000	
Sweets Pond near Farmington, Me			1,000
Mashpee Lake near Mashpee, Mass		9,725	
Applicants in Massachusetts		4,875	
Kilpatrick Lake near Woodland, Mich		10,000	
Portage Lake near Grayling, Mich		10,000	
Lake Michigan near Charlevoix, Mich		300,000	
Manistique, Mich		190,000	
Lake Huron near East Tawas, Mich		200,000	
Cheboygan, Mich		100,000	
Alpena, Mich		200,000	
Lake Superior near Isle Royal, Mich		740,000	
Duncan Bay, Isle Royale, Mich		100,000	
Fish Island, Isle Royale, Mich		100,000	
Rock Harbor, Isle Royale, Mich		40,000	
Tobin Bay, Isle Royale, Mich		100,000	
Fishermans Home, Isle Royale, Mich		200,000	
Todd Harbor, Isle Royale, Mich		200,000	
Lake Lizzie near Pelican Rapids, Minn		50,000	
Eagle Nest Lake near Ely, Minn		5,000	
Burnside Lake near Ely, Minn		45,000	
Lake Superior near French River, Minn		100,000	
Two Harbors, Minn		100,000	
Beaver Bay, Minn		100,000	
Poplar River, Minn		50,000	
Duluth, Minn		120,000	

Details of distribution—Continued.

Species and disposition.	Eggs.	Fry and fingerlings.	Adults and yearlings.
Lake trout—Continued.			
Lake Superior near Grand Marais, Minn		430,000	
Chicago Bay, Minn		200,000	
St. Louis County, Minn		40,000	
Nebraska State Fish Commission, Nebr	200,000		
Nevada State Fish Commission	50,000		
New York State Fish Commission	200,000		
Otsego Lake near Cooperstown, N. Y		25,000	
Trout Lake near St. Regis Falls, N. Y		20,000	
Lake Ontario off Stony Island, N. Y		200,000	
Grenadier Island, N. Y		975,000	
Pillar Point, N. Y		200,000	
Tibbetts Point, N. Y		200,000	
Cape Vincent, N. Y		22,000	
Devil Lake near Devil Lake, N. Dak		30,000	
Lake Erie off Rattlesnake Island Reef, Ohio		685,400	
Hoodley Lake near Waymart, Pa		4,447	
Lake Minola near Scranton, Pa		4,500	
Mountain Lake near Troy, Pa		8,000	
Vermont State Fish Commission	300,000		
Lake Champlain near Isle La Motte, Vt			1,000
Willoughby Lake near Westmore, Vt		37,000	
Caspian Lake near Greensboro, Vt		1,671	
Fountain and other brooks near New Lisbon, Wis		5,000	
Lake Superior near Bayfield, Wis		1,150,000	
Oak Island near Bayfield, Wis		200,000	
Rice Island near Bayfield, Wis		50,000	
Cranberry, Wis		50,000	
Lake Mary near Genoa Junction, Wis		20,000	
Lake Michigan near Sheboygan, Wis		150,000	
Wyoming State Fish Commission	200,000		
Lake Superior off Port Arthur, Canada		198,000	
Department of Agriculture, Berne, Switzerland	50,000		
Scotch sea trout:			
Craig Pond near Orland, Me			1,376
New York State Fish Commission, Caledonia, N. Y	5,100		
Golden trout:			
Green Lake at Ellsworth, Me		10,200	
Flood Pond near Otis, Me		11,500	
Great Brook near Green Lake, Me			10
Yellow perch:			
Applicants in Georgia			60
Idaho			200
Newman Lake near Hauser, Idaho			200
Cedar River near Cedar Rapids, Iowa			400
Storm Lake near Storm Lake, Iowa			50
Applicants in Iowa			100
Toms Creek near Emmittsburg, Md		812,000	
Deep Creek near Great Falls, Mont			200
Applicants in Montana			300
North Dakota			200
Sioux River near Sioux Falls, S. Dak			75
South Palouse River near Guy, Wash			200
Loon Lake near Tacoma, Wash			50
Lake St. Clair near Tacoma, Wash			100
Silver Lake near Castlerock, Wash			100
Pickerel:			
Cedar River near Cedar Rapids, Iowa			50
Phantom Lake near Mukwonago, Wis			700
Cedar Lake near Schleisingerville, Wis			650
Whitefish:			
Government of Japan	50,000		
Bear Lake near Fishhaven, Idaho		2,940,000	
Turkey Lake near Syracuse, Ind		2,000,000	
Lake Huron near East Tawas, Mich		2,000,000	
Oscoda, Mich		4,000,000	
North Point, Mich		5,000,000	
Alpena, Mich		1,850,000	
Sturgeon Point, Mich		2,000,000	
Scarecrow Island, Mich		3,000,000	
Lake Michigan near Frankfort, Mich		2,000,000	
Epoufette, Mich		2,000,000	
Naubinway, Mich		2,000,000	
Manistique, Mich		2,450,000	
Lake Erie near Monroe, Mich		8,800,000	
Lake Superior near Washington Harbor, Mich		2,000,000	
Isle Royale, Mich		2,000,000	
Detour Passage near Detour, Mich		4,000,000	
Straits of Mackinac near Mackinaw City, Mich		4,000,000	
Whitefish Lake near Corinne, Mich		1,500,000	
Lake Superior near Duluth, Minn		250,000	
St. Lawrence River near Cape Vincent, N. Y		500,000	

Details of distribution—Continued.

Species and disposition.	Eggs.	Fry and fingerlings.	Adults and yearlings.
Whitefish—Continued.			
Lake Ontario off Grenadier Island, N. Y		5,500,000	
Tibbetts Point, N. Y		14,000,000	
Lake Erie off Rattlesnake Island Reef, Ohio		22,620,000	
North Bass Island Reef, Ohio		23,460,000	
Ballast Island Reef, Ohio		7,300,000	
Port Clinton, Ohio		13,280,000	
Kelley Island Reef, Ohio		5,070,000	
Middle Bass Island Reef, Ohio		5,070,000	
Toledo Field, Ohio		3,300,000	
West Sister Island Reef, Ohio		4,200,000	
Starve Island Reef, Ohio		5,600,000	
Niagara Reef, Ohio		11,080,000	
Buckeye Island Reef, Ohio		5,070,000	
Green Island Reef, Ohio		6,400,000	
Peach Point Reef, Ohio		1,400,000	
Lake Superior near Bayfield, Wis		5,750,000	
Lake herring:			
Lake Erie near Put-in Bay, Ohio		696,000	
Large-mouthed black bass:			
McCullough Creek near Venitia Station, Ala			200
Black Creek near Gadsden, Ala			50
Applicants in Alabama			150
Clear Creek near Alma, Ark			100
Spadra Creek, near Clarksville, Ark			100
Applicants in Arkansas			75
Colorado			150
Connecticut			100
Horseneck Brook near Greenwich, Conn			200
Applicants in District of Columbia			100
East Lake near Atlanta, Ga			100
Lake Demorest near Demorest, Ga			100
Talking Rock River near Talking Rock, Ga			100
Applicants in Georgia			707
Newman Lake near Hauser, Idaho			60
Applicants in Idaho			210
Paris Reservoir, Paris, Ill			300
Bangs Lake near Wauconda, Ill			200
Applicants in Illinois			450
Twin Lake near Lima, Ind			100
Still Lake near New Carlisle, Ind			50
Upper Long Lake near Albion, Ind			300
Bass Lake near Bass Lake, Ind			100
White River near Richmond, Ind			150
Lake Kurtz near Riley, Ind			100
Clear Lake near Westville, Ind			100
Muscatatuck River, North Vernon, Ind			150
Yellow Lake near Cloverland, Ind			50
Hillsdale Park Lake near Newcastle, Ind			100
Hunt Lake near Laporte, Ind			50
Applicants in Indiana			550
Indian Territory			75
Storm Lake near Storm Lake, Iowa			175
Upper Iowa River near Chester, Iowa			100
Turkey River near West Union, Iowa			100
Des Moines River (above the dam) near Des Moines, Iowa			200
Des Moines River near Fort Dodge, Iowa			100
Iowa State Fish Commission			300
Cedar River near Cedar Rapids, Iowa			500
A., T. & S. F. R. R. Co., Hospital Pond near Fort Madison, Iowa			100
Applicants in Iowa			50
Slate Creek near Wellington, Kans			200
Strawberry Lake near Fort Scott, Kans			100
Lake View at Lake View, Kans			150
Applicants in Kansas			300
Green River near Moreland, Ky			140
Falling Fork Creek near Louisville, Ky			140
Salt River near Harrodsburg, Ky			140
Eagle Creek near Williamston, Ky			75
Kentucky River near Winchester, Ky			100
Dix River near Danville, Ky			140
Licking River near Mount Sterling, Ky			140
Kentucky River near Irvine, Ky			100
Lake Ellerslie near Lexington, Ky			140
Ludlow Lagoon near Ludlow, Ky			100
Applicants in Kentucky			695
Choplins Dam near Natchitoches, La			100
Applicants in Louisiana			200
Patapsco River near Woodstock, Md			90
Potomac River near Cabin John Bridge, Md			75
Applicants in Maryland			150
Lake Gardner near Amesbury, Mass			100

Details of distribution—Continued.

Species and disposition.	Eggs.	Fry and fingerlings.	Adults and yearlings.
Large-mouthed black bass—Continued.			
Curtis Lake near North Dana, Mass			100
Applicants in Massachusetts			133
Little Brooks Lake near Newaygo, Mich			240
Big Brooks Lake near Newaygo, Mich			240
Hersy Lake near Lawton, Mich			145
Little Brown Lake near Rockford, Mich			180
Carp Lake near Traverse, Mich			60
Clear Lake near Sidnaw, Mich			100
Mill Lake near Wingleton, Mich			160
Kalamazoo River near Marshall, Mich			120
Duck Lake near Springport, Mich			120
Fish Lake near Wexford, Mich			240
Donaldson Lake near Kendall, Mich			120
Clear Lake near Beaver Lake, Mich			120
Crab Lake near Traverse, Mich			120
Rust Dam near Alger, Mich			60
Strawberry Lake near Evart, Mich			300
Frains and Murray lakes near Ypsilanti, Mich			120
Yellow Lake near Buchanan, Mich			205
Eagle Nest Lake near Tower, Minn			200
Estelle Lake near Penn, Miss			100
Horticultural Pond near Oktibbeha, Miss			100
Spring Lake near Canton, Miss			100
Round Lake near Canton, Miss			200
Applicants in Mississippi			750
Missouri State Fish Commission			100
Moreau Creek near Jefferson City, Mo			150
Williams Lake near Webb City, Mo			30
Applicants in Missouri			200
Missouri River near Great Falls, Mont			75
Lake Hagan near Butte, Mont			75
Johnson Lake near Elliston, Mont			75
Tributary of Missouri River near Townsend, Mont			100
Applicants in Montana			325
New Hampshire			100
Ramapo River near Mahwah, N. J			200
Pohatcong Lake near Tuckerton, N. J			185
Stafford Lake near Manahawkin, N. J			50
Applicants in New Jersey			250
Laguna Grande near Las Vegas, N. Mex			200
Reservoir, Springer, N. Mex			200
Lake McMillan near Eddy, N. Mex			250
Susquehanna River near Binghamton, N. Y			100
Hurlbut pond near Clymer, N. Y			50
Damon Pond near Clymer, N. Y			100
Schoharie Creek near Central Bridge, N. Y			100
Ararat River near Mount Airy, N. C			150
Yadkin River near Wilkesboro, N. C			100
Applicants in North Carolina			100
Spirit Wood Lake near Jamestown, N. Dak			225
Fish Lake near Jamestown, N. Dak			100
Applicants in North Dakota			75
Scioto River near Delaware, Ohio			110
Prospect, Ohio			40
Indian River near Portsmouth, Ohio			50
Tinker Creek near Bedford, Ohio			25
Branch of Mahoning River near Newton Falls, Ohio			25
Grand Reservoir near Celina, Ohio			25
Little Miami River near Xenia, Ohio			100
Olentangy River near Waldo, Ohio			40
Scioto River near Batavia Junction, Ohio			100
West Fork of Beaver River near East Liverpool, Ohio			50
Grand River near Eagleville, Ohio			100
Horseshoe Lake near Kenton, Ohio			50
Applicants in Ohio			650
Hog Creek near Guthrie, Okla			100
Applicants in Oklahoma			200
Dover Lake near Salem, Oreg			75
Mill Creek near Salem, Oreg			25
Big Creek near Waldport, Oreg			75
West Branch of Perkman Creek near Colebrookdale, Pa			100
Quittapahilla Creek near Annville, Pa			250
Kreiders Dam near Annville, Pa			140
French Creek near St. Peters, Pa			100
Sherman Creek near Carlisle, Pa			100
Branch of Juniata River near Bedford, Pa			145
Washington Lake near Schohala, Pa			50
Applicants in Pennsylvania			285
Goose Creek near Otranto, S. C			138
Applicants in South Carolina			180
Cascade Creek near Cascade, S. Dak			40

Details of distribution—Continued.

Species and disposition.	Eggs.	Fry and fingerlings.	Adults and yearlings.
Large-mouthed black bass—Continued.			
Lake Creek near Pine Ridge Agency, S. Dak			300
Canyon Lake near Rapid City, S. Dak			40
Lake Edgemont near Edgemont, S. Dak			41
Wall Lake near Sioux Falls, S. Dak			50
Sioux River near Sioux Falls, S. Dak			1,012
Applicants in South Dakota			41
Forked Deer River near Trenton, Tenn			150
Hiawassee River near Higdon, Tenn			100
Cane Creek near Hohenwald, Tenn			100
Tellico River near Mount Verd, Tenn			100
Duck River near Shelbyville, Tenn			100
Elk River near Estill Springs, Tenn			200
Nolachucky River near Chucky Valley, Tenn			100
Sole Creek near Chickamauga, Tenn			200
North White Creek near Glenmary, Tenn			100
Doe River near Elizabethton, Tenn			200
Chickamauga Lake near Chickamauga, Tenn			400
Applicants in Tennessee			300
Palestine Lake near Palestine, Tex			200
Lake McDonald near Austin, Tex			100
Graham Creek near Mobeetie, Tex			200
Cheyenne Creek near Channing, Tex			100
Hurst Lake near Fort Worth, Tex			100
Lake Hunter near Thurber, Tex			200
Applicants in Texas			2,100
Smith River near Martinsville, Va			100
Forest Hill Park Lake near Richmond, Va			100
Robinson River near Somerset, Va			100
Falling River near Appomattox, Va			100
Rapidan River near Rapidan, Va			100
Occoquan Creek near bridge over Bull Run, Va			100
South Anna River near Ashland, Va			150
Applicants in Virginia			150
Lover Lake near Tacoma, Wash			100
Lake Cavanaugh near Seattle, Wash			75
Silver Lake near Castlerock, Wash			50
Welty Lake near Northport, Wash			100
Lake St. Clair near Tacoma, Wash			150
Clear Lake near Bucoda, Wash			100
Applicants in Washington			50
Rock River near Mayville, Wis			200
Pine Lake near Jeffries, Wis			85
Phantom Lake near Mukwonago, Wis			1,500
Lemonweir River near Mauston, Wis			100
Cedar Lake near Schleisingerville, Wis			1,200
Elbow Lake near Amburg, Wis			100
Lake Como near Lake Geneva, Wis			300
Applicants in Wisconsin			100
Lakes in Yellowstone National Park, Wyoming			500
Small-mouthed black bass:			
Swift Creek near Higgston, Ga			50
Applicants in Georgia			50
Headwaters of Quantico Creek near Hebron, Md			100
Potomac River near Little Falls, Md			100
Great Falls, Md			150
Applicants in Maryland			50
Merriwold Lake near Gilman, N. Y			50
Kinderhook Lake near Niverville, N. Y			108
Lake Huntingdon near Coshocton, N. Y			50
Applicants in New York			150
Goose Creek near Otranto, S. C			57
Sunfish:			
Applicants in Georgia			35
Rock bass:			
McCullough Creek near Venitia Station, Ala			400
Fossil Pond near Hillman, Ala			100
Applicants in Alabama			400
Arizona			95
Clear Lake near Mayflower, Ark			300
Applicants in Arkansas			200
Colorado			100
Crawfish Spring Lake near Chickamauga, Ga			300
Tate Pond near Jasper, Ga			300
Atherton Pond near Jasper, Ga			200
Applicants in Georgia			742
Illinois			600
Yellow Lake near Cloverland, Ind			300
Cypress Bend near Booneville, Ind			155
Bear Lake near Albion, Ind			230
Applicants in Indiana			200
Osceola Lake near Bluejacket, Ind. T			300

Details of distribution—Continued.

Species and disposition.	Eggs.	Fry and fingerlings.	Adults and yearlings.
Rock bass—Continued.			
Cedar River near Cedar Rapids, Iowa			200
Applicants in Iowa			700
Mulberry Creek near Ford, Kans			250
Crystal Lake near Dodge City, Kans			200
Sappa Creek near Colby, Kans			185
Applicants in Kansas			4,300
Kentucky River near Winchester, Ky			300
Clear Creek near Shelbyville, Ky			300
Lake Reba near Richmond, Ky			300
South Licking River near Cynthiana, Ky			300
Salt River near Taylorsville, Ky			400
Valley Creek near Elizabethtown, Ky			75
Applicants in Kentucky			1,000
Louisiana			63
Maryland			600
Yazoo River near Yazoo City, Miss			200
Applicants in Mississippi			950
Zoo Park Lake near Springfield, Mo			200
Moreau Creek near Jefferson City, Mo			400
Applicants in Missouri			800
Nebraska State Fish Commission			300
Crystal Lake near Alliance, Nebr			190
Applicants in Nebraska			100
New Jersey			400
Lake McMillan near Eddy, N. Mex			300
Applicants in New Mexico			400
Tuscarora Creek near Addison, N. Y			150
York Lake, Sullivan County, N. Y			200
Applicants in New York			200
Cane Creek near Mebane, N. C			150
Maple Creek near Shelby, N. C			150
Waterworks Lake at Henderson, N. C			130
Applicants in North Carolina			1,120
Bull Creek near New Waterford, Ohio			270
Brush Creek near Hillsboro, Ohio			400
Applicants in Ohio			880
Kingfisher Creek near Kingfisher, Okla			150
Skelton Creek near South Enid, Okla			150
Applicants in Oklahoma			1,200
Applicants in South Carolina			510
Little River near Maryville, Tenn			300
Mossy Creek near Mossy Creek, Tenn			200
Big Lake near Kenton, Tenn			150
Barren Fork of Collins River near McMinnville, Tenn			150
Pigeon River near Sevierville, Tenn			300
Big Pigeon River near Newport, Tenn			200
Stone River near Murfreesboro, Tenn			200
Applicants in Tennessee			399
Amarillo Creek near Amarillo, Tex			300
Fountain Lake near Waco, Tex			200
Lake McDonald near Austin, Tex			200
Leon River near Gatesville, Tex			150
Clear Fork of Trinity River near Fort Worth, Tex			200
Dillon Lake near Amarillo, Tex			200
Squaw Creek near Glenrose, Tex			300
Lake Hunter near Thurber, Tex			200
Applicants in Texas			4,150
Bear River near Salt Lake City, Utah			190
Smith River near Montreal, Va			200
Bannister River near Franklin, Va			150
Rapidan River near Rapidan, Va			200
Blackwater River near Rocky Mount, Va			150
Four Mile Run near Bull Run, Va			200
South Anna River near Ashland, Va			300
Applicants in Virginia			1,400
Sandy Creek near Newbury, W. Va			200
White bass:			
Cedar River near Cedar Rapids, Iowa		19,500	
Cod:			
Buzzards Bay off Woods Hole, Mass		17,549,000	
Vineyard Sound		21,166,000	
Great Harbor off Woods Hole, Mass	846,000	1,792,000	
Boston Bay off Gloucester, Mass		18,394,000	
Gloucester Harbor off Gloucester, Mass		6,465,000	
Mackerel:			
Merryconeag Sound off Orr Island, Me		213,000	
Boothbay Harbor off Boothbay Harbor, Me		500	
Vineyard Sound off Woods Hole, Mass		210,000	
Buzzards Bay off Woods Hole, Mass		621,000	
Boston Bay off Gloucester, Mass		747,000	
Gloucester Harbor off Gloucester, Mass		150,000	

Details of distribution—Continued.

Species and disposition.	Eggs.	Fry and fingerlings.	Adults and yearlings.
Tautog:			
Vineyard Sound near Woods Hole, Mass		7,650,000	
Great Harbor off Woods Hole, Mass		9,925,000	
Flatfish:			
Vineyard Sound near Woods Hole, Mass		7,580,000	
Great Harbor near Woods Hole, Mass		892,000	
Lobster:			
Long Island Sound near Noank, Conn		2,588,000	
Long Island Sound near New London, Conn		7,550,000	
Piscataqua River near Kittery Point, Me		283,000	
York River near York, Me		154,000	
Merryconeag Sound off Orr Island, Me		151,000	
Mouth of Limkins Bay off Ocean Point, Me		40,000	
Damariscotta River off Little Heron Island, Me		35,000	
Boothbay Harbor off Big Cove Island, Me		36,000	
Burnt Island, Me		10,000	
Sheepscott River off Isle of Springs, Me		50,000	
Vineyard Sound off Woods Hole, Mass		34,303,500	
Buzzards Bay off Woods Hole, Mass		6,013,000	
Goslin, Mass		22,112,500	
Great Harbor off Woods Hole, Mass		10,600,000	
Nantucket Harbor off Nantucket Island, Mass		480,000	
Marblehead Harbor off Marblehead, Mass		450,000	
Massachusetts Bay off Rockport, Mass		398,000	
Boston Bay, Mass		1,935,000	
Gloucester Harbor, Mass		8,772,000	
Massachusetts Bay off Gloucester, Mass		714,000	
Sandy Bay, Mass		68,000	
Ipswich Bay, Mass		126,000	
Piscataqua River near Castle, N. H		150,000	

REPORT UPON THE INQUIRY RESPECTING FOOD-FISHES AND THE FISHING-GROUNDS.

By Richard Rathbun, *Assistant in charge.*

FUR-SEAL INVESTIGATIONS.

During the summer of 1895 the investigations respecting the natural history of the fur-seal and the changes in the condition of its rookeries or breeding-grounds, which devolve upon the Fish Commission by act of Congress, were prosecuted upon a much larger scale than in any previous year. The plans for this work were briefly outlined in the last report. The regular annual examination of the rookeries on the Pribilof Islands, including their delineation and photographing, was made, as heretofore, by Mr. C. H. Townsend, naturalist of the steamer *Albatross*, aided by Mr. N. B. Miller, the general assistant on the same vessel. Mr. A. B. Alexander, fishery expert of the *Albatross*, was attached during August to one of the successful pelagic sealing vessels, which gave him the opportunity of making important observations on the pelagic habits of the seals. The part taken by the *Albatross* itself in connection with this subject is described under another heading.

Novel features of the season's operations were detailed studies respecting the several problems connected with the welfare of the seal herds on both the American and Asiatic coasts, these inquiries having been conducted on the Pribilof Islands by Mr. Frederick W. True, curator of mammals in the U. S. National Museum, assisted by Mr. D. W. Prentiss, jr.; and on the Commander Islands by Mr. Leonhard Stejneger, curator of reptiles in the National Museum, and a well-known authority on the mammalia. These gentlemen were transported to their stations by the steamer *Albatross*, reaching the Pribilof Islands on June 24 and the Commander Islands on July 3, respectively. Mr. True remained in the field until August 23, and Mr. Stejneger until September 16.

The results of this season's investigations by these several parties, as well as the reports of previous work by the Fish Commission in this direction, have been published during the past fiscal year.*

*The Russian Fur-Seal Islands. By Leonhard Stejneger, of the United States National Museum. Bull. U. S. Fish Com., XVI, for 1896, pp. 1-148, pls. 1-66.

Reports of the agents, officers, and persons, acting under the authority of the Secretary of the Treasury, in relation to the condition of seal life on the rookeries of the Pribilof Islands, and to pelagic sealing in Bering Sea and the North Pacific Ocean, in the years 1893-1895. In two parts. Part II. With maps and illustrations. Results of investigations under the direction of the U. S. Commissioner of Fish and Fisheries. Printed as Senate document 137, part 2, Fifty-fourth Congress, first session. Washington: Government Printing Office, 1896. This part is published in two volumes, one of text (154 pages), with numerous maps, charts and plates; the other being a portfolio of photographic reproductions.

Mr. Townsend spent the 25th and 26th of June, while the *Albatross* was at St. Paul Island en route to the Commander Islands, in making a preliminary examination of Lukannon, Ketavie, Reef, Lagoon, and Tolstoi rookeries, on which the female seals were then scarce, the season being still early. He returned to the Pribilof Islands on July 9, beginning then his systematic observations, which were continued until August 9. Detailed studies were made of each rookery, and its condition determined and compared as closely as possible with that in 1894. Marked changes were found to have occurred in the abundance of the seals, which were less abundant than in the previous year, this fact being graphically demonstrated by a comparison of the maps and photographs covering the two seasons. The thinning out of the breeding seals, the most marked feature of the decrease, is clearly indicative of the effects of pelagic sealing, which is now being severely felt upon the islands. An approximate count of the seals was made in conjunction with Mr. True, and special attention was paid to the question of the loss of young seals by starvation through the killing of the parents at sea while seeking food.

Mr. Townsend's report also covers the operations of the pelagic sealing fleet during 1895, based upon the direct observations of the *Albatross* during the open season in Bering Sea and upon subsequent inquiries at the several ports where the fares were landed. The important subjects discussed in this report are the total number of seals taken, with the places and dates of killing, showing their distribution in both the North Pacific Ocean and Bering Sea during the hunting seasons; the proportionate number of each sex represented in the catch, and the breeding condition of the females; the ages and food of the seals so obtained, and the condition, present and prospective, of the business of pelagic sealing. Elaborate tables and charts are given, showing in detail the facts brought out by the catch of each vessel.

The object of Mr. True's inquiries was to study the natural history of the seals on the Pribilof Islands from a comprehensive standpoint with special reference to the measures necessary to insure the preservation of the rookeries. His work was partly carried on in company with Mr. Townsend, and to some extent covered the same subjects which have been mentioned above. The practical results of his observations related more especially to the extent and causes of mortality among the pups; the conditions of the rookeries as evidenced by the number of seals of each sex and of different ages upon them; the extent and causes of decrease, and the remedies which might prove effectual therefor; the effects of pelagic sealing and of the present methods of driving and culling on the islands, etc.

The investigations of Mr. Stejneger on the Commander Islands were undertaken for the purpose of securing more definite information concerning the Asiatic herd of fur-seals, which it was thought might be of value in reaching final conclusions respecting the sealing problems now in controversy, as it was understood that the habits of these animals, as well as the methods of their pursuit, were identical on the two coasts. His inquiries were rendered possible through the courtesy of the Russian Government, which not only granted permission for Mr. Stejneger to reside upon the islands and make the necessary observations, but also signified its indorsement of the objects of his visit. The local representatives of the Government, as well as of the Russian Seal Skin Company, also gave their hearty cooperation in the work, and were instrumental in bringing it to a successful issue. Mr. Stejneger was especially well qualified to make this study and to pass upon the changes in the seal herd which had taken place in recent years, as he had been stationed upon the islands, under the auspices of the Smithsonian Institution, during eighteen months in 1882 and 1883, at which time, in addition to his regular natural-history observations, he paid considerable attention to the habits of the fur-seals and the conditions of the rookeries.

Mr. Stejneger's report, already cited, is in reality a comprehensive monograph on the subject of his study. The natural history of the Asiatic seals in relation to their physical surroundings, both on the land and in the sea, is described at some length, much pains having been taken to secure the data for this purpose. The methods of driving and killing, the changes in the condition of the rookeries and their causes, the mortality among the pups, pelagic sealing, the history of the sealing industry, and all other matters which were pertinent to his inquiry are discussed in detail. The illustrations consist of a very elaborate series of charts and photographic reproductions which picture the principal features of interest connected with the subject, the more important and significant being those which graphically represent the changes in the population of the rookeries from 1883 to 1895.

The experiences of Mr. Alexander in connection with the sealing fleet during the summer of 1895 were of special interest. He was given accommodations by Capt. H. F. Siewerd, on board the *Dora Siewerd*, a schooner of 100 tons register, belonging at Victoria, British Columbia, and every facility was afforded him to conduct the inquiries for which he had been detailed. This vessel was among the more successful ones, securing a total of 1,577 skins between August 1 and September 20. Mr. Alexander's observations related to the proportionate number of each sex killed at sea, the food of the seals, their condition and habits, their distribution, the temperature and other conditions of the sea and air, the methods of working, and all incidents of the voyage which might be instructive in respect to the several sealing problems. Detailed notes were kept, and all important facts obtained have been embodied in his report.

As elsewhere explained, the *Albatross* was again detailed to take part in the fur-seal inquiries of the season of 1896, which were planned upon a much more comprehensive basis than heretofore. This was done in accordance with a joint resolution of Congress authorizing the President to assign a Government vessel for that purpose, and placing the conduct of the work under the direction of the Secretary of the Treasury. This resolution further provided for the organization of a party of experts, both by employment and by detail from the Government service, to conduct a scientific investigation into the present condition of the fur-seal herds on the Pribilof, Commander, and Kuril islands. Similar action was taken by the Government of Great Britain, but no provision was made for joint cooperation by the two parties, either in carrying on their investigations or in considering the results of their observations. In the lack of better facilities for transportation, however, two of the British representatives accepted accommodations on the *Albatross*, which had been extended to them by the Secretary of the Treasury.

When the vessel set sail from Seattle, therefore, on June 24, 1896, it carried a large scientific party, as follows: Representing the United States, Dr. David Starr Jordan, in charge; Mr. Leonhard Stejneger and Mr. F. A. Lucas, of the United States National Museum; Lieut. Commander Jeff. F. Moser, U. S. N., commander, and Mr. C. H. Townsend, naturalist, of the steamer *Albatross;* Col. Joseph Murray, special agent of the Treasury Department; Mr. G. A. Clark, secretary. Representing Great Britain, Prof. D'Arcy W. Thompson, of University College, Dundee, Scotland; Mr. James M. Macoun, of the Geological Survey of Canada, and Mr. A. Marett, photographer.

OPERATIONS OF THE ALBATROSS IN THE NORTH PACIFIC OCEAN AND BERING SEA.

The operations of the steamer *Albatross* during the summer of 1895 were again chiefly directed, as in the previous four years, to the study of the several problems connected with the fur-seal question in Bering Sea, under the immediate direction of her commander, Lieut. Commander F. J. Drake, U. S. N., but, instead of being attached to the patrol fleet, as had been the custom heretofore, the vessel was given an independent status under the orders of the Commissioner of Fisheries, so that the special line of work which she is particularly fitted to engage in might be carried on uninterruptedly. The commanding officer, however, was commissioned to board and inspect such pelagic sealers as might be encountered, in order to afford the opportunity for securing the important information only to be obtained in that way. The instructions provided for the same general character of observations as in preceding years. The investigation of the pelagic habits and distribution of the fur-seals was to be made the principal feature of the cruise, but fishing trials were to be conducted whenever the vessel was on suitable ground for that purpose. Special attention was to be paid to the hydrographic features of the sea, both in the shallow waters of the platform and in the deeper areas, with reference to their bearing upon the different sealing and fishery problems, and assistance was to be rendered the several parties detailed to conduct the shore inquiries on both the Pribilof and Commander islands, as elsewhere explained.

The cruise began on May 18, 1895, when the *Albatross* left San Francisco for Puget Sound. Several days were occupied at Port Townsend, Wash., and Victoria, British Columbia, in collecting information respecting the operations of the sealing fleet, after which the vessel proceeded northward through the passage inside of Vancouver Island, having on board Mr. F. W. True and his assistant, Mr. D. W. Prentiss, jr., who were to spend the season at the Pribilof Islands. Unalaska was reached on June 15, where Mr. Leonhard Stejneger joined the ship soon afterwards, and the seal islands on the 24th of the same month. Messrs. True and Prentiss and Mr. N. B. Miller were landed at the latter place, and on the 26th the vessel proceeded on the way to the Commander Islands, off the Siberian coast, running a line of soundings westward along the parallel of 56° N., from longitude 177° 30′ W., to which position her hydrographic work had been carried during a previous season.

This line of soundings was in progress at the beginning of the fiscal year, July 1, 1895, stations being made at intervals of 50 miles. An average depth of about 2,106 fathoms was carried across the deep basin of Bering Sea, a distance of 530 miles, to a point 22 miles N. ¾ W. from the northeast point of Bering Island, the bottom throughout this area being composed principally of brown mud and ooze, but changing to gray sand and mud as the shelf surrounding Bering Island was approached. Cape Yushin, the most northerly point of the island, was sighted on the morning of July 3, the high table-land of the interior standing out through the mist, while the shore line was obscured by a low fog bank. A line of reefs runs parallel to the northern shore line, with outlying rocks not definitely located. The water shoals up rapidly in places. The soundings were carried around the northwest end of Bering Island, passing within 5 miles of the northwest point, with 20 fathoms on the reef which extends west from the point. Anchorage was then made in Nikolski Harbor, where visits were exchanged with the governor of the islands, Col. N. A. Grebnitsky, and arrangements made for the landing of Mr. Stejneger and for the conduct of his inquiries. During the short stay in port a visit was paid by several of the officers of the vessel to the North Rookery, of which some excellent photographs were obtained by Mr. Townsend.

Leaving Nikolski on July 6, and connecting with the previous line of soundings in 70 fathoms, 5 miles off Cape Yushin or North Cape, Bering Island, a course was laid N. 51° E., true, for a distance of 315 miles, crossing the Kamchatka basin. In a run of 9 miles a depression of 1,017 fathoms was found, the bottom on this slope consisting of gray sand and mud. The greatest depth, 2,137 fathoms, green ooze, was reached at a distance of 99 miles from Bering Island. One hundred miles farther a rise of 1,727 fathoms, or a depth of 410 fathoms, was developed, this position being in latitude 57° 29′ N., longitude 170° 09′ E., or inside of the 100-fathom curve as at present delineated on the charts of the United States Coast and Geodetic Survey. Continuing the soundings southeastward at 10-mile intervals for a distance of 40 miles, the extent and nature of the eastern face of the platform was determined at a mean depth of 556 fathoms, the bottom being composed of brown ooze, sand, and gravel. A rise of temperature here of 3°, as compared with the Kamchatka basin north of Bering Island, indicated that a branch of the Japan Stream flows around the Oliutorsk platform. Proceeding 70 miles farther in the same direction the ship was carried off the platform, the margin of which descends with a gentle slope, a depth of 1,898 fathoms having been reached 111 miles S. 46° E., true, from Cape Oliutorsk. The above line of soundings took the *Albatross* into localities where depths of less than 50 fathoms are recorded on the charts of Bering Sea. The original soundings were evidently made along lines running southward from the above-named cape, and the observations of the *Albatross* tend to confirm the report that this coast line is now charted 15 miles too far to the eastward, as noted on sheet III of Hydrographic Office chart No. 528, North Pacific Ocean.

Again entering the deep basin, a second line of soundings was run across it, S. 76° E., true, from latitude 58° 37′ N., longitude 172° 54′ E., to a point 145 miles from St. Paul Island, in latitude 56° 55′ N., longitude 174° 48′ W., the greatest depth encountered being 2,084 fathoms, and a slight rise occurring at the eastern end of the line. The characteristic features of the bottom were blue, brown, and green ooze and mud. The two lines made this season indicate a comparatively level floor, with no traces of the remarkable rise of 1,481 fathoms discovered the previous year 65 miles farther north.

St. Paul Island was reached on July 9, and Mr. Townsend was there landed with the necessary outfit for delineating and photographing the rookeries. The *Albatross* then proceeded to Unalaska for coal and returned to the Pribilofs on the 16th, spending the remainder of the month in that locality, in order to render assistance in connection with the shore work, in which the commanding officer also participated, with the assistance of Ensign W. G. Miller of his staff. Mr. A. B. Alexander was left at Unalaska, where he secured accommodations on board the Canadian sealing schooner *Dora Siewerd*, for the purpose of making observations on the hunting-grounds during the open season beginning August 1.

On August 4 the *Albatross* began the investigation of the habits and distribution of the seals during their pelagic movements in search of food, giving most attention to the waters outside of the protected zone, east of the one hundred and eightieth meridian and north of the fifty-fourth parallel. In connection with this work the sealing belt of the season was developed, soundings were made, the beam trawl and towing nets were frequently employed, and observations were taken at all stations respecting the temperature and density of the water. A large part of the region to which the seals resort from their breeding-grounds on the islands at this time of year was visited, and much progress was made toward perfecting the knowledge of the more important features of this exceedingly interesting area. The following pelagic sealing vessels were boarded and information obtained from them regarding the extent and character of their catch both in Bering Sea and in the North Pacific Ocean during the earlier part of the season, namely, the *Rattler*, *Maud S.*, *Borealis*, *M. M. Morrill*, *Enterprise*, *Vera*, *Victoria*, *Triumph*, *George W. Prescott*, and *Columbia*. It was found that much greater care was exercised in discriminating between the sexes in the catch made by the United States than by the Canadian vessels, due no doubt to the fact that all fares are carefully inspected by custom-house officials when landed at ports in the United States, while no such precautions are taken on the other side.

Mr. True and Mr. Prentiss embarked on board the *Albatross* at St. Paul Island on August 23, having completed their inquiries. The vessel was at Unalaska from August 25 to 30, and left that port on the latter date, bound south. The trip was made by way of Kadiak, Yakutat Bay, Sitka, and the inland passage to New Whatcom, Wash., which was reached on September 18. Nearly a month was spent in the Puget Sound region in obtaining information respecting the salmon industry, in order to supplement the observations made during the summer by the members of the Joint Fishery Commission, as elsewhere explained. Attention was paid chiefly to locating, mapping, and photographing the large salmon traps and the several canneries, all of the principal fishing centers being visited for that purpose. Some inquiries were also made relative to the fishery resources of Hood's Canal. During the State fair held at New Whatcom, the *Albatross* remained for several days at that place, being opened up to visitors, very many availing themselves of the opportunity to examine the novel features of the ship. Mr. Townsend was principally engaged during this period in completing the records concerning the results of pelagic sealing during the past season by inquiries at Port Townsend and Victoria and in inspecting the catch of returning vessels.

Leaving Puget Sound on October 16, the *Albatross* proceeded southward, reaching San Francisco on the 20th and the Mare Island navy-yard on the 24th. She remained at the latter place until January 22, 1896, undergoing general repairs and overhauling, and from January 30 to April 12 was stationed at San Diego, Cal. While here an examination of San Diego Bay was made by means of the steam launch and other small boats, the object of this inquiry being to determine the principal characteristics and resources of the bay, and especially its suitability for oyster-culture.

On April 12 the ship proceeded to the vicinity of Cortes and Tanner banks, which lie some distance off the coast in about the latitude of San Diego, for the purpose of working out the depths and character of the bottom immediately to the westward of these small submarine elevations, which seem to promise considerable inducement for a local fishery whenever a demand shall have been established. After the first day, however, operations were interrupted by stormy weather, but a number of soundings and one successful haul of the beam trawl were made. Leaving this region, the *Albatross* went to Santa Barbara, where she remained from the 14th until the 20th of April, participating, by invitation of the authorities, in the annual flower festival of the town. From the 20th to the 26th of the same month the ship was at San Pedro, where she took part in "la Fiesta de los Angeles." San Francisco was reached on April 28 and Mare Island on May 1.

From May 7 to 18 the steamer *Albatross* was under the orders of the president of the Naval Trial Board, being used in connection with the official speed trial of the battle-ship *Oregon*, which took place off Santa Barbara on the 14th of the month. On completion of this duty preparations were made for the season's work in northern waters. Mr. C. H. Townsend, the naturalist of the steamer, who had been stationed in Washington during most of the winter, on duty connected with the preparation of his report on the fur-seal inquiries of the previous summer, returned to the *Albatross* about May 1. The greater part of that month was spent by him in making investigations in San Francisco Bay relative to its oyster-grounds and the suitability of its water for oyster-culture, supplementing his studies begun in 1891. Special attention was given to the changes which had occurred in the extent and character of the industry during the past few years, the position and extent of territory occupied by eastern oysters, the methods employed, and the relations of planted beds to their surroundings with reference to their extension by natural processes of reproduction. The *Albatross* assisted directly in this work by making a series of dredgings in the deeper water, which was commenced at the mouth of the lower bay and was carried up the channels as far as Point San Bruno.

Mr. A. B. Alexander, fishery expert, was dispatched to Puget Sound on the 17th of May, for the purpose of taking up some special inquiries respecting the halibut, salmon, and oyster fisheries of that region.

An understanding having been reached early in the season that the services of the *Albatross* would not be required in connection with the fur-seal operations of the Government during the summer of 1896, except to make the customary delineations and photographs of the rookeries on the islands, plans were perfected looking to the investigation of the more important fishery resources of southeastern Alaska. The principal species on which observations were desired were the halibut and salmon. The extent of coast to be covered by the inquiries was from the southern boundary of Alaska to the vicinity of Kadiak Island. The halibut-grounds were to be located and their productiveness ascertained, mainly with the view of establishing their value for vessel fishing; while the salmon rivers were to be studied more especially with reference to suggesting measures to prevent their depletion.

While halibut are known to be generally distributed along the entire Alaskan coast, no systematic attempt has yet been made to define the areas where they might be fished for profitably south of the banks in the vicinity of Kadiak, most of the information regarding the southern grounds having been obtained from the fishing vessels which occasionally visit that region. A considerable quantity of this species has been marketed during the past few years through ports on Puget Sound, the most of these fish having been caught in Hecate Strait, off the north ends of Graham and Vancouver islands, and at the mouth of the Strait of Fuca. Although very little hydrographic work has been done along the outer coast of southeastern Alaska, the indications are that the shore platform is there relatively narrow, thus precluding the existence of such extensive fishing-banks as occur farther north. It is probable, however, that good halibut grounds will be found along the outer coast as well as in the channels among the islands, where some fishing on a small-scale has been carried on for some time. The development of the continental slope was one of the important features of the season's work as laid out.

The salmon investigations contemplated determining primarily the relations of the several species of that important group to the different rivers, inlets, and other channels which they enter in sufficient numbers to afford the means for commercial fishing. The physical inquiries were to relate to the characteristics of each waterway, with the special object of supplying data which might be useful in determining the character of fishing methods proper to be allowed in each locality, and the restrictions necessary to insure the perpetuation of the salmon runs. This information is urgently demanded in view of the rapid development of the salmon canning business in Alaska, and the imminent danger of this important industry receiving permanent injury should the present practices continue unrestrained.

Circumstances, however, necessitated an entire change in the summer plans, and the postponement until another year of the investigations above detailed. The *Albatross* left San Francisco on June 5, and proceeded to Seattle, Wash., where arrangements were completed for the northern work in conformity with an act of Congress, providing for extensive inquiries by a scientific party relative to the fur-seal in Bering Sea and on the Asiatic coast, as elsewhere explained.

Departure was taken from Seattle on June 24, the ship proceeding by way of the passage inside of Vancouver Island, and on June 30, the close of the fiscal year, being in the North Pacific Ocean, en route to Unalaska.

During the year the *Albatross* was at sea 124 days, and steamed 11,702 miles. The number of sounding stations made was 139, and of dredging stations, 33. A daily record was also kept of meteorological and of water temperature and density observations, as well as of all other important data collected in the course of cruising.

JOINT INVESTIGATION OF FISHERIES IN WATERS CONTIGUOUS TO CANADA AND THE UNITED STATES.

The investigations undertaken in conformity with the provisions of the joint agreement of December 6, 1892, between the United States and Great Britain, were practically completed during the past year, and considerable progress was made in the preparation of the report relating thereto. Field work was carried on in the waters adjacent to the boundary line between the State of Washington and British Columbia, in the region of Lake of the Woods and Rainy Lake, in Passamaquoddy Bay, at the mouth of the Bay of Fundy, and throughout the mackerel region of the Atlantic coast.

The two representatives, Dr. William Wakeham, on the part of Great Britain, and Mr. Richard Rathbun, on the part of the United States, left Ottawa for the Pacific Coast on July 8, 1895. Making a short stop at Port Arthur, on the north shore of Lake Superior, for the purpose of completing arrangements for the inquiries in the waters between Minnesota and Canada, they reached Vancouver, British Columbia, on July 15. One month was spent by this party on the west coast, chiefly in studying the conditions and requirements of the important salmon fisheries of the Fraser River and of the adjacent salt waters of the Gulf of Georgia, Puget Sound, and the Strait of Fuca, but some attention was also paid to other branches of the fisheries which are of international interest. Visits were paid to all points on both sides of the boundary where salmon are taken extensively or where salt-water fishing is carried on, the fishermen and others connected with the industry were interviewed, and as much information was obtained by direct observations as was possible in the short time available.

The salmon fisheries greatly exceed all others in this region in the extent and value of their production, and they are still rapidly growing. Up to the present time no decrease in the abundance of the fish has been observed, but over a considerable part of these waters no regulations are in force, and unless some protective measures are introduced there is every reason to expect that the resources will sooner or later be overtaxed. The salmon are taken not only in the Fraser River, but over a wide area of the salt waters as well, an excellent quality of fish being obtained and the canneries finding a ready sale for all they can put up. Quite a large quantity of fresh salmon is also shipped to the interior and eastern part of the country, and an important trade in fresh halibut is being established.

The investigations along the boundary between Minnesota and Ontario were conducted during the latter half of July and during August by Mr. A. J. Woolman, of Duluth, Minn., with two assistants. Their work was begun in the upper part of this very diversified water system and was carried thence down through Rainy Lake and River and Lake of the Woods. The latter body of water had been examined in 1894, as explained in the last annual report, but it was deemed advisable, in view of the rapid growth of the sturgeon fishery, to repeat the observations and to obtain a more complete knowledge of the fishes inhabiting this lake as well as the upper waters of the chain. Mr. Woolman has submitted a very full report upon his inquiries, including a detailed account of the changes which have taken place in the fisheries during the past year. The sturgeon constitute the important feature of Lake of the Woods from a fishery standpoint, and their capture gives rise to the principal industry which it affords. They occur there in unusual abundance, and are readily taken in large numbers, but the small size of the lake makes their depletion a question of only a few years if fishing is allowed to continue unrestrained, as it is at present.

The inquiries in Passamaquoddy Bay related mainly to the herring or sardine fisheries, but in part also to those for the lobster and other species, and were conducted by Mr. H. F. Moore, who was engaged upon the same subject in 1893. Mr. Moore accompanied the steamer *Fish Hawk* eastward from Portland during July, 1895, while detailed to the mackerel investigations, and was thereby enabled to extend his observations along a considerable part of the Maine coast. Subsequently he established headquarters at Eastport, Me., working from that center until the last of September. The mackerel investigations, which were carried on partly in connection with the joint inquiries, are discussed under their appropriate heading.

The notes collected by the joint commission are very voluminous and relate to a great variety of subjects. Their reduction and compilation have been carried on at all times when the representatives have not been engaged in field work, but it has been impossible to forward their consideration as rapidly as was expected. The representatives met in Washington on March 1, 1896, for the purpose of engaging conjointly in the preparation of their report, and continued to be so occupied until into April, when it became evident that the work could not be finished within the limit of time set by the agreement, which was June 1, 1896. An extension of time to December 31, 1896, was accordingly arranged by an exchange of notes between the two Governments.

MACKEREL INVESTIGATIONS.

Investigations respecting the natural history of the mackerel and the fisheries which it affords were assiduously carried on during all parts of the year when this species is present on the coast. These inquiries, begun several years ago and inaugurated mainly with the object of determining to what extent, if any, the fluctuations in the abundance of this fish may have resulted from human agencies, have recently been conducted as a part of the work of the joint commission referred to above.

At the beginning of the fiscal year the schooner *Grampus*, commanded by Mr. E. E. Hahn, master, with Mr. W. C. Kendall as naturalist, was at Gloucester, Mass., having just completed a cruise in Canadian waters. Operations were resumed on July 8, 1895, and were continued until the latter part of September, the field of work being the coast of New

England, between the Bay of Fundy and Block Island. During this period the cruises were made partly in company with the fishing vessels and partly independently, in order to cover the largest possible area. The observations related to all subjects which have customarily been covered by these investigations, including the physical conditions of the sea, the distribution, abundance, habits, sizes, and food of the mackerel, the operations of the fishermen, their methods, extent and character of catch, etc. This was the first year that extensive inquiries had been made in the offshore waters of northern New England, and many important results were secured. While in port, from time to time, advantage was also taken of the opportunity to keep track of the operations of the fishing fleet in the Gulf of St. Lawrence, so as to complete the record of the year, the information on this subject being obtained from the returning vessels.

The spring cruise in 1896 began on April 11, on which date the *Grampus* left Gloucester, Mass., reaching Lewes, Del., on the 16th of the same month. The instructions issued for the guidance of the vessel, which were carried out in all particulars as closely as the circumstances permitted, were essentially the same as in previous years. The general purpose of the cruise was to observe and record the principal events connected with the first appearance of the mackerel on the southern Atlantic coast, and with their subsequent movements northward into the Gulf of St. Lawrence. The schooner remained most of the time in company with the fishing fleet, as affording the best means of keeping track of the schools of fish and of obtaining an abundance of specimens for examination. Occasionally, however, trips were made back and forth across the area traversed by the mackerel, in order to determine the width of territory which they occupy, and every effort was made to keep track of the position of the advance schools and of the main center of their abundance, with the object of ascertaining, so far as possible, the principal influences, physical and biological, which control their movements. Some fishing was done directly from the *Grampus*, and hourly observations were made respecting the temperature and density of the sea, meteorological conditions, and the amount of life present at the surface.

Lewes was made the headquarters until May 8, the vessel returning to port, however, only when the weather was too stormy to continue operations. The first mackerel taken by the fleet this year were caught in a purse seine on April 6, in latitude 37° north, on the edge of soundings. The species was more than usually abundant throughout the season, a larger number of fish being seen and a greater quantity captured than in any one spring during a considerable period. The total quantity obtained was about ten times greater than in 1895. After leaving Lewes on the 8th, the *Grampus* worked northward along the New Jersey coast, and thence eastward off Long Island and Block Island, reaching Woods Hole on the 14th.

The regular cruising closed at this time, the vessel being detailed to engage in the collecting of mackerel eggs for hatching purposes. This work, however, necessitated her keeping in localities where spawning fish were expected to occur, and the customary observations were continued so far as possible, Mr. Kendall giving his entire time to this subject. The *Grampus* remained in the Vineyard Sound region until about June 1, when she proceeded to the eastern part of the coast of Maine, being still engaged in procuring eggs of the mackerel at the close of the fiscal year.

Inshore work respecting the mackerel was carried on during the summer of 1895 by Capt. A. C. Adams and Dr. W. E. Wolhaupter, on the same plan as in 1894. These two assistants remained in company on the coast of Maine during the month of July, having the use of the steamer *Fish Hawk*, Lieut. Franklin Swift, U. S. N., commanding, in order to facilitate their movements and afford the opportunity of reaching outlying fishing-grounds. Reaching Portland on July 2, this vessel remained in the vicinity of Casco Bay until July 11; thence proceeding to Booth Bay, Monhegan Island, Port Clyde Harbor, Rockland, Seal Harbor, Matinicus Island, Great Duck Island, Southwest Harbor, Bar Harbor, Long Island Harbor, Burnt Cove Harbor, Isle au Haut, and back to Rockland, where the cruise ended. Many places of less prominence were also visited. Dr. Wolhaupter subsequently extended his observations east to Machias, Cutler, and Eastport, after which both he and Captain Adams returned southward along the coast of New Hampshire and Massachusetts. Capt. Adams completed his field work at Gloucester the last of August, while Dr. Wolhaupter also visited Boston, several places on Cape Cod, Woods Hole, Newport, Block Island, New York, and the northern part of the New Jersey coast, reaching Washington early in October.

During the early spring fishery of 1896, the Commission was represented at Fulton Market, New York City, by Mr. A. G. Maddren, temporary assistant, who carried on the customary inquiries at that place from the middle of April until the latter part of May. These related to the fresh mackerel landed at New York by the purse-seiners and to those brought there from the shore fisheries, both to the southward and eastward. His observations were largely supplemental to those made on board the schooner *Grampus*.

OYSTER INVESTIGATIONS.

Apalachicola Bay, Florida.—In compliance with a resolution of the United States Senate, adopted February 15, 1895, the steamer *Fish Hawk*, commanded by Lieut. Franklin Swift, U. S. N., was detailed to make investigations respecting the oyster fisheries on the coast of Florida during the winter of 1895-96. As the extent of the coast referred to was far too great to be covered in a single season, it was concluded to restrict the operations at that time to Apalachicola Bay and the adjacent waters, where the fishery has for some years been of relatively much importance, on the ground that more satisfactory and useful results could be accomplished in that way. The survey was begun on November 12 and completed on March 28. The inquiries were conducted entirely by Lieutenant Swift and the other officers of the vessel, among whom Mate James A. Smith, U. S. N., should be especially mentioned for efficient services, his previous long experience on the Fish Commission having well fitted him for work of this character.

The total area included within the scope of the investigation extended about 21 miles east and west, with a greatest width of 6½ miles, and consisted of Indian Lagoon, St. Vincent Sound, Apalachicola Bay, East Bay, and the western end of St. George Sound.

The main objects of the inquiry, as stated in the instructions, were to determine—(1) the positions, outlines, characteristics, and richness or productiveness of all oyster beds located in the waters named; and (2) the positions, outlines, and characteristics of all areas of the bottom suitable for the planting of oysters, either in their natural condition or after preparation. The carrying out of these directions involved a detailed and careful survey of the entire region with respect to hydrographic features, as well as to the density and temperature of the waters, and the location and condition of oyster growths. The work was conducted in an exceedingly able manner, and the results as presented by Lieutenant Swift* can not fail to prove both instructive and suggestive. So far as the surveys made some years ago by the Coast Survey were applicable to the purpose they were utilized, but many changes in the contour of the bottom were found to have taken place, and a large number of the signal stations had disappeared, partly through the wearing away of the shores. The amount of hydrographic work which it was necessary to undertake was, therefore, very great, and owing to the care shown in making these observations, the chart accompanying the report is as important for navigation as for the oyster fisheries.

The general scheme and methods of work adopted are described as follows by Lieutenant Swift:

The work, in accordance with the instructions given, was not to be a mere reconnoissance or examination of a few important beds, but a complete survey of every bed and area where oysters were found, as well as a thorough examination of the bottom of the whole region covered, in order to determine its suitability for oyster planting. Therefore it was necessary to adopt a scheme of hydrographic surveying in which the lines of sounding should be close enough together to insure the detection of every oyster reef, however small, and show the character of the bottom in every locality, and at the same time not to run the lines unnecessarily close, so that the work might be pushed on as quickly as possible. The local oystermen, although able to give the approximate location of the more important beds, could not, of course, be depended upon to give the limits of all regions where oysters were found or to give the location of the smaller beds. These facts could only be determined by actually running the lines, keeping an accurate record, and plotting the resulting development on the projection. However, the elaborate development of the bottom, as generally required in the Coast Survey work, was not here necessary, and the ground could be covered more quickly as far as the hydrographic part was concerned. But, in addition to the hydrographic work, there were many other considerations;

*Report of a survey of the oyster regions of St. Vincent Sound, Apalachicola Bay, and St. George Sound, Florida. By Lieut. Franklin Swift, U. S. N. Report U. S. Fish Com. 1896, pp. 187-221.

of the first importance was the question of density or salinity of the water, the determination of which alone would show, to a great degree, the suitability of any locality for cultivating purposes.

The questions of the physical observations on the beds and the examinations of the oysters themselves were of the greatest importance. It was necessary that sufficiently accurate current observations should be taken to establish the approximate velocity and the general set of ebb and flood tides, as such data is essential in connection with the food supply of the oyster and the amount of silt or mud deposited on the beds.

As the spawning habits of the oyster depend to a great extent on the temperature of the water, the temperature observations were important. Information in regard to the spawning was to be collected from local sources and from a study of the specimens preserved.

On account of the shallowness of the water in localities where oysters were found, it was impossible to use the ship for dredging purposes. The oystermen employ tongs entirely, and tongs were found to be more serviceable than the boat dredge for our purpose. In estimating the number of oysters to the stated given area—as, for instance, a square yard, the comparison generally used in former surveys—the boat was moored, and the oysters on the bed were tonged and counted within the limits covered by the bottom of the boat, and the result reduced to square yards. Any method employed for this purpose, although correct enough for the particular locality where used, would, of course, only give a rough approximation for the whole oyster region, unless an almost infinite number of such observations were made. Still this method gives a standard to which observations made in future surveys may be compared, and thus shows the increase or decrease from time to time in the number of oysters on the beds.

The shoalness of the water allowed the use of poles in taking soundings and obtaining the character of the bottom. * * *. These poles were 1½ inches in diameter at the lower end and slightly tapering to the upper end. They were 14 feet long, and, constructed as described, were light, well balanced, and strong. By their use the presence of oysters could be immediately detected, not only by the "feel" of the pole to the poleman, but also by the ringing sound given out on striking shells, easily heard by the officer in charge of the boat. * * * All oyster reefs and areas of scattered oysters were carefully located, the reefs composed solely of old shells, as well as those of live oysters, and whether of the raccoon type or not.

Full notes were kept in the record books of the results of the examinations—the type of oyster, shape, size, and appearance of the shell, whether single or in clusters, growth on shell, appearance of spat or young growth, flavor and condition of oyster, number of oysters to stated area, proportion of live oysters to dead shells, appearance of bed, growth and cleanliness of bed. A careful lookout was kept for enemies of the oyster, as starfish, drumfish, drills, conchs, sponges, etc., and their presence noted. * * * In considering the question of bottom suitable for the planting of oysters, those areas were recorded favorable when the bottom was sufficiently hard to prevent the oyster from sinking, and, at the same time, possessing sufficient cohesion to resist the shifting action of the waves, all other conditions being also favorable. Very soft, muddy bottoms were considered unsuitable, but those of a somewhat firmer consistency it was considered possible to make suitable by covering them with layers of stones or shells.

The results of the survey are discussed in detail for all parts of the region studied, beginning with St. Vincent Sound and Indian Lagoon at the west. The principal features brought out for each are the depth of water and composition of the bottom, the physical characteristics, the nature and extent of the oyster growths, whether dense or scattered, of marketable quality or of raccoon type, and the position and extent of territory which it is thought may be adapted to oyster planting.

Formerly a large part of the oysters marketed at Apalachicola were obtained in St. Vincent Sound, but the principal seat of operations has been shifted farther eastward. In this sound the best oyster growths are found to be eastward of the Bulkhead, but here, as elsewhere throughout the region, there has been a very extensive destruction of oyster beds by recent hurricanes. The whole eastern part of St. Vincent Sound is well fitted for the cultivation of oysters. The density and temperature are favorable, the bottom is smooth and uniform in depth, and the locality is generally well sheltered from violent storms.

Apalachicola Bay has a total area of 63 square miles, and, with the exception of a single deep channel, is generally shallow. The most noticeable hydrographic feature is an oyster reef called St. Vincent Bar, which is composed mostly of dead shells and practically divides the western part of the bay. Between St. Vincent Bar and Apalachicola are located all the oyster reefs of this section of the bay. These beds were formerly productive, but are not worked at present. The central part of the bay is devoid of oyster beds, and only a few beds, mostly of scattered oysters, are found in the eastern part until St. George Sound is reached. A considerable area of bottom was ascertained to be suitable for planting purposes.

The only oyster beds in St. George Sound which are now important are the large ones at the west end. There are other beds eastward of the limits of the survey, some of which were formerly productive, but at present none are worked. The area from Cat Point southeast to St. George Island, for an average width of nearly three-fourths of a mile, forms one large continuous oyster bed, although different names are given to different parts of it. It is here that the oyster fleet, consisting of about 32 vessels, has recently been concentrated, and during the season of the survey practically all the oysters brought into Apalachicola were obtained on these beds.

According to Lieutenant Swift, oysters were first taken for the local market in the region covered by the investigations in 1836, but not in any quantities until 1850. During the war the beds were left undisturbed and they improved so much that they were subsequently in very good condition. The business was again resumed, but was not carried on extensively until 1878. During the winter of 1893–94 the beds of St. Vincent Sound and Apalachicola Bay were nearly destroyed, and since then practically no oysters have been obtained in those places. This destruction was partly the result of overfishing, but was due mainly to the effects of freshets, hurricanes, and freezing. The Bulkhead and Cat Point bars have lately furnished about all the oysters brought into market, although some few have been taken at Porters Bar to the eastward. It seems to be the general opinion that the beds are deteriorating at the Platform and on the Bulkhead and Cat Point bars, where oystering is going on at present, and the reason assigned is that the beds are overworked, the supply being unequal to the demand.

The advantages of these waters for the cultivation of oysters and the benefits which might be gained by utilizing for that purpose the bottoms where oysters do not occur at present are thus discussed by Lieutenant Swift:

As before stated, planting was tried experimentally on the north side of St. Vincent Sound, and enough was done at the time to show that it could be made a decided success, if the laws of the State regarding planting could be enforced. As it was, no protection whatever was given, and the experiment proved unsuccessful for that reason. The State laws protect the planters, but there appears to be no attempt to enforce the laws, and the moral sentiment among the oystermen is not in favor of such protection. This is due to a misunderstanding of the subject by the oystermen; the law makes a distinction between the cultivated beds and natural beds and relates wholly to the cultivated beds, but the oystermen have the idea that any protection given the planters is of the nature of a monopoly and is an encroachment on their rights. Of course such is not the case, as the laws protecting planters do not in any way interfere with oystering as it is now carried on on the natural beds. All oyster cultivation would be carried on entirely away from the natural beds, and in some cases in localities quite remote from them. The chart shows exactly where oysters may be cultivated, and any intelligent person by using a compass may locate himself with sufficient accuracy to find the limits of the planting ground; in this connection a sounding pole will be of great assistance, as by it he can judge of the character of the bottom as well as the depth of water. By closely studying the limits of the planting area a person can select certain natural ranges which will help him locate himself.

The whole question of oyster cultivation is of the greatest importance to the people of Apalachicola and vicinity, as undoubtedly if the law is enforced and the planters protected it may be made a great industry, and it is only necessary to cite as an example the great success met with by the oyster cultivators of Long Island Sound in order to show what a great business may be developed. But first the oystermen must be brought to a realization of the fact that the protection of oyster cultivation does not in any way infringe upon their rights, and that on the contrary it is directly for their best interests. All have equal rights, and any man having sufficient thrift and energy may, without much doubt, better his condition by undertaking the cultivation of oysters and uniting with others to respect the laws.

The cultivation of oysters would be more easy on account of the number of oyster shells brought into Apalachicola. By simply spreading these shells over the areas of planting ground, the spat would attach itself to the cultch, and only a little care in cleaning and spreading would be required to form, in time, a productive bed. It should always be borne in mind, as has already been mentioned, that oysters grow and thrive much better in a current than in still water, as they have a better food supply. In transplanting oysters the clusters should be broken up and each oyster should be thoroughly cleaned of barnacles and mussels.

It is almost certain that if the question of oyster cultivation were taken up in the proper way by the people of Apalachicola and vicinity, excellent results would be obtained. No better flavored or conditioned oysters can be found anywhere than those at Cat Point Bar and at Sylvas Bar, and by using the seed from these bars it can be safely prophesied that oysters of the cultivated bed will excel those of the natural beds. There is little doubt that if the oysters on the Bulkhead, where the vegetable growth renders them unfit for canning purposes, were transplanted to other localities, they would lose the peculiar characteristics so injurious to them, and become, like the Cat Point oysters, most excellent in quality.

Pacific coast.—The inquiries made during the year on the Pacific coast relative to the oyster-grounds and the opportunities for oyster cultivation are referred to under the operations of the steamer *Albatross.*

THE LOBSTER.

In 1890, at the invitation of the Commissioner, Prof. Francis H. Herrick, of Adelbert College, Cleveland, Ohio, began the preparation of a comprehensive work upon the habits and development or general biology of the American lobster, the most important, by far, of all the crustaceans of this country. As very little attention had been paid by anyone to the natural history of this species, it became necessary for Professor Herrick to take up the subject as a practically novel one and to conduct a protracted series of observations which extended through five years.

The material required for this purpose was obtained and the study of living material carried on chiefly at the Woods Hole station of the Commission, where exceptionally favorable advantages are presented for researches of this character. Brief references to the progress of Professor Herrick's work have been made from year to year in the annual reports. His task was completed during 1895, and his monograph was published before the end of the past fiscal year.*

Professor Herrick's training and his previous elaborate studies of the Alpheus group of crustaceans especially qualified him to undertake this important work, which he has conducted in the most conscientious and painstaking manner. The result has been exceedingly gratifying. From a purely scientific standpoint the report submitted is of the highest merit, and in that respect will justly attract widespread attention; but it is more than a scientific memoir, as, under the influence of his practical surroundings, the author has carried his researches to a point where their utility will readily be perceived by the fish-culturist and the legislator. No other object of the fisheries has received more thorough and systematic treatment by a single writer.

It would be impossible to review even the more essential features of Professor Herrick's work within the limits of this report. Its scope is indicated by the principal chapter headings, as follows: Habits and environment; reproduction; molting and growth; defensive mutilation and regeneration of lost parts; large lobsters; enemies; the tegumental glands and their relations to sense organs; variations in color and structure; structure and development of the reproductive organs; habits from the time of molting until the period of maturity; history of the larval and early adolescent periods; embryology. Aside from a few photographic reproductions, the illustrations, which number nearly 300 figures in all, are almost exclusively from drawings and paintings by the author. They relate to practically all the subjects discussed which are capable of being graphically presented.

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*The American Lobster: A study of its habits and development. By Francis Hobart Herrick, Ph. D., professor of biology in Adelbert College of Western Reserve University. Bull. U. S. Fish Com., xv, for 1895, pages 1-252, plates A-J and 1-54.

A brief summary is given of the most important observations made, especially in those directions bearing upon the artificial propagation of the species. The extreme geographical range of the lobster is from Labrador to North Carolina, and its range in depth from about 1 to upward of 100 fathoms, but its distribution in abundance is restricted within much narrower limits. There appears to be no pronounced coastwise migration, but large numbers move to and from the deep waters in the fall and spring. They approach the shores in the Vineyard Sound region when the temperature of the water rises to between 50° and 55° in the spring.

The adult lobsters feed chiefly on fish and invertebrates, but they also take small quantities of algæ and eelgrass. About 80 per cent of the spawning females extrude their eggs during July and August, the remainder at other seasons, but the hatching period is chiefly in the late spring and early summer, the eggs in the majority of cases being carried, therefore, from 10 to 11 months. The number of eggs produced at each laying varies from about 5,000, in an 8-inch lobster, to over 60,000 in one measuring 17 inches long, but in a few instances over 90,000 eggs have been observed on lobsters from 15 to 16 inches long.

The female lobsters become sexually mature when from 8 to 12 inches long. They spawn not oftener than once in two years, the spawning interval being apparently biennial. Molting takes place chiefly during the four months from June to September, inclusive, but there is no month in which soft lobsters may not be caught. It is concluded that the rate of growth varies considerably with the individual and its surroundings. The length of the young lobster when it hatches from the egg is about 7.84 mm., and the increase in length at each molt is about 15.3 per cent. The lobster molts from 14 to 17 times during the first year. A 10½-inch lobster has molted from 25 to 26 times, and is about 5 years old. The greatest size attained by the species is thought to be about 25 pounds, most of the accounts of the extreme weights of these animals being unreliable.

The lobster hatches from the egg as a pelagic free-swimming larva. It lives at the surface of the ocean from six to eight weeks, when, after having molted five or six times, it goes to the bottom and appears in habit and structure like a very small adult lobster. After reaching the bottom it travels toward the shore and establishes itself in rock piles in harbors and at the mouths of rivers, where it remains until driven out by ice. At very low tide they can be found by digging away the loose stones. The larvæ feed upon minute pelagic organisms of all kinds, showing little discrimination at this time. Great destruction is wrought upon the free-swimming stages by both animate and inanimate enemies. A survival of 2 in every 10,000 larvæ hatched would maintain the species at an equilibrium, and the destruction of the young under the present conditions of the fishery is probably even greater than this implies.

INDIAN RIVER, FLORIDA.

Indian River, Florida, was made the subject of an investigation during January, 1896, with respect to the character and condition of its fisheries, in accordance with a provision of the sundry civil appropriation bill, approved March 2, 1895, as follows: That it shall be the duty of the Commissioner of Fisheries to make special investigations as to the extermination of migratory fishes on the Indian River of Florida. The scientific inquiries were conducted by Prof. Barton W. Evermann, assisted by Mr. Barton A. Bean, of the United States National Museum, and Mr. A. G. Maddren, and those relating to the statistics and methods of the fisheries by Mr. W. A. Wilcox. The field work was planned on a comprehensive basis, and contemplated securing as complete information as possible on the following subjects: The kinds of food-fishes occurring in the river, either continuously or as regular visitants; their distribution, movements, spawning, and other habits; their abundance at present as compared with the past, the extent of any decrease among them, and its causes; and the remedial measures advisable to take in order to preserve, and if need be to restore, the fishery resources of these waters. In determining these matters it was necessary to study the physical characteristics as well as the natural history of the region, and to obtain a thorough knowledge of the history of the fisheries from their inception to the present time. The work was carried on chiefly by interviewing the fishermen, fish-dealers, and others acquainted with the subject, and by examining the catches as they were landed or received at market, but much seining was done and observations were made respecting the temperature and density of the waters and other physical conditions.

Indian River is in reality a long, narrow, and shallow salt-water lagoon or sound, about 135 miles long and separated from the sea by a narrow strip of very low land. It is connected more or less directly with the ocean at four different places. The commercial fishes number about 24 species, of which, however, only about 16 species occur in sufficient abundance to be important, the most conspicuous among these, based upon the value of the catch in 1895, being the mullet, pompano, sheepshead, and squeteague. Oysters are also obtained in considerable quantities.

The fisheries of Indian River have been developed only within a comparatively few years, beginning practically in 1878, and it was not until railroad communication had been opened up in 1886 that they became thoroughly established. With the increase of facilities in this regard the industry has grown rapidly and has been extended to a large part of the river. More than half the catch and nearly a third of its value were represented by the mullet. The pompano, the most highly esteemed species, has decreased greatly in abundance, especially since 1894, and the explanation of the fishermen, that this is due chiefly to the severe weather during the winter of 1894–95, is not without reason. As this species seems to spawn inside the river, it is thought that a close season during its spawning period would prove advantageous.

Although the mullet may be less abundant at present in some parts of the river than when fishing first began, they are now sufficiently plentiful to more than meet the current demands, and the dealers are frequently obliged to place a limit on the catch. While these conditions continue, the fishery will regulate itself, but with the improvement in means of preserving and of transporting fish from this region, a larger market will undoubtedly soon be opened up, and some restrictive measures are required to insure the preservation of the supply of this species. No decrease is reported among the other fishes of the river. Turtles, however, are much less abundant than formerly, owing to overfishing, and there has also been a large reduction in the average size of those caught. The oysters are of fair size and good quality, but have received little attention. Their more general utilization and the formation of artificial beds, doubtless soon to be undertaken, will be one of the principal factors in the future development of the fishing industry.

INVESTIGATIONS OF INTERIOR WATERS.

COLUMBIA RIVER BASIN.

The inquiries respecting the salmon and other fishes in the Columbia River basin, begun in 1892, have been continued systematically during each succeeding year, with interesting results. The investigations of 1894 showed that both the redfish or blueback salmon and the chinook salmon have important spawning-grounds in the regions of Big Payette Lake and the Redfish lakes of Idaho, and these waters were selected as the field of operations for 1895, a party being sent to each. The work was directed by Prof. Barton W. Evermann. Mr. Thomas M. Williams, of Stanford University, was assigned to Big Payette Lake, where he remained from July 19 until September 25. Redfish lakes were covered by Prof. Evermann, Prof. Seth E. Meek, of the Arkansas Industrial University; Dr. Oliver P. Jenkins and Mr. N. B. Scofield, of Stanford University, and Mr. William Barnum, of the Fish Commission, whose observations extended from July 17 to September 24.

Two forms of redfish have been found to breed in the inlets to these lakes. They differ, however, only as to size, the smaller weighing about half a pound each and the larger from 3½ to 6 pounds, and are considered to represent only a single species. Both of these varieties, as well as the chinook salmon, were the subject of careful daily observations, gill nets of different-size mesh being employed, so as to intercept their movements in certain of the inlets and outlets and furnish the opportunity for keeping a close watch upon their habits. The results obtained were of great value, leading to definite conclusions on several points in the natural history of these species, which have never been clearly understood. Some of the more important may be briefly stated as follows: Both forms of redfish had reached the lakes prior to July 20, when the nets were first used. The larger form is considered to be anadromous, but the evidence that the smaller one comes up from the sea is not complete. The mutilations, sores, fraying out of fins, etc., are not received while en route to the spawning-grounds, but subsequent to reaching them; and all the redfish die soon after spawning. The young remain in the lakes and connecting waters for at least one year after the eggs are laid. The chinook salmon arrived on or about July 24, at which time they were practically without mutilations or sores. They all die after spawning, the same as the redfish, and the young appear to remain for one year after the period of spawning near where they were hatched.

In the report of the season's work* Professor Evermann describes at length the methods and progress of the examination. Besides the inquiries respecting the salmon and other fishes collected, observations were made upon the physical features of the lakes and streams and upon the plant and lower animal life which belong to them. All of the facts obtained are fully discussed, and many illustrations are given. The paper concludes with a "Detailed report upon the salmon and other fishes observed," in which 21 species are enumerated, with very complete natural-history and technical notes, especially upon the *Salmonidæ*.

The investigations of this season must be regarded as especially noteworthy in their results, having added conspicuously to the sum of knowledge previously acquired respecting the habits and life history of the Pacific group of salmon.

INVESTIGATIONS IN THE NORTHWESTERN STATES, 1896.

In the spring of 1896 plans were drawn up for extensive investigations in the northwestern part of the United States, relating more especially to the requirements of that region from a fish-cultural standpoint. In accordance with the directions of the Commissioner that arrangements be made looking to the increase of hatching operations in regard to the salmon, it was necessary to provide for the examination of as many important rivers as possible, in order to ascertain the best locations for new and auxiliary stations, where eggs could readily be obtained and where a supply of water by gravity was available.

The carrying out of these instructions necessitated a change from the methods of previous years, and called for a rapid reconnoissance of a wide extent of territory, although it was intended that the work should everywhere be executed in as thorough a manner as the time permitted. These inquiries were to cover not only the Columbia River basin, but the entire Pacific watershed of the States of Washington, Oregon, and California, to the southern limit of salmon distribution. In the Columbia River basin it was considered important that several good sites for the collecting of eggs should be discovered and their advantages in that respect carefully determined. In the Puget Sound region it was furthermore desired to ascertain, especially in the interest of the Joint Fishery Commission, to what rivers the blueback or sock-

* A report upon salmon investigations in the headwaters of the Columbia River, in the State of Idaho, in 1895, together with notes upon the fishes observed in that State in 1894 and 1895. By Barton Warren Evermann. Bull. U. S. Fish Comm., XVI, for 1896, pages 149-202, plates 67-72.

eye salmon resort for spawning purposes, and their relative abundance in each. Arrangements were also made for repeating the observations begun on Big Payette Lake and the Redfish Lakes in 1894, with respect to the presence and the spawning and other habits of the several varieties of salmon, by detailed observations carried on continuously during that part of the season when the fish occur in those upper waters. In view of the prolonged strike of the fishermen on the lower Columbia River, which was then in progress, and the opportunity thus afforded for the uninterrupted movement of the fish during a considerable period, it was expected that the results of the observations this year would have unusual significance.

An additional subject to be attended to in connection with the above inquiries was the examination of Lake Washington, at Seattle; of lakes Pend d'Oreille and Cœur d'Alene, Idaho, and of Crater and Klamath lakes, Oregon, with regard to the following matters, namely: The commercial and game fishes which are native to them, the expediency of introducing new species, and the survival of the plants of whitefish which have been made in some of them.

These investigations were placed in the direct charge of Prof. Barton W. Evermann, and the following persons were designated to assist him: Mr. A. B. Alexander, fishery expert of the steamer *Albatross;* Prof. S. E. Meek; Prof. U. O. Cox, of Mankato, Minn., and Mr. A. G. Maddren. The field work was to be actively taken up on July 1, the beginning of the fiscal year, but the following inquiries were made before that date:

Lake Washington.—Having been detailed from the *Albatross* in May, Mr. Alexander proceeded to Seattle, where he made an investigation of Lake Washington, extending from May 28 to June 17, 1896, for the purpose of determining, if possible, the presence of the common whitefish of the Great Lakes (*Coregonus clupeiformis*), the fry of which had been planted there by the Fish Commission several years before. The examinations were conducted mainly by means of gill nets having 3½-inch mesh, in all depths from the shallow water around the shores to a depth of 25 fathoms. Drag seines were also employed. The results of the numerous trials made were entirely negative, nothing but a species of sucker being obtained in the gill nets, although quite a large variety of forms was secured in the seine. Mr. Alexander is led to conclude from his observations and from the testimony of several inhabitants about the lake that the whitefish did not survive; but whether this was due to unfavorable physical conditions or to the destruction of the fry or young by predaceous fishes he was unable to ascertain. The inquiries will be repeated in the fall, at which season this species spawns in the Great Lakes, coming into shallow water for that purpose.

While at Seattle, Mr. Alexander also made inquiries respecting the vessel halibut fishery of the past year, the extent of that industry, the grounds resorted to, the size and quality of the fish found on each, etc. He likewise paid some attention to the oyster-grounds in the Puget Sound region.

Lake Pend d'Oreille.—This lake, situated in the northern part of Idaho, was the subject of investigation by Mr. Alexander and Professor Cox, beginning on June 25, 1896, and extending for some time into July. The object of the inquiry was similar to that concerning Lake Washington, namely, to ascertain if the fry of the common whitefish planted there by the Commission in 1889 had survived, and the result was also the same. Both gill nets and seines were employed in the examination, but the conditions proved very unsatisfactory for the work, the water being unusually high. Important observations, however, were made respecting the physical characteristics of the lake and the fishes and other forms of life which inhabit it. This was done with the object of determining whether its waters were suitable for any of the important fishes not now native to it, and whether the introduction of new forms was advisable.

INQUIRIES RESPECTING THE SHAD.

In the spring of 1896 specimens of shad were received from the Black Warrior River at Tuscaloosa, Ala., which proved upon examination to present such marked differences from the common shad of the Atlantic coast rivers that it has been classed as a new species under the name *Alosa alabamæ* Jordan and Evermann.* It agrees entirely in structure with a number of young shad collected at Pensacola, Fla., in 1882, by Dr. David S. Jordan, who considered them at the time to represent a new species, but withheld his description of them from publication. The significance of the discovery in 1896 was not appreciated until it was too late to make extensive investigations in the South, but the collections contained in the United States National Museum were carefully gone over, and visits were paid to the Potomac, Susquehanna, Delaware, Hudson, and Connecticut rivers, where large numbers of specimens were examined. No examples of the new species were found among the material from any of the rivers on the eastern coast. According to Prof. Evermann—

> This is undoubtedly the native shad of the Gulf of Mexico and tributary streams, though it is probably less abundant in those waters than *Alosa sapidissima*, which has been extensively introduced there by the United States Fish Commission.

WOODS HOLE LABORATORY.

The Woods Hole laboratory of the Commission, with its exceptional advantages for the study of marine biology in all its branches, was kept open as usual during the summer of 1895. Besides the inquiries conducted there by its employees, advantage was taken of the customary facilities granted to independent workers by thirty persons interested in special lines of investigation, who represented twenty different institutions of learning of greater or less prominence. The supervision generally given to the station at this season by the Commissioner, whose illness prevented his being present, and whose death occurred at the close of the summer, was greatly missed.

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* Description of a new species of shad (*Alosa alabamæ*) from Alabama. By Barton Warren Evermann. Rept. U. S. Fish Com. for 1895, pp. 203-205.

The laboratory was in charge of Dr. James I. Peck, of Williams College. The others in attendance were as follows:

Dr. William Patten, of Dartmouth College; Dr. Henry V. Wilson, of the University of North Carolina; Mr. James E. Peabody and Mr. S. Gato, of Harvard University; Mr. Ulric Dahlgren, of Princeton University; Mr. George Lefevre, Mr. Hubert L. Clark, and Mr. Arthur L. Lamb, of Johns Hopkins University; Mr. John A. Sampson, of Johns Hopkins Medical School; Dr. Ira Van Gieson and Mr. Israel Strauss, of the College of Physicians and Surgeons, New York; Mr. J. R. Slonaker, of Clark University; Dr. Lewis Murbach, of Berkey, Ohio; Mr. Alvin Davison, of Lafayette College; Mr. Herbert Tetlow, of Adelbert College; Dr. Thomas H. Montgomery, jr., of the Wistar Institute of Anatomy, Philadelphia; Mr. Maurice Bigelow, Mr. Charles Hazzard, and Mr. W. S. Nickerson, of Northwestern University; Mr. William H. Dudley, of Lake Forest University; Mr. N. R. Harrington, of Columbia University; Mr. E. R. Boyer, Dr. H. S. Pepoon, Mr. Frederic C. Lucas, and Mr. W. Whitney, of the high schools, Chicago; Dr. Mary A. Schively and Miss Alice H. Beckler, of Philadelphia; Miss Bessie V. Gaines, of Adelphi Academy, Brooklyn; Mr. John I. France, of Johnstown, N. Y.

The researches carried on by Dr. Peck were undertaken in the interest of the Commission, and related to the food and feeding habits of the younger stages of a large number of the important food-fishes of the region. The work was in continuance of studies which have now been in progress during three consecutive seasons, the earlier results being referred to in previous reports. This year's inquiries had reference mainly to the length of the period elapsing from the hatching of the egg until the young fish begins to feed and to the character of its first food, subjects of great importance in respect to fish-cultural methods.

Other investigations which may be noted in this connection are the following: Dr. H. V. Wilson was engaged in the preparation of a report upon marine sponges collected by the steamer *Albatross*. Dr. Patten continued his studies on the central nervous system of the young horseshoe-crab and of the young of several kinds of fishes. Dr. Montgomery was occupied with researches on the anatomy, histology, and development of Nemertean worms, and completed, while at the station, a paper on the origin of the land and fresh-water species of that group. Dr. Murbach studied the embryology and the nettling organs of the Medusæ. Dr. Van Gieson's investigations were directed toward determining the difference in structure between the sensory and motor ganglion cells of both vertebrates and invertebrates, in which work he secured the cooperation of several of the students present at the laboratory, which gave the opportunity for extending the observations to many forms representing a number of different groups. Besides these a great variety of subjects was represented by the inquiries of other investigators and students, many of which relate to structural features among the useful fishes and invertebrates. In this manner and by such voluntary labors important facts, which ultimately derive practical significance at the hands of specialists in fishery matters, are brought to light each season, showing how dependent on the precise methods and deductions of science are the improvements which are taking place in the means for preserving and increasing the objects of our fisheries.

Mr. Vinal N. Edwards, the permanent observer at Woods Hole, has continued his almost daily collecting trips throughout the year, as well as his record of the seasonal appearance and disappearance of the different fishes and of their relative abundance from time to time. Some of the special inquiries conducted by him are referred to in another connection. During the summer he assisted those in attendance at the laboratory in obtaining the materials for their studies.

The aquaria and the exhibition collection of marine animals and plants have been properly maintained throughout the year, and many additions have been made to the latter. The aquaria are especially serviceable to the workers in the laboratory, as they afford not only the means of keeping animals alive for an indefinite period, so as to have them available for study at all times, but also the opportunity of observing their habits under conditions which are as nearly natural as it has been possible to provide them. The names of the different species contained in each tank are displayed on a large label for the benefit of the public, which continues to find the exhibition rooms on the lower floor an attractive place to visit.

TEMPERATURE OBSERVATIONS.

The Fish Commission has continued to receive, through the courtesy of the Light-House Board and the Southern Pacific Company, the daily records of water-temperature observations taken at the following sea-coast and inland stations:

Temperature stations on the Atlantic Coast.

Stations of the Light-House Board:

- Coast of Maine: Petit Manan Island, Mount Desert Rock, Matinicus Rock, Seguin Island, Boon Island.
- Coast of Massachusetts: Race Point, Pollock Rip light-ship, Great Round Shoal light-ship, Nantucket New South Shoal light-ship, Vineyard Sound light-ship.
- Coast of Rhode Island: Brenton Reef light-ship, Block Island southeast light.
- Long Island Sound: Bartlett Reef light-ship.
- Coast of New Jersey: Absecon Inlet, Five Fathom Bank light-ship.
- Delaware Bay: Fourteen-Foot Bank light-ship.
- Coast of Virginia: Winter Quarter Shoal light-ship.
- Chesapeake Bay: Windmill Point, Stingray Point, York Spit.
- Coast of North Carolina: Cape Lookout, Frying Pan Shoal light-ship.
- Coast of South Carolina: Charleston Bar light-ship, Martin's Industry Shoal light-ship.
- Coast of Florida: Fowey Rocks, Carysfort Reef, Dry Tortugas.

Temperature stations on the Pacific Slope.

Stations of the Southern Pacific Company:

- Sacramento River at Tehama and Yolo bridges and Kings Landing, California.
- Feather River at Feather River bridge, California.
- American River at American River bridge, California.
- Mokelumne River at Lodi, Cal.
- Tuolumne River at Modesto, Cal.
- San Joaquin River at the upper and lower railroad crossings.
- King River at Kingsburg, Cal.
- Colorado River at Yuma, Ariz.

REPORT OF THE DIVISION OF STATISTICS AND METHODS OF THE FISHERIES.

By HUGH M. SMITH, *Assistant in Charge.*

PERSONNEL AND RESOURCES.

The regular force of this division during the fiscal year ending June 30, 1896, consisted of an assistant in charge, 6 clerks, 5 statistical field agents, and 2 local agents. The field force was augmented by the temporary detail of employees from other divisions and by the employment for short periods of persons outside the service. Mr. William Barnum, of the Commissioner's office, was assigned to field work in Idaho, Utah, Oregon, and Washington; Mr. E. A. Tulian, superintendent of the United States Fish Commission station at Leadville, Colo., was detailed for duty in Colorado and Utah; Mr. A. B. Alexander, fishery expert on the *Albatross*, was ordered to make some inquiries in Nevada and California; Mr. C. E. Ingersoll, of Cambridge, Mass., a former employee of the division, and Mr. Burnside Clapham, of Fort Wayne, Ind., were employed for several months in investigating the fisheries of the Ohio Valley. Mr. F. C. James, of the car and messenger service, was employed for several months in this division on general clerical work pending repairs to the car of which he was in charge. Mr. W. A. Roberts, field agent, who had been detailed in May, 1895, for duties in connection with the Atlanta Exposition, returned to the division in April, 1896.

The appropriation for the field inquiries and miscellaneous expenses of this division was $5,000. This sum was expended as follows:

Field investigations	$4,578.58
Miscellaneous	112.09
Total	4,690.67
Balance unexpended	309.33
	5,000.00

FIELD INVESTIGATIONS.

INTERIOR WATERS.

At the beginning of the fiscal year the investigation of the fisheries of the minor interior waters of the United States, begun in the latter part of the previous year and suspended on account of lack of funds, was resumed and actively pushed during the entire year. The order in which the major investigations were taken up had special reference to the seasons. During the warmer months the field force was placed in the States drained by the upper tributaries of the Mississippi and Ohio rivers. As the season wore on the agents worked southward, and during the colder months the inquiries in the Southern States were resumed. Some special examinations of the fisheries of certain extreme Eastern and Western States were also made.

By the close of the year the canvass of the interior streams and lakes had been completed. A full report on the investigation is in preparation and will soon be issued. The States in which inquiries were conducted during the present year were Vermont, New York, West Virginia, Ohio, Kentucky, Indiana, Illinois, Wisconsin, Minnesota, Iowa, Missouri, Kansas, Nebraska, South Dakota, Nevada, Utah, Idaho, and California. A brief account of the extent of the fisheries in each of these will be given. In the last report of the division an outline of the extent of the fresh-water fisheries of Louisiana, Mississippi, Alabama, Arkansas, and Tennessee was presented.

The agents participating in the canvass of these States and the territory covered by them were as follows: John N. Cobb, Vermont and New York; W. A. Wilcox and T. M. Cogswell, all of Minnesota and Kansas, and parts of Illinois, Iowa, Kentucky, Missouri, Nebraska, and Wisconsin; C. H. Stevenson, South Dakota and parts of Illinois, Iowa, Missouri, and Nebraska; Ansley Hall, parts of West Virginia, Ohio, Indiana, Kentucky, Illinois, Wisconsin, Missouri, and Iowa; C. E. Ingersoll, parts of Indiana, Ohio, and Kentucky; B. Clapham, parts of West Virginia, Ohio, and Indiana; William Barnum, part of Idaho; E. A. Tulian, Colorado, Utah, and part of Idaho; A. B. Alexander, Nevada and California.

It was not considered necessary to prosecute inquiries in any other interior States, owing to the small amount of economic fishing carried on because of the limited resources, the existence of restrictive laws, or other conditions militating against the industry.

The fisheries of the interior waters of the country, as shown by the inquiries of this division, had the following extent in 1894. These figures are given provisionally, and are liable to slight changes when the final tabulations are made. In these statistics, it should be understood, no account is taken of the fisheries of the Great Lakes nor of any of the coast rivers, which have been covered in previous reports of the Commission.

Persons employed	11,282	Value of other property	$104,203
Boats used	8,844	Total capital invested	$722,328
Value of boats	$241,367	Pounds of products taken	55,415,400
Value of apparatus of capture	$376,748	Value of yield to fishermen	$1,791,145

Vermont.—An examination of the commercial fisheries of Vermont was made in January and February, 1896. The only fishing of a business character is done in Lake Champlain and the tributary streams. The industry has varied considerably in extent in recent years, owing to the fact that in 1893 and 1895 seining was permitted, while in 1894 the use of seines was prohibited. In 1894 and 1895, the two years covered by the investigation, the fisheries had the following extent, respectively: Persons engaged, 93 and 169; capital invested, $979 and $4,794; products taken, 58,639 pounds and 208,139 pounds; value of catch, $3,275 and $7,166. In 1894 the principal products taken for market in Vermont were bullheads, wall-eyed pike, and frogs; in 1895 the three most prominent species were whitefish, bullheads, and yellow perch. In his canvass, Mr. Cobb received valuable advice and assistance from Mr. John W. Titcomb, superintendent of the Government hatchery at St. Johnsbury.

New York.—The economic fishing interests of the interior lakes and rivers of this State were investigated in February, 1896. The extent of the fisheries of New York carried on in the ocean, coastal waters, coast rivers, and Great Lakes was well known, but no data were available showing the importance of the business in the interior sections. Of more than 100 lakes and ponds of sufficient size and importance to show on good general maps, only a comparatively small number support fishing which can be considered as a business. The State authorities have naturally regarded the preservation of the fishery resources of these waters in the interests of anglers as of vastly more importance than the temporary advantage which might accrue to the fishermen if unrestricted fishing were permitted. Consequently the market fishing is of very limited extent, the use of any forms of nets is rarely sanctioned, and most of the catch is taken with lines.

The lakes showing the most important fishing are George, Champlain, Oneida, Onondaga, Cayuga, Seneca, Canandaigua, Otsego, and Chautauqua, the last-named being considerably in advance of the others in the value of the catch. The number of persons ascertained to be dependent on fishing for a part of their livelihood was 422 in 1894 and 543 in 1895. The capital invested in apparatus, boats, and other property was $16,103 in 1894 and $19,745 in the following year. The quantity of products taken was 591,119 pounds, worth $55,072, in 1894, and 754,730 pounds, valued at $60,086, in 1895. The most prominent species and the value of the catch of each in 1895 are as follows: Black bass, $5,078; bullheads, $8,492; lake trout, $4,627; muskellunge, $15,920; smelt, $4,506; frogs, $6,572.

The work in this State was much facilitated by the advice and assistance of Mr. A. N. Cheney, State fish-culturist. Aid was also rendered by other members of the State Fish Commission board.

West Virginia.—In 1894, about 70 persons living in 7 counties of West Virginia made a business of taking fish in the Ohio River for market. The principal fishing was done with seines and set lines, but gill nets and fyke nets were also used. The investment in fishing property was $4,075. The most prominent fishes taken in this part of the Ohio River are catfish, fresh-water drum, suckers, and wall-eyed pike. The aggregate catch was 162,000 pounds, valued at $8,700, of which more than a third was catfish.

Ohio.—The fisheries of this State are rather important and are peculiar in that they are chiefly prosecuted in artificial bodies of water.

Aside from the Ohio River, practically all the fishing is done in Grand, Lewiston, Loramie, and Licking reservoirs, two of which have more extensive interests than the river named.

Of the 309 persons engaged in the fisheries of Ohio (exclusive of Lake Erie) in 1894, 96 fished in the Ohio River, 107 in Grand Reservoir, 57 in Lewiston Reservoir, 40 in Licking Reservoir, and 9 in Loramie Reservoir. Seines, fyke nets, and set lines are the principal apparatus used, the first-named being restricted to the Ohio River and the fyke nets being especially numerous in the reservoirs. The capital invested, amounting to $14,016, represented 231 boats, 23 seines, 2,879 fyke nets, 541 set and other lines, 3 gill nets, and other property. The yield of the fisheries in 1894 was 1,239,300 pounds, for which the fishermen received $59,400.

Buffalo-fish and fresh-water drum, which in other States of the Mississippi Basin enter largely into the catch, are only sparingly taken in the fisheries of Ohio. The most prominent species are catfish, sunfish, black bass, and yellow perch, while crappy, carp, wall-eyed pike, sturgeon, rock bass, warmouth bass, paddle-fish, and eels are taken in limited quantities. Nearly three-fifths of the entire yield was obtained with fyke nets and more than one-half the remainder with lines. The former apparatus took 701,000 pounds, worth $31,900, and the latter 351,400 pounds, worth $15,650. The output of some of the most prominent fish was as follows: 320,360 pounds of catfish, $9,590; 185,850 pounds of black bass, $17,150; 188,300 pounds of yellow perch, $4,275; 315,875 pounds of sunfish, $9,590; 100,600 pounds of suckers, $4,465. Turtles, terrapins, and frogs are taken in considerable quantities, all of the latter being from Grand and Lewiston reservoirs. The value of the catch in the different waters was: $26,151 in Grand Reservoir, $12,602 in the Ohio River, $10,750 in Licking Reservoir, $7,820 in Lewiston Reservoir, and $2,080 in Loramie Reservoir.

Indiana.—Indiana has fisheries that are among the most important in the interior States. The Ohio and Wabash rivers are the principal grounds, although fishing is also done on the Kankakee, White, and Tippecanoe rivers, and numerous lakes, among which are Maxinkuckee, Chapman, Pike, Center, Crystal, Huffman, Palestine, Andricks, Oswego, Barber, Shriner, Cedar, Round, Manitou, Little Eagle, and Big Eagle. About four-fifths of the quantity and value of the yield are from the two rivers first named.

The persons employed in the fisheries of the State in 1894 numbered 889, of whom 490 fished in the Ohio, 200 in the Wabash, 82 in the Kankakee, and 117 in other waters. The investment in fishing property was $25,590, divided as follows: $7,505 in 868 boats; $11,067 in 2,050 fyke nets; $1,460 in 2,363 set lines; $2,230 in 82 seines; $778 in 83 gill nets, and $2,550 in miscellaneous and shore property. Of the total yield of 2,504,775 pounds, valued at $124,169, over 2,000,000 pounds, worth $103,000, were taken in the Ohio and Wabash rivers. Catfish constituted about one-third the catch, or 802,025 pounds, valued at

$43,325. Between 350,000 and 400,000 pounds each of buffalo-fish, suckers, and fresh-water drum were taken. Other products obtained, in quantities ranging from 20,000 to 100,000 pounds, are wall-eyed pike, sturgeon, sunfish, black bass, crappy, pike, white and rock bass, paddle-fish, moon-eye, frogs, turtles, and terrapins.

Kentucky.—For an interior State, Kentucky has comparatively important fisheries. Fishing is carried on in the Ohio, Mississippi, Kentucky, Cumberland, Tennessee, and Green Rivers, the industry being most extensive in the first-named stream. In 1894, 587 persons were engaged in the economic fisheries of the State, 447 of whom fished in the Ohio River, 44 in the Kentucky River, 49 in the Cumberland River, 12 in the Tennessee River, 14 in the Green River, and 21 in the Mississippi River. About $35,000 was invested in fishing property, divided as follows: Eighty-one seines, $3,323; 2,825 fyke nets, $17,975; 1,985 set lines, $1,458; 639 boats, $10,175; other apparatus and shore property, $2,563. Fresh-water drum, buffalo-fish, catfish, and suckers comprise the bulk of the catch, the yield of these four species alone amounting to nearly 2,000,000 pounds. Other fish taken in lesser abundance are sturgeon, 82,000 pounds; paddle-fish, 78,000 pounds; white, yellow, and rock bass, 37,000 pounds; wall-eyed pike, 36,000 pounds; black bass, 24,000 pounds; moon-eye, 13,000 pounds; crappy, 13,000 pounds; carp, 12,000 pounds; eels, 3,000 pounds; turtles and terrapins, 4,281 pounds. The aggregate catch, amounting to 2,273,585 pounds, was worth $90,024. Fyke nets take one-half the entire catch. Set lines and seines come next in order of importance, while the catch of cast nets, dip nets, drift nets, and other apparatus is insignificant. Nearly four-fifths of the entire yield are from the Ohio River.

Illinois.—Illinois has the distinction of maintaining more important fisheries in its interior waters than any other State. The State is well supplied with water-courses containing food-fishes in large variety and quantities, and permitting the employment of numerous fishing devices. In allusion to the abundance of suckers, Illinois is popularly known as the "Sucker State," an appellation which is well warranted, since fishes of the sucker tribe constitute much more than half the total annual production. Very important fisheries are prosecuted in the Mississippi, Ohio, and Illinois rivers, and interests of less extent center in the Wabash, Kankakee, Sangamon, Kaskaskia, and Big Muddy rivers and in Horseshoe and Pittsburg lakes.

In 1894 the fisheries of this State (excluding those in Lake Michigan) were engaged in by over 1,650 persons, of whom about 770 were on the Mississippi, 610 on the Illinois, and 160 on the Ohio. The value of the boats, apparatus, and other property used in the industry in that year was about $156,000; this sum was apportioned approximately as follows: $52,000 in 1,459 boats, $58,780 in 11,276 fyke nets, $3,290 in 126 trammel nets, $19,310 in 203 seines, $5,660 in gill nets, set and other lines, small traps, etc., and $16,765 in shore and accessory property. The quantity of fishery products taken and sold was over 11,537,000 pounds, for which the fishermen received about $332,975. The species most prominent in the catch are buffalo-fish and other suckers (6,237,200 pounds, $156,000), catfish (1,962,400 pounds, $81,615), fresh-water drum (1,113,158 pounds, $26,300), carp (860,300 pounds, $21,300), black bass and other basses (253,700 pounds, $15,100), crappy (168,200 pounds, $7,700), sunfish (205,500 pounds, $5,200), wall-eyed pike (77,300 pounds, $5,100), turtles and terrapins (198,500 pounds, $3,190).

Wisconsin.—Economic fishing in this State is important in the Mississippi River and Lake Winnebago. The extent of the business in the remaining waters (except Lakes Superior and Michigan) is very limited, considering their number and area. The yield in the river and lake named is sufficiently large, however, to give Wisconsin prominent rank among the States of the Mississippi Basin.

The persons engaged in the fisheries in 1894 numbered 466; of these, 229 fished in the Mississippi and 137 in Lake Winnebago. The invested capital amounted to about $55,000, of which $25,600 represented 3,676 gill nets, $8,300 represented 820 fyke nets, and $11,800 represented 291 boats. Other prominent appliances are seines and set lines. The quantity of fish taken was 3,504,000 pounds; for this the fishermen received $91,980. About 980,000 pounds, worth $27,650, were obtained in the Mississippi River, and 1,598,100 pounds, valued at $39,975, in Lake Winnebago. The wall-eyed pike is the most important fish in this State; over 555,000 pounds were taken, having a value of $27,880. The next prominent fish is the catfish, of which 506,000 pounds, worth $14,130, were caught. The species taken in largest quantities is the fresh-water drum; about 858,000 pounds were secured, but the value was only $4,900. Among the other fish taken for market are the buffalo-fish (211,000 pounds, $4,680), pike (246,500 pounds, $10,805), saugers (129,300 pounds, $5,960), and sturgeon (185,400 pounds, $5,500). Gill nets, fished chiefly in Lake Winnebago, take about half the fish credited to the State, and fyke nets catch about half the quantities obtained in gill nets, or about the same as all the other apparatus combined.

Minnesota.—In the importance of its fisheries Minnesota ranks next to Illinois among the States under consideration. It has extensive fisheries in the Mississippi River and the Lake of the Woods, and also in the St. Croix River, Big Stone Lake, and numerous other lakes. About four-fifths of the catch credited to the State comes from Mississippi River and Lake of the Woods, which waters have a corresponding proportion of the persons engaged and capital invested.

There were 936 persons employed in the fisheries in 1894, of whom 325 were on Mississippi River, 190 on St. Croix River, 173 on the Lake of the Woods, and 248 on other lakes. The capital invested was $123,975, of which $38,473 represented vessels and boats, $53,871 apparatus of capture, and $31,605 shore and accessory property. A prominent feature of the fisheries was the employment of 148 pound nets in Lake of the Woods. The aggregate catch, amounting to 6,401,280 pounds, had a market value of $162,782.

The yield in the Mississippi River was 2,934,068 pounds, valued at $69,968; in the St. Croix River, 701,938 pounds, $14,873; in Lake of the Woods, 2,198,984 pounds, $56,747; and in other lakes, 566,290 pounds, $21,194. The Mississippi and St. Croix catch was made up largely of buffalo-fish, catfish, saugers, shovel-nose sturgeon, and suckers. In the Lake of the Woods the bulk of the output was pike, lake sturgeon, wall-eyed pike, and whitefish, about half being sturgeon. In the other lakes black bass, pike, and wall-eyed pike predominated. The production of the principal species in the entire State was as follows: Sturgeon, 1,560,448 pounds, $43,190; buffalo-fish, 1,587,802 pounds, $31,228; catfish, 747,274 pounds, $18,200; wall-eyed pike, 651,850 pounds, $20,128; whitefish, 422,198 pounds, $10,648; suckers, 324,999 pounds, $6,031; and pike, 396,165 pounds, $10,042.

Iowa.—This is one of the foremost States of the interior as regards commercial fishing. The industry is important on the Mississippi, Big Sioux, Des Moines, and Skunk rivers, and on Okoboji and Spirit lakes, although by far the most extensive interests are on the Mississippi. The business gave employment to 944 persons, of whom 680 fished in the Mississippi River. The invested capital was $46,710, of which $40,100 represented the value of boats, apparatus, etc., used in the Mississippi. The aggregate catch was 4,079,704 pounds of fish and other products, having a value of $124,851; of this amount, 3,367,497 pounds, worth $96,190, were from the Mississippi.

The number and value of the principal forms of apparatus used in this State were as follows: Seines, 103, $6,515; trammel nets, 80, $2,204; fyke nets, 3,106, $14,285; set lines, 1,783, $1,646; 695 fishing boats and 44 house boats, $14,837.

The prominent fishes of the State are buffalo-fish, catfish, fresh-water drum, suckers, and carp. The quantity and value of the yield of each of these in 1894 were as follows: Buffalo-fish, 1,350,144 pounds, $33,209; catfish, 985,983 pounds, $43,934; fresh-water drum, 704,744 pounds, $15,916; suckers, 209,545 pounds, $3,789; carp, 203,377 pounds, $5,218. Other fish taken in less quantities than 100,000 pounds were wall-eyed pike, paddle-fish, yellow perch, black bass, crappy, sunfish, sturgeon, eels, saugers, white and yellow bass. Nearly 150,000 pounds of mussel shells for use in the manufacture of buttons were gathered by the fishermen; these brought $2,072. Seines were credited with taking the largest amount of products, although the fyke-net and set-line catches were nearly as great.

Missouri.—The fisheries of this State are carried on principally in the Mississippi and Missouri rivers. Little River, Big Lake, and Pemiscot Lake, the remaining waters having commercial fisheries, are situated in the extreme southeastern portion of the State. Swamps and sunken lands, formed from overflows of the Mississippi, also in this portion of the State, are hunted for frogs. In 1894, 575 persons engaged in the fisheries, of whom 379 fished in the Mississippi River, 143 in the Missouri River, and 53 in the Little River, Big Lake, and

Pemiscot Lake. The investment in boats, apparatus, and other property was $44,205, divided as follows: 523 boats, $11,221; 95 seines, $5,237; 120 trammel nets, $3,654; 3,014 fyke nets, $14,207; 1,235 set lines, $1,056; 375 drift and hand lines, $95; 58 spears, $68; shore and accessory property, $8,667. More than one-half the investment was on the Mississippi River. The products of the fisheries amounted to 3,821,654 pounds, with a value to the fishermen of $119,786. The species taken in largest quantities were buffalo-fish and catfish, 1,724,078 pounds of the former, and 757,566 of the latter, or nearly two-thirds of the aggregate yield, being obtained. Fresh-water drum, suckers, paddle-fish, crappy, black bass, and carp were each taken in quantities of over 100,000 pounds. Sturgeon, sunfish, white bass, rock bass, pike perch, eels, and moon-eye are obtained in limited quantities; 154,818 pounds of frogs, having a value to the fishermen of $9,676, were also secured.

Kansas.—The fisheries of this State are restricted to the Missouri and Kansas rivers, and are comparatively unimportant. In 1894 only 61 persons followed the business. These had $3,411 invested and took 242,387 pounds of fish, valued at $11,022. The investment was made up of $683 in 61 boats, $715 in 12 seines, $1,210 in 190 fyke nets, and $803 in other apparatus and shore property. The principal fish caught for market are catfish, buffalo-fish, fresh-water drum, suckers, carp, paddle-fish, sturgeon, and eels. Catfish constituted nearly two-thirds of the aggregate catch.

Nebraska.—The fisheries of this State, which are prosecuted in the Missouri and Platte rivers, have not attained much development. In 1894 they gave employment to only 76 persons; the capital invested was $2,721 (chiefly in seines), and the value of the yield was $14,015. The fishes taken in largest quantities are buffalo-fish, catfish, fresh-water drum, and paddle-fish, which comprised over 306,000 pounds in a total catch of 340,400. Over 311,000 pounds, worth $12,490, came from the Missouri River, and more than half the aggregate output of the State is obtained with seines.

South Dakota.—The Missouri River and its tributaries, the Vermillion, Big Sioux, and Dakota rivers, are the principal fishing-grounds in this State, although considerable fishing is, in the aggregate, done in Big Stone, Madison, Wall, and Herman lakes. The physical conditions are not favorable to the development of important fisheries, and the industry is further curtailed by the interdiction of net fishing except in the Missouri River. The 121 persons engaged in fishing in 1894 had 97 boats, 26 seines, 15 gill nets, 18 trammel nets, 48 fykes, 136 set and hand lines, which, with other property, had a value of $2,911. The catch was 416,920 pounds, valued at $13,261. Only two kinds of fish are taken in noteworthy quantities, buffalo-fish and catfish, of which 196,000 pounds and 125,000 pounds, respectively, were obtained.

Colorado.—Mr. E. A. Tulian, superintendent of the United States Fish Commission station at Leadville, Colorado, was detailed in March, 1896, for an examination of the economic fisheries of this State. The report of the Eleventh Census showed that in 1889 the fisheries of Colorado had the following extent: Persons employed, 27; value of boats and apparatus, $673; value of products, $4,564. During March and April Mr. Tulian visited all parts of Colorado, but failed to find any commercial fishing, with the exception of a small business in fish taken from private ponds. The enactment of restrictive legislation since 1889 had caused the suspension of all fishing for market purposes.

Utah.—On the completion of Mr. Tulian's inquiries in Colorado, he was ordered to the adjoining State of Utah, in which commercial fishing was known to exist. During the month of April, Mr. Tulian visited Utah Lake, and Bear Lake, and took an account of the fishing there carried on. The Eleventh Census returns for this State indicated that in 1889 the number of persons engaged in this branch was 18, the capital invested was $388, and the value of the catch was $5,167. The examination of the State waters by Mr. Tulian showed that fishing as a business is carried on in Utah Lake, Bear Lake, Panguitch Lake, Weber Lake, Ogden River, and numerous small lakes and streams. The industry is most important in the first-named lakes, and in Utah Lake is especially interesting because two introduced fishes, black bass and carp, are the principal products. The semiprofessional fishing with rod and line in the smaller waters of Utah is, in the aggregate, very extensive, suckers constituting the bulk of the catch. It is only in Bear Lake and Utah Lake that any apparatus except lines is employed; in the former, gill nets and seines are operated for trout and suckers, respectively, and in the latter, seines are used for carp and suckers.

The extent of the fisheries of Utah in 1895 was as follows: Persons engaged, 630, of whom 145 were professionals; capital invested, $11,735; pounds of fish sold, 1,230,124; value of catch, $37,480. The quantities of the different fishes composing the yield are: Suckers, 962,400 pounds; trout, 85,800 pounds; carp, 133,324 pounds; black bass, 300,000 pounds, and whitefish, 18,600 pounds.

Idaho.—The commercial fisheries of this State are of limited extent. They are prosecuted in Snake River and Bear and Pend d'Oreille lakes, the last-named water having quite unimportant interests. The bulk of the fishing in Snake River is done with seines for salmon and steelheads; a few thousand pounds of sturgeon are taken with set lines and some salmon are caught with wheels. In Pend d'Oreille Lake there is a trout line fishery. Seines and gill nets are employed for the capture of trout and suckers in Bear Lake. The fisheries of the State were investigated by Mr. William Barnum in August, 1895, with the exception of those of Bear Lake, which were covered by Mr. E. A. Tulian in April, 1896. It was ascertained that in 1894 57 persons were engaged in the industry; $2,375 was invested in 30 boats, 20 seines, 4 wheels, and other property; 235,058 pounds of fish were taken, for which the fishermen received $11,929. Of the products, 89,160 pounds, worth $3,991, were salmon; 36,698 pounds, valued at $1,638, were steelheads; 4,500 pounds, valued at $230, were sturgeon; 37,200 pounds, worth $3,570, were trout, and 67,500 pounds, valued at $2,500, were suckers.

Nevada.—The commercial fisheries of this State were canvassed in April, 1896, by Mr. A. B. Alexander, fishery expert on the *Albatross*, who was detailed to make this investigation while on his way from Washington, D. C., to the Pacific Coast. The water area of this State is very limited, and the fisheries are of little value, although they appear to have been more extensive some years ago than they are at present.

The fishing of commercial importance reported by Mr. Alexander is done in Pyramid Lake and Truckee River. There is also some fishing carried on by Indians and others for home consumption in various lakes, rivers, and sloughs, of which no record was obtained. The persons who can be regarded as fishermen numbered only 39 in 1894 and 40 in 1895, 30 of these each year fishing in Pyramid Lake. The value of the boats and lines used was about $685. The catch, consisting wholly of trout, was worth $3,056 in 1894 and $2,083 in 1895, these sums representing 42,820 pounds and 28,700 pounds, respectively.

Winnemucca Lake was at one time a rather important fishing-ground, but no fishing is now done in it, owing to the scarcity of water, which began to recede in 1891; but lately the water has been slowly increasing and the fishermen are looking forward to a resumption of business.

California.—While the Commission had on several occasions canvassed all commercial fishing in the coast rivers of California, it had never inquired into the extent of the industry in the interior lakes. Therefore, Mr. Alexander, in conjunction with his examination of the lakes and rivers of Nevada, was ordered to visit lakes Tahoe, Tulare, and such other lakes in California as supported any fishing for market purposes.

The principal fishing was found to exist in Lake Tahoe, where there is a rather important line fishery for cut-throat trout, the catch being shipped to San Francisco and also sold locally to hotels. About 40 men made a business of taking trout by trolling; in 1894 these caught 47,800 pounds, valued at $7,169, and in the following year 41,590 pounds, worth $6,035. In Independence and Donner lakes and the Truckee River, a small amount of line fishing for trout was met with. In Lake Tulare, a large shallow body of water in the south-central part of the State, there was some terrapin fishing in 1894, which in 1895 was supplemented by seine fishing for Sacramento perch.

The total number of persons ascertained to be employed in the fisheries of the waters was 50 in 1894 and 68 in 1895. The capital invested was $3,236 and $5,693, respectively, of which $2,710 in 1894 and $2,965 in 1895 represented boats. The total catch was 55,714 pounds worth $8,246 in 1894, and 76,960 pounds worth $8,542 in 1895.

INDIAN RIVER, FLORIDA.

The sundry civil bill making appropriations for this Commission for the fiscal year 1895–96 contained a provision for "a special investigation as to the extermination of migratory fishes in the Indian River of Florida." The investigation was conducted in January and February,

1896. Mr. W. A. Wilcox, field agent of this division, was detailed to study the commercial aspects of the fisheries of that water in conjunction with Prof. B. W. Evermann, who had in charge the scientific features of the subject. Mr. Wilcox's report of his inquiries was submitted to the Commissioner on March 31, 1896. He visited all the fishing centers on the river, and obtained, in addition to descriptive notes, data showing for each locality the number of persons employed, the number and value of each kind of fishing appliance used, and the quantity and value of the fish and other products taken. His report treats of the development of the Indian River fisheries, the fishing centers and grounds, the fishery resources, the fishing apparatus and methods, the fishermen, prices, shipments, markets, etc., and the statistics of the industry.

The Indian River fisheries in 1895 gave employment to 254 persons, represented an investment of $41,512, and yielded 2,659,815 pounds of products valued at $37,657. The most prominent fishery objects are mullet, pompano, sheepshead, squeteague, and oysters. The catch of mullet was 1,610,869 pounds, worth $12,251. The most valuable fish—and the most highly esteemed of all the species in the river—was the pompano, of which only 149,000 pounds were taken, but which brought the fishermen $9,475.

PASSAMAQUODDY BAY, MAINE.

In February, 1896, Mr. Ansley Hall, field agent, was sent to the eastern coast of Maine to obtain certain data regarding the fishing industry of the contiguous waters of Maine and New Brunswick for the use of the International Fishery Commission. The information specially desired by the Commission was as follows: The quantity of herring caught in the American and Canadian weirs in the Passamaquoddy region, the number of boxes of smoked herring prepared, and the number of cases of sardines manufactured during the calendar years 1893, 1894, and 1895; and, for 1895, the number and location of the weirs operated in American and Canadian waters. Advantage was taken of this opportunity to have a very full and complete study made of the present aspects and condition of the sardine, smoked herring, and related branches at Eastport, Lubec, and other centers of that region. Besides very detailed statistical matter, secured largely from the books of the firms, descriptive notes were obtained relating to the methods pursued and the recent changes therein. Mr. Hall completed his inquiries in April. The material desired by the joint commission was furnished in May. The remaining information will be incorporated in a special paper treating of the herring fishery and dependent industries of the eastern Maine coast.

NEW ENGLAND MACKEREL FISHERY.

In July, 1895, Mr. F. F. Dimick, local agent of the Commission at Boston, Mass., was instructed to obtain, for the use of the International Fisheries Commission, certain information regarding the New England mackerel fishery during the season of 1895. In February, 1896, Mr. Dimick submitted a report on this subject, which was transmitted to the United States representative on the joint commission. The report covered the general extent and results of the vessel fishing on the various grounds and during the different months; the methods employed and the quantities of mackerel taken by each method; the average prices received for mackerel; the monthly importations of mackerel from the British provinces; the extent of the fishing carried on with traps and from small boats.

SHAD FISHERIES OF THE ATLANTIC COAST.

In May, 1896, a general canvass of the shad fisheries of the entire Atlantic coast was begun. The work was inaugurated in Florida, and by June 30 had embraced Georgia, South Carolina, and North Carolina. The intention is to take up the canvass in the various remaining streams about the time shad fishing is suspended, in order that a full account of the business during the season of 1896 may be obtained. The investigation will cover the following statistical details for each stream, in addition to full descriptive notes on the condition and methods of the fisheries: Number of persons employed in each branch of the shad fishery; the number and value of the boats and various kinds of apparatus employed; the number, weight, and value of the shad taken with each kind of apparatus. Coincident with the investigation of the shad fishery a canvass of the alewife and salmon fisheries will be made.

PACIFIC STATES.

About three years having elapsed since the last general canvass of the Pacific States, another investigation of the important interests of that region appeared opportune and was accordingly begun in the latter part of the fiscal year. Mr. W. A. Wilcox, who had twice before covered the fisheries of the west coast, was assigned to the work. The inquiries began in the Columbia River in May, and by the close of the fiscal year had progressed satisfactorily.

There were certain features of the fishing industry of this section which the Commissioner desired to have specially considered. The investigation was assigned to the writer, who left for San Francisco on May 15 and was engaged in the work at the close of the year. The subjects to which special attention was given were the condition and extent of the shad and striped-bass fisheries, the results of the attempts to introduce lobsters into Pacific waters, and the development of the sardine industry of southern California.

INQUIRIES AT GLOUCESTER AND BOSTON, MASS.

Capt. S. J. Martin and Mr. F. F. Dimick, the local agents of the Commission at Gloucester and Boston, respectively, have continued their inquiries relative to the fishery products landed at those places by American fishing vessels. Following is an outline of the results of their inquiries during the calendar year 1895. A more detailed exhibition of the extent and importance of the fisheries centering at these ports will appear in a special paper. The work of the agents included the procuring of accurate data for each of the 7,491 fares of fish landed, the observations covering over 150,000,000 pounds of fresh and salt fish, with a first value of over $3,550,000.

The fish discharged at Gloucester in 1895 by American fishing vessels consisted of 26,064,664 pounds of fresh fish and 50,566,813 pounds of salt fish, the aggregate receipts being 76,631,477 pounds, with a value of $2,205,619. The receipts were about 3,000,000 pounds less than in the previous year. The principal decrease occurred in the mackerel, halibut, cusk, and hake, while there was a noteworthy increase in the cod.

Cod is the preeminent fish in the Gloucester fisheries, constituting much more than half the quantity and value of the catch. Over 43,000,000 pounds of salt fish, worth about $1,050,000, and more than 4,100,000 pounds of split fresh fish, valued at over $85,000, were brought in. The combined yield of fresh and salt cod exceeded the yield in 1894 by about 5,430,000 pounds and in 1893 by 8,781,000 pounds. The grounds contributing to the increase were the Grand Banks and Nantucket Shoals. From the former grounds over 21,440,000 pounds of cod were landed and from the latter 3,666,000 pounds. From Georges Bank 13,086,000 pounds were brought in.

Other members of the cod family were represented as follows in the Gloucester receipts: Cusk, 2,515,000 pounds, $37,000; haddock, 5,405,000 pounds, $31,500; hake, 4,843,000 pounds, $28,000; pollock, 1,782,000 pounds, $9,400. The principal quantities of cusk and hake came from Cashes Bank, of haddock from Georges Bank, and of pollock from the New England shore.

The halibut is the next important fish to the cod. In 1895 the halibut receipts aggregated 7,418,000 pounds of fresh fish, valued at $571,000, and 1,062,000 pounds of salt fish, valued at $52,000. Compared with 1894, these figures show a decrease in quantity of 755,000 pounds and in value of $68,000. There were fewer fish caught on Western Bank and on the Greenland and Iceland grounds, while there were more taken on the Grand Banks.

The Gloucester mackerel fishery in 1895 was even poorer than in 1894, when the outcome was very disappointing. The decrease in the catch, however, was more than compensated for by an increase in the price of the fish, owing to the quality of the yield and a more active demand, so that the value of the fishery was greater than in the previous year. The fishery on the Cape shore and in the Gulf of St. Lawrence resulted in the taking of 12,962 barrels of salt mackerel, having a value of $194,947. The fishery on the New England shore yielded 6,226 barrels of salt fish, worth $103,574. The fresh mackerel brought to Gloucester amounted to 206,407 pounds, valued at $19,099.

A summary of the receipts at Gloucester, specified by fishing-grounds and the condition in which the fish were brought in, is given in the following table:

Summary by fishing-grounds of certain fishery products landed at Gloucester in 1895 by American fishing vessels.

Fishing-grounds.	Cod.				Cusk.			
	Fresh.		Salted.		Fresh.		Salted.	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
East of 66° W. longitude:								
La Have Bank	145,100	$2,537	2,065,422	$49,089	120,600	$2,205	9,120	$214
Western Bank	1,000	28	688,720	16,480			5,000	100
Quereau Bank	1,000	30	678,580	13,027				
Sambro Bank			60,000	1,675				
St. Peters Bank			54,400	1,443				
Green Bank			21,500	621				
Burgeo Bank			340,580	6,570				
Grand Bank			21,441,745	450,792				
Canso Bank			43,780	1,020				
Greenland and Iceland			57,000	1,058				
Cape North			787,500	15,287				
Cape Shore	111,500	2,461	410,180	10,942	71,000	978	30,000	651
Gulf of St. Lawrence			421,000	8,715				
Total	258,600	5,056	27,070,407	577,319	191,600	3,183	44,120	965
West of 66° W. longitude:								
Browns Bank	233,988	4,405	597,670	18,293	103,000	1,404	8,000	170
Georges Bank	1,304,620	22,844	11,781,438	358,447	89,500	1,224	198,220	4,532
Cashes Bank	752,100	11,156			1,542,480	21,045		
German Bank	5,600	90	102,200	2,684	6,200	81	5,000	125
Fippenies Bank	6,000	105			8,000	116		
Tillies Bank	9,000	130			18,000	262		
Jeffreys Ledge	19,000	394			74,400	1,058		
Ipswich Bay	157,640	4,706	5,000	138				
Middle Bank	2,000	32						
Off Chatham	17,500	262	10,000	213				
South Channel	77,500	1,016			193,400	2,731		
Nantucket Shoals	10,000	160	3,656,248	93,679				
Shore, general	1,251,978	35,018	5,000	133	33,000	462		
Total	3,846,926	80,378	16,157,556	473,587	2,067,980	28,383	211,220	4,827
Grand total	4,105,526	85,434	43,227,963	1,050,906	2,259,580	31,566	255,340	5,792

Fishing-grounds.	Haddock.				Hake.			
	Fresh.		Salted.		Fresh.		Salted.	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
East of 66° W. longitude:								
La Have Bank	36,000	$210			366,000	$2,071	20,000	$250
Western Bank							5,000	50
Cape Shore	2,000	10	7,000	$70	42,000	248	41,000	573
Total	38,000	220	7,000	70	408,000	2,319	66,000	873
West of 66° W. longitude:								
Browns Bank	105,500	813			135,000	790	12,000	150
Georges Bank	4,795,660	25,987	8,200	120	120,400	816		
Cashes Bank	169,000	988			2,989,600	16,018		
German Bank	4,000	24	8,000	101	25,000	130	75,000	901
Fippenies Bank					21,600	120		
Tillies Bank					105,600	634		
Jeffreys Ledge	9,000	130			204,500	1,242		
Ipswich Bay	6,200	40						
Middle Bank	7,000	56			8,000	40		
Off Chatham	15,000	75						
South Channel	28,600	162			369,000	2,076		
Shore, general	199,726	2,732	5,000	60	291,670	1,991	12,000	150
Total	5,339,686	31,007	21,200	281	4,270,370	23,857	99,000	1,201
Grand total	5,377,686	31,227	28,200	351	4,678,370	26,176	165,000	2,074

Summary by fishing-grounds of certain fishery products landed at Gloucester, etc.—Cont'd.

Fishing-grounds.	Pollock.				Halibut.			
	Fresh.		Salted.		Fresh.		Salted.	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
East of 66° W. longitude:								
La Have Bank	2,000	$10	....	....	463,666	$44,891	....	....
Western Bank	....	....	....	....	748,400	73,404	1,400	$84
Quereau Bank	....	....	....	....	2,078,205	169,312	....	....
St. Peters Bank	....	....	....	....	358,585	25,064	....	....
Green Bank	....	....	....	....	337,615	26,310	....	....
Burgeo Bank	....	....	....	....	193,600	11,748	5,400	324
Grand Bank	....	....	....	....	1,089,125	111,165	86,810	5,402
Greenland and Iceland	....	....	....	....	....	....	958,000	45,560
Off Newfoundland	....	....	....	....	53,990	4,316	....	....
Cape North	....	....	....	....	26,000	1,470	4,400	264
Cape Shore	....	....	....	....	27,200	2,492	....	....
Gulf of St. Lawrence	....	....	....	....	81,860	4,298	6,100	366
Total	2,000	10	....	....	6,358,246	474,530	1,062,110	52,000
West of 66° W. longitude:								
Browns Bank	1,000	7	....	....	17,825	1,459	....	....
Georges Bank	18,200	115	....	....	1,039,040	94,768	....	....
Cashes Bank	5,000	28	....	....	750	73	....	....
German Bank	....	....	....	....	980	118	....	....
Jeffreys Ledge	128,155	810	....	....	....	....	....	....
Off Chatham	25,000	188	118,000	$1,290	....	....	....	....
Nantucket Shoals	....	....	4,000	40	1,570	151	....	....
Shore, general	1,381,069	6,931	....	....	....	....	....	....
Total	1,558,424	8,088	122,000	1,330	1,060,165	96,569	....	....
Grand total	1,560,424	8,098	122,000	1,330	7,418,411	571,099	1,062,110	52,000

Fishing-grounds.	Mackerel.				Other fish.			
	Fresh.		Salted.		Fresh.		Salted.	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
East of 66° W. longitude:								
La Have Bank	....	....	....	....	1,240	$50	....	....
Cape Shore	....	....	1,512,000	$95,400	....	....	....	....
Gulf of St. Lawrence	....	....	1,080,400	99,547	....	....	....	....
Total	....	....	2,592,400	194,947	1,240	50	....	....
West of 66° W. longitude:								
Georges Bank	3,250	$338	10,800	878	....	....	11,000	$79
Jeffreys Ledge	....	....	....	....	....	....	10,000	90
Ipswich Bay	6,200	757	....	....	21,850	167	111,000	1,071
Middle Bank	3,947	336	....	....	....	....	....	....
Race Point	1,575	143	18,200	1,206	....	....	2,600	39
South Channel	1,650	154	263,400	18,440	....	....	8,000	521
Nantucket Shoals	15,900	1,438	12,400	837	....	....	....	....
Shore, general	173,885	15,933	940,400	82,213	435,170	2,824	1,720,000	17,096
Total	206,407	19,099	1,245,200	103,574	457,020	2,991	1,868,600	18,896
Grand total	206,407	19,099	3,837,600	298,521	458,260	3,041	1,868,600	18,896

Summary by fishing-grounds of certain fishery products landed at Gloucester, etc.—Cont'd.

Fishing-grounds.	Total products.				Total number of trips from each ground.
	Fresh.		Salted.		
	Pounds.	Value.	Pounds.	Value.	
East of 66° W. longitude:					
La Have Bank	1,134,606	$51,974	2,094,542	$49,553	126
Western Bank	749,400	73,492	700,120	16,714	63
Quereau Bank	2,079,205	169,342	678,580	13,027	130
Sambro Bank	....	....	60,000	1,675	1
St. Peters Bank	358,585	25,064	54,400	1,443	17
Green Bank	337,615	26,310	21,500	621	12
Burgeo Bank	193,600	11,748	345,980	6,894	8
Grand Bank	1,989,125	111,165	21,528,555	456,194	161
Canso Bank	....	....	43,780	1,020	1
Greenland and Iceland	....	....	1,015,000	47,227	11
Off Newfoundland	53,990	4,316	....	....	3
Cape North	26,000	1,470	791,900	15,551	4
Cape Shore	253,700	6,189	2,000,180	107,636	81
Gulf of St. Lawrence	81,860	4,298	1,507,500	108,628	64
Total	7,257,686	485,308	30,842,037	826,183	682
West of 66° W. longitude:					
Browns Bank	596,313	8,878	617,670	18,613	37
Georges Bank	7,370,670	146,092	12,009,658	364,056	734
Cashes Bank	5,458,930	49,308	....	....	150
German Bank	41,780	443	190,200	3,811	7
Fippenies Bank	35,600	341	....	....	2
Tillies Bank	132,600	1,026	....	....	6
Jeffreys Ledge	435,055	3,643	10,000	90	34
Ipswich Bay	191,890	5,730	116,000	1,209	59
Middle Bank	20,947	464	....	....	10
Race Point	1,575	143	20,800	1,246	4
Off Chatham	57,500	525	128,000	1,503	6
South Channel	670,150	6,139	271,400	18,961	46
Nantucket Shoals	27,470	1,749	3,672,648	94,556	112
Shore, general	3,766,498	65,891	2,688,400	99,652	1,331
Total	18,806,978	290,372	19,724,776	603,696	2,538
Grand total	26,064,664	775,740	50,566,813	1,429,879	3,220

The following table shows, by fishing-grounds and species, the receipts of fish at Boston in 1895:

Summary by fishing-grounds of certain fishery products landed at Boston, Mass., in 1895 by American fishing vessels.

Fishing-grounds.	Cod.		Cusk.		Haddock.		Hake.	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
East of 66° W. longitude:								
La Have Bank	1,842,500	$38,972	557,700	$7,357	1,426,000	$10,047	761,500	$6,344
Quereau Bank	33,000	735	....	....	....	....	....	....
Western Bank	353,500	7,836	110,000	1,506	92,500	6,302	104,000	810
Cape Shore	646,800	13,128	81,000	1,039	427,000	6,980	147,200	1,221
West of 66° W. longitude:								
Browns Bank	835,800	17,131	451,000	5,997	1,183,500	12,774	241,400	2,015
Georges Bank	4,604,900	98,618	340,000	4,859	12,440,000	122,335	752,000	9,234
Cashes Bank	770,000	16,885	548,000	7,305	552,200	8,921	936,000	7,950
Fippenies Bank	136,400	3,227	137,000	2,010	153,000	2,724	230,000	2,768
Tillies Bank	3,000	103	500	10	19,000	620	4,500	80
German Bank	26,000	510	33,000	450	21,000	415	10,000	150
Clark Bank	82,000	1,242	....	....	69,700	660	14,000	150
Ipswich Bay	192,000	4,079	1,000	13	126,000	2,187	3,400	38
Jeffreys Ledge	821,900	20,827	121,700	1,669	2,354,400	53,887	919,800	8,105
Middle Bank	740,200	17,904	46,600	782	2,666,500	52,556	763,000	5,471
Platts Bank	6,500	163	3,000	45	4,500	68	7,500	113
Off Race Point	260,500	7,383	....	....	348,500	5,797	10,700	67
Off Highland Light	879,400	21,019	65,000	827	2,495,700	46,927	817,300	6,062
Off Chatham	698,900	14,171	18,000	239	1,952,900	31,549	497,500	3,651
South Channel	4,291,100	90,086	651,800	8,653	7,382,000	127,866	3,500,400	25,262
Nantucket Shoals	1,787,500	36,130	12,000	141	906,100	14,300	154,500	1,210
Shore, general	953,250	22,693	129,600	1,734	1,579,400	38,693	622,700	4,757
Total	19,965,150	432,842	3,306,400	44,696	36,199,900	550,008	10,497,400	85,524

Summary by fishing-grounds of certain fishery products landed at Boston, etc.—Cont'd.

Fishing-grounds.	Pollock.		Halibut.		Mackerel.			
					Fresh.		Salted.	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
East of 66° W. longitude:								
La Have Bank	71,100	$1,097	387,500	$40,976	.....	.....	.....	.....
Quereau Bank	.....	.....	22,000	1,945	.....	.....	.....	.....
Western Bank	9,100	89	198,000	20,890	.....	.....	.....	.....
Cape Shore	10,500	175	29,200	2,936	32,000	$3,200	57,800	$3,830
West of 66° W. longitude:								
Browns Bank	30,200	356	153,300	13,385	.....	.....	.....	.....
Georges Bank	57,700	774	281,325	28,962	25,650	2,156	.....	.....
Cashes Bank	52,400	601	8,586	944	.....	.....	.....	.....
Fippenies Bank	30,000	498	7,000	732	.....	.....	.....	.....
Tillies Bank	500	8	.....	.....	.....	.....	.....	.....
German Bank	.....	.....	500	60	.....	.....	.....	.....
Clark Bank	.....	.....	19,900	1,043	.....	.....	.....	.....
Ipswich Bay	400	10	.....	.....	.....	.....	.....	.....
Jeffreys Ledge	186,000	2,054	5,400	602	.....	.....	.....	.....
Middle Bank	50,800	546	7,300	515	28,000	2,285	.....	.....
Platts Bank	100	2	.....	.....	.....	.....	.....	.....
Off Race Point	8,000	80	1,800	191	41,085	4,050	6,200	409
Off Highland Light	25,900	367	8,400	734	15,925	1,403	.....	.....
Off Chatham	14,800	164	7,660	782	6,250	450	.....	.....
South Channel	148,500	1,670	88,250	9,089	5,250	540	.....	.....
Nantucket Shoals	56,500	552	8,600	935	.....	.....	.....	.....
Shore, general	43,400	561	7,100	879	192,757	18,038	131,800	9,772
Total	795,900	9,604	1,241,821	127,400	346,917	32,122	195,800	14,011

Fishing-grounds.	Other fish.		Total products.		Number of trips from each ground.
	Pounds.	Value.	Pounds.	Value.	
East of 66° W. longitude:					
La Have Bank	5,000	$100	5,051,300	$114,793	135
Quereau Bank	5,000	75	60,000	2,755	3
Western Bank	27,125	546	804,225	37,985	40
Cape Shore	18,000	315	1,449,500	32,824	42
West of 66° W. longitude:					
Browns Bank	2,000	30	2,897,200	51,688	60
Georges Bank	638,275	31,513	19,130,850	298,451	449
Cashes Bank	100	4	2,867,286	42,670	95
Fippenies Bank	.....	.....	693,400	11,959	34
Tillies Bank	.....	.....	27,500	821	4
German Bank	.....	.....	90,500	1,585	2
Clark Bank	.....	.....	185,600	3,095	10
Ipswich Bay	.....	.....	322,800	6,327	38
Jeffreys Ledge	10,513	613	4,419,713	87,317	516
Middle Bank	4,330	118	4,306,730	80,177	560
Platts Bank	.....	.....	21,600	391	2
Off Race Point	47,900	1,193	724,685	19,170	137
Off Highland Light	6,400	568	4,314,025	77,907	382
Off Chatham	450	51	3,196,460	51,057	200
South Channel	90,002	2,284	16,156,802	265,850	627
Nantucket Shoals	6,400	336	2,931,600	53,604	181
Shore, general	397,280	12,120	4,057,287	104,247	745
Total	1,258,775	49,866	73,808,063	1,346,073	4,271

The quantity of fish landed at Boston by American fishermen in 1895 was about 73,808,000 pounds, valued at $1,346,000. With the exception of a few salt mackerel, practically the entire receipts consisted of split fresh fish. Compared with 1894 the foregoing figures represent a decrease in quantity of about 13,657,000 pounds and in value of $322,000. An analysis of the returns shows that 266 fewer fares of fish were landed in 1895, and that cod, cusk, haddock, hake, pollock, halibut, and mackerel were all taken in smaller quantities. About 5,000,000 pounds of the decrease was in the catch on the more eastern grounds.

Haddock is the most prominent fish in the fisheries centering at Boston. Half the quantity and two-fifths the value of the receipts consist of this fish. The amount discharged in 1895 was about 36,200,000 pounds, valued at $550,000. The figures for 1894 were 39,500,000 pounds, worth $639,000, the principal decrease being in the yield in the South Channel, which, next to Georges Bank, is the most productive ground, these two places yielding nearly 20,000,000 pounds of haddock in the year under consideration.

The quantity of fresh cod landed at Boston in 1895 was 19,965,000 pounds, having a value of $432,800. Georges Bank, South Channel, and Nantucket Shoals contributed about half of this quantity. The decreased output compared with 1894, amounting to 1,722,000 pounds, worth $66,000, was generally distributed among the various banks.

In point of value, halibut ranks next to cod; 1,241,000 pounds were landed, having a value of $127,400. The principal halibut grounds resorted to by the fresh-fish fishermen of Boston are La Have, Western, Georges, and Browns banks. The slight decrease, as compared with 1894, was due chiefly to a smaller catch on Western Bank.

Hake comes next to haddock and cod in quantity. About 10,500,000 pounds, worth $85,500, were brought to Boston in 1895, against 14,863,000 pounds, worth $134,775, in 1894. One-third of the yield is from the South Channel.

The other prominent fish in the Boston vessel receipts are cusk (3,306,000 pounds, $44,700), pollock (795,900 pounds, $9,600), mackerel (347,000 pounds fresh, $32,000, and 979 barrels salted, $14,000), and swordfish, menhaden, herring, sea catfish, etc. (1,258,775 pounds, $49,870).

SOME RESULTS OF FISH ACCLIMATIZATION.

Owing to the wide territory over which the distributions of the Commission are made and the numerous applicants yearly supplied with fish, it is entirely impracticable to keep well informed regarding the results except in a very small proportion of cases. The employees of the Commission, when in the field, secure some information as to the outcome of plants, especially when public waters are concerned; correspondents who have been interested in the introduction of fishes into certain waters often voluntarily report regarding the success of the deposits, and the State fish commissions, in the official reports, frequently notice the results of plants of fish made in their respective waters by this Commission, but as to the success or failure of a large majority of the plants no information is ever received.

The following notes embody some of the data relative to this subject that have come into the possession of the Commission during the year 1896, the files of the division of fish-culture contributing a number of the items:

Salmon in the Middle States.—Great interest has been manifested in the attempts to stock the rivers of the Middle Atlantic States with salmon, and the interest has been heightened by the success which has attended the experiments in the Hudson and Delaware rivers during the past few years. In July, 1895, the writer, while in New York City, made some inquiries regarding the catch of salmon in that vicinity during the previous months. The existence of a law prohibiting the retention of salmon accidentally caught in Hudson River prevented the ascertainment of thorough knowledge as to the abundance of the fish in that stream, although there is every reason to believe that the species is increasing and that the Hudson will in time, under proper restrictions, be a self-sustaining salmon river. About twenty salmon from New York Bay, having an average weight of 12 pounds, and twelve from pound nets on the northern coast of New Jersey, reached the New York market in June. A few were also received from Peconic Bay, Long Island.

The run of salmon in Delaware River in 1895 was noteworthy. The Philadelphia *Ledger* of May 30 reported that during the previous week hundreds of salmon were caught on their way to the spawning-grounds in the shad nets between Chester and Delaware Water Gap. These fish were grilse and appeared to represent a plant of 60,000 fry in 1890. The weight of the salmon taken was from 9 to 15 pounds. At nearly every fishery, from 1 to 4 or more fish were caught and readily sold at 75 cents to $1 a pound. The existence of a law prohibiting the use of nets for salmon made it difficult to obtain from the fishermen an accurate account of the number taken. Mr. W. deC. Ravenel, of the United States Fish Commission, was informed by Hon. H. C. Ford, of the Pennsylvania Fish Commission, that fully 300 salmon were caught in the Delaware during the season of 1895.

Rainbow trout.—This native of the mountain streams of the Pacific Coast has been successfully acclimatized in almost every State east of the Rocky Mountains, and in some of them has attained noteworthy prominence as a game and food fish. In a paper on the artificial propagation of this species, prepared by Mr. George A. Seagle, superintendent of the United States Fish Commission station at Wytheville, Va., correspondence on this subject is published from which some of the following notes are abstracted. Similar references might be made to numerous other States, but it is thought the notes given will be sufficient to show the general adaptability of the rainbow trout to the colder waters of the United States, the rapid growth and propagation of the fish, its superior game qualities, and its value as food.

Mr. W. D. Noel, of Lebanon, Mo., wrote under date of April 7, 1896, that the rainbow trout planted about twelve years ago in Bennett's Spring (which flows into Neaugua River) have increased to a wonderful extent in the spring, and also in the river, in which they have been caught 8 miles above and 25 miles below the spring branch. Mr. Noel states that it is the gamiest fish they have, that it takes the fly more readily than any bait, and that for eating qualities it is not equaled by any fresh-water fish.

In parts of Missouri the rainbow trout distributed from the Neosho hatchery are doing well. Mr. W. J. Barrows, game and fish warden, writing from Waynesville, Mo., June 13, 1896, states that on February 17, 1895, he placed 1,000 young rainbow trout in Roubidoux Creek at that place and that they are now biting well, some weighing a pound being caught. In Hickory Creek and Crane Creek a number of adults were taken in 1896.

The Laramie River, in Wyoming, has been very successfully stocked with rainbow trout, from eggs sent from the McCloud River, California, in 1895 and 1896, and from Neosho, Mo., and the State hatchery in recent years. Mr. Gustav Schnitger, fish commissioner of Wyoming, reports in letters dated October 16 and December 4, 1895, that the Big and Little Laramie rivers and the upper waters of the North Platte River have proved excellent for rainbow trout, and that some are reported as weighing as much as 9 pounds. By use of a seine, Mr. Schnitger ascertained the presence of many fine rainbow trout in holes in the Big Laramie River, and forwarded to the Commission a photograph of 13 thus secured; the largest was 24½ inches long and weighed over 7 pounds, several others weighed 6 pounds, and the smallest weighed over 4 pounds. It is reported that over 100 were taken from a hole at one haul of the seine. In Wyoming the rainbow trout is regarded as "truly a fine food-fish, as well as an excellent fish for anglers."

Mr. J. D. Phipps, of Longs Gap, Grayson County, Va., states that the young rainbow trout deposited in Peach Bottom Creek, a tributary of the New River (which, in turn, is a branch of the Kanawha), have grown and propagated as fast as any fish he ever saw, much faster, in fact, than the brook trout. The stream was posted and no fishing allowed for four years; in 1895 the creek was full of the finest trout, examples 22 inches long having been caught. Their flavor is fine and they are the gamiest fish Mr. Phipps ever met with.

In the Holston River, in Smyth County, Va., the rainbow trout is abundant. The reports received from this stream several years ago announced excellent line fishing. One 24 inches long and weighing 6¾ pounds was taken in the river at the mouth of Staley Creek by Mr. Coalson, of Marion, in 1892; and Mr. A. H. Gibboney, of the same place, has, with a friend, taken 110 rainbow trout from Staley Creek in two days' fishing, the fish averaging a foot in length.

Mr. Frank N. Clark, superintendent of the United States Fish Commission station at Northville, Mich., writes as follows regarding the rainbow trout in parts of Michigan:

> The Au Sable River was first planted with rainbow trout about seventeen or eighteen years ago, I think, from eggs forwarded from the collecting station in California to the Michigan Fish Commission, hatched at their hatchery, and planted by them. Since that time there have been several plants made at different times, but not in large numbers. The success of this river is probably the most marked of any of the rivers of Michigan where rainbow trout have been planted. In certain portions of the river large rainbows are taken with hook and line, often weighing from 5 to 7 pounds, and in our net fishing for brook trout during October, 1895, the trout caught would run

about one-third rainbow; in addition to this we would catch from 100 to 1,000 last spring's hatch, and they would run a larger number rainbow than brook trout. The rainbow caught in the Au Sable are considered by sportsmen as more gamy than either brook trout or grayling, and it requires heavier tackle for this fish than for a brook trout of equal weight. Rainbow trout are also taken quite frequently with hook and line in Pere Marquette River; also the branches of that stream.

According to Mr. W. K. Hancock, of the United States Fish Commission station at Leadville, Colo., the rainbow trout is not plentiful in the streams throughout that part of the State, and its average size would probably be only three to five fish to a pound, although one is occasionally taken weighing one-half to three-fourths of a pound. In the streams and small ponds in the immediate vicinity of the station their growth is very slow. In the lower parts of the State, however, south and southwest of Leadville, they are more abundant and of much larger size. In Twin Lakes, 12 miles south of Leadville, the rainbow attains a weight of 12 or 13 pounds. Some 25 to 28 inches long and weighing 8 to 13 pounds have been taken by station employees. They are very gamy and are excellent for the table.

Among other waters in which the rainbow trout have been successfully acclimatized are the Tippecanoe River, near Monticello, Ind.; tributaries of the Susquehanna river in Maryland; the Green River, North Carolina, where large examples have been caught; Silver Creek and a tributary of the Chattooga River, Georgia; Broad River, South Carolina; Battenkill River, Vermont; and Spring River, near Mammoth Spring, Ark.

Shad and striped bass in California.—The remarkable success attending the introduction of these fish into Pacific waters has been frequently referred to in publications of the Commission. Their recent history in California warrants brief notice.

The consumption of shad in California has been diminishing for several years, and in 1895 the receipts at San Francisco, the principal market, were very much less than in the two preceding years. The returns for the first six months of 1896, however, show a substantial increase, the receipts being more than in the corresponding period of the three preceding years, and more than in the whole year of 1895, as shown in the following table:

Shad received in the San Francisco market.

Years.	Pounds.
1893	405,391
1894	209,379
1895	146,399
1896 (first six months)	224,590

The following is from the report of the California Fish Commission for 1895–96:

The shad fisheries continue to be influenced by the demand for the fish. The fishermen are limited by the marketmen to that amount which is daily consumed, this being deemed the only means by which they can keep the market from being overstocked. Little do our people appreciate the fact that one of the best and most sought-for fish in the East is always here at hand and is to be obtained many months in the year at a price which places it within the reach of all.

Notwithstanding a very active fishery, the striped bass continues to increase in abundance, as shown by a greatly augmented catch. The receipts at San Francisco during each of the recent years have been almost double those of the preceding year, and in 1895 nearly twice as much striped bass as shad was sold in the San Francisco market. This fish is very popular in California, is generally regarded as one of the best of food-fishes, and from present appearances its capture will in time constitute one of the principal fisheries. A comparison of the quotations of the New York and San Francisco markets discloses the interesting fact that striped bass are selling at a much lower price on the west coast than in the East.

A comparison of the receipts of striped bass in San Francisco for several years is given in the following table. It is seen that the quantity during the first half of 1896 was more than in the whole of 1893 and 1894 and only 20 per cent less than in 1895.

Striped bass received in the San Francisco market.

Years.	Pounds.
1893	80,793
1894	149,907
1895	252,177
1896 (first 6 months)	204,316

The market value to the fishermen of the shad and striped bass taken in the Pacific States between 1888 and 1896 (to July 1) was about $192,000, of which $112,000 represents shad and $80,000 striped bass. The aggregate expense of introducing these fish to the Pacific Coast was under $5,000.

Catfish and carp on the Pacific Coast.—These fishes continue to increase in the waters of the Pacific States to which they have been acclimatized; and while the demand is much less than the supply, the consumption seems to be growing yearly. In the first six months of 1896 the receipts by San Francisco dealers were much larger than for any previous corresponding period, and in the case of the carp greatly exceeded the total receipts during any other year. As the dealers restrict the quantities shipped in by the fishermen, it is apparent that the consumption is increasing in San Francisco. While no figures are now at hand for points on the San Joaquin, Sacramento, and Columbia rivers, it is thought that the sales of both of these fish were larger in 1895 and 1896 than previously. The California fish commissioners say that "these fish, though little considered by most of our people, furnish food for a large number, and figure to a large extent as a market fish."

A comparison of the receipts of these fish in San Francisco during the years 1893, 1894, 1895, and 1896 follows. This shows that 154,784 pounds of carp and 129,159 pounds of catfish were disposed of, the approximate value of which was $6,000.

Pounds of carp and catfish received in the San Francisco market.

Years.	Carp.	Catfish.
1893	33,084	36,544
1894	42,580	31,465
1895	26,864	32,282
1896 (first 6 months)	52,256	28,868

Eastern fish in Lake Cuyamaca, California.—In January, 1896, the California Fish Commission instructed one of its deputies, Mr. Arthur G. Fletcher, to proceed to Lake Cuyamaca, near San Diego, Cal., to ascertain what results, if any, had attended the planting of fish by the United States Fish Commission in the fall of 1891. The plants then made consisted of 250 spotted catfish, 3,980 yellow perch, 1,990 large-mouth black bass, 285 crappie, 400 rock bass, and 400 pike. Mr. Fletcher visited the lake on January 14, 1896, and reports as follows on the results of his examination:

In order that definite results might be obtained, I took a small seine with me as well as my rod, and as I found the prospects of obtaining help to operate the net later in the day were not encouraging, I determined to make the trial with that the first thing in the morning. Like all mountain lakes in California, this proved to be full of hidden snags, and although we made but three hauls, nearly the whole day was spent in so doing, not without fair success, however. The first haul resulted in the taking of three pike, two perch, and two large-mouth black bass. We secured one more pike the second haul, and failed to get anything but snags the last time.

All of these fish were small, running from 4 to 8 inches, and all were in splendid condition. Had my net permitted of our hauling in deep water, we would no doubt have secured larger specimens. Later I secured a crappie which had been killed by being washed through one of the gates in the dam. All of these specimens have been forwarded to the board at San Francisco.

I am told that the pike are the most numerous, although not taken by hook as often as the crappie. Both of the pike which I forwarded to San Francisco were females and had spawn well advanced. The black bass are doing very well and a great many have been taken the last two years. The same can be said of the catfish. I found the head and skeleton of one on the shore, the same being about a foot long. Both the perch and crappie have done splendidly and large numbers have been taken, although I gather they were not large fish. I have not been able thus far to learn anything about the rock bass.

The distance of the lake from here [San Diego], the greater part of the 55 miles being covered by stage, made it impossible to make the thorough investigation at this time that I would like to have made, but I am satisfied that all of the fish planted—aside from the rock bass, and I hope later information will show otherwise—have done unusually well.

In a conversation with J. E. Friend, of this place, who has but recently returned from a fishing excursion to Lake Cuyamaca, where he remained with a party of campers some six weeks, I learn that they took large numbers of perch, three black bass of from 2½ to 3½ pounds, two pike of about 2 pounds, and several catfish of about

1½ pounds. They did not take any rock bass, nor am I able to learn that any have been taken.

I am told that fish were taken from Lake Cuyamaca and placed in Sweetwater Dam, of this county, and I shall try to get the particulars and results.

Later, the California commission transferred a number of adult fish from Lake Cuyamaca to other waters of the State, some of the bass being fine specimens weighing as much as 5 pounds. The distribution from this lake consisted of 541 large-mouth black bass (*Micropterus salmoides*), 454 yellow perch (*Perca flavescens*), 116 sunfish (*Lepomis cyanellus*), 27 pickerel (*Lucius vermiculatus*), and 253 shiners (*Abramis crysoleucas*). The last-named species has apparently been accidentally introduced, as it is not referred to in the record of the original plants.

Crappies.—Both species of this excellent food and game fish have been very successfully introduced into the Potomac River, as the result of a small lot supplied by this Commission. In March, 1894, Mr. Joseph H. Hunter, of Washington, D. C., was assigned 62 crappies from Quincy, Ill., which he deposited in the Wide Water of the Chesapeake and Ohio Canal about 14 miles above Washington, in the Potomac River at the same place, and in Black Pond, Virginia, which is about 20 feet above low-water mark in the river.

The first known result of this plant was a small fish taken on a line in the spring of 1896 at Four-Mile Run, Virginia, an arm of the Potomac River between Washington and Alexandria. Since then the fish has been taken in comparatively large numbers in the vicinity of Washington and elsewhere in the Potomac basin. Some of these have been caught by anglers and some have been secured with collecting seines by representatives of the Fish Commission.

These fish are abundant in Little River, a branch of the Potomac River separating Analostan Island from the mainland of Virginia; as many as 36 crappies, weighing from ½ to 1½ pounds, were taken there by an angler one day in the summer of 1896, and 6 or 8 specimens have been obtained in a single haul of a small collecting seine. In the Potomac, near the Seven Locks, 65 crappies, weighing about half a pound each, were taken by two anglers during a part of one afternoon in 1896; the fish bit at both live and dead minnows with great avidity. The lower part of the canal contains a great many of these fish, and some have been observed in the canal above Harpers Ferry.

In Black Pond crappies are very common. Mr. Hunter has watched their multiplication, and states that now (1896) thousands may be seen in the shallow waters, and that one day in July, 1896, he took 14 crappies with a fly in a short time. In Cat Pond, Maryland, 14 miles above Georgetown, crappies have been taken in large quantities. This pond is about 100 feet from the bank of the Potomac and connects with the river at high water. In the summer of 1896, two gunny sacks full of large crappies were reported taken there with a seine by some fishermen. Several weeks later fifty, 3 or 4 inches long, were seined by an agent of the Commission.

While both species of crappie have been obtained, the strawberry bass (*Pomoxis sparoides*) is as yet comparatively rare. The largest specimens have been about 10 inches long, while a great many have been 6 to 7 inches long; those only 3 or 4 inches long are common, plainly indicating that the fish have spawned. By local fishermen the fish are called crappies, strawberry bass, and strawberry perch.

Black bass.—During the past few years a number of plants of large-mouth black bass have been made by the Commission in the Potomac River and its tributaries, the effects of which have been marked. In 1896 bass were more abundant and taken in larger numbers in the Potomac River in the vicinity of Washington than ever before. They are found as far down the Potomac as Mattawoman Creek, 25 miles below Washington, and are especially numerous in Little River, where they are found in company with crappies. During the fall of 1896, the fisherman for the first time took noteworthy quantities of bass for market. One fisherman secured 150 pounds of bass at one haul of a small seine in Piscataway Creek. Many bass of large size were caught by boys around Washington, and during the summer of 1896 it was no uncommon sight to see boys and men passing through the streets of the city with long strings of bass which they had taken from the Long Bridge and elsewhere. In making collections of fishes for the aquarium at Central Station, Mr. Harron seined large numbers of bass of all sizes in the vicinity of Washington. On November 14, 1896, in nine hauls of a 150-foot seine in Little River, near the Aqueduct Bridge, 200 large-mouth bass, from 6 to 8 inches long, were taken.

As an illustration of the magnitude of the results that may accrue from comparatively small plants of bass in suitable waters, the following is quoted from a letter from the Tanning Extract Company, of Deming, N. Mex.:

> Two years ago you kindly furnished us about three dozen small black bass from Quincy, Ill., for our pond. They have done well, and now (1896) we have thousands from 1 to 3 inches long, spawned this season. Should you have applications for stock from this vicinity we will be glad to supply them free of any charge and will publish a notice in the paper here to that effect.

MISCELLANEOUS MATTERS.

Reports issued.—During the year several reports of the division relating to the commercial aspects of the fisheries and based on original field inquiries were printed.

A paper* by Mr. W. A. Wilcox on the fisheries of the Pacific States represents the results of investigations made by the author in 1892 and 1893, which were outlined in the annual report of this division for 1893.

The special inquiries regarding the menhaden fishery, fully outlined

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* The Fisheries of the Pacific Coast. Rept. U. S. Fish Com. 1893, pp. 139-304, pl. 1-14.

in the last annual report, were brought together in a paper* prepared from the agents' returns and printed in the Fish Commission Bulletin for 1895.

The outcome of the past 25 years' work of the national and State fish commissions in increasing the fish supply of the Pacific States by the introduction of non-indigenous species was considered in a report† by the writer, which is based on original observations by the Commission employees, supplemented by valuable data supplied by the various State commissions.

Atlanta Exposition.—In July and August the writer, in conjunction with Prof. B. W. Evermann, prepared for the Fish Commission exhibit at the Atlanta Exposition a series of articles on the principal food and game fishes of the South Atlantic and Gulf States. For each of the principal species a plate was shown, accompanied by brief descriptive text relating to distribution, size and weight, natural history, and commercial importance, the entire collection being neatly mounted in swinging screens. Some general notes on the extent of the fisheries, the nature of the aquatic resources, and the methods of the fisheries of the regions named, extracted from printed reports of the Commission, served as an introduction to the regular series.

Utilization of weakfish sounds.—In March, 1896, the office entered into correspondence with a number of fishermen relative to the saving of the sounds or swim-bladders of weakfish. The initial step in the inquiry was a communication from a prominent isinglass manufacturer of Massachusetts, who reported that he would purchase large quantities of sounds if they could be obtained at a price warranted by the market value of the product prepared therefrom. At one time the income of the fishermen of the Atlantic coast was considerably increased by the sales of weakfish sounds. The dried sounds sometimes brought as much as a dollar a pound, but of late the price has been so low (about 25 cents) that the fishermen have, as a rule, ceased to save them. Weakfish are taken in large quantities in all the seaboard States from Massachusetts to Texas, the catch in New York, New Jersey, Virginia, and North Carolina being especially important, and many thousands of pounds that are now wasted could be easily saved if there were any inducement. The letters received from various fishing centers indicated that the fishermen would be glad to resume the practice of utilizing the swim-bladders if the prices rose to 50 cents or more per pound for dried sounds.

Courtesies extended and received.—In March, 1896, at the request of Mr. A. N. Cheney, State fish-culturist, Glens Falls, N. Y., the division prepared for the New York Fish Commission a summary of the com-

*Notes on an investigation of the Menhaden Fishery in 1894, with special reference to the food-fishes taken. By Hugh M. Smith. Pp. 285-302.

†A Review of the History and Results of the Attempts to acclimatize Fish and other Water Animals in the Pacific States. By Hugh M. Smith. Bull. U. S. Fish Com. 1895, pp. 379-472, pl. 73-83.

mercial fisheries of the interior waters of New York, as determined by Mr. John N. Cobb, field agent.

Mr. Oscar Andrews, of the firm of Ayers & Andrews, Gloucester, Mass., forwarded samples of prepared cod and other ground fish.

Mr. John P. Babcock, chief deputy of the California Fish Commission, forwarded a sample of canned striped bass, prepared at Black Diamond, Cal. Mr. Babcock also sent data regarding receipts of shad, striped bass, carp, catfish, and salmon by San Francisco dealers, and furnished much useful information regarding the results of the attempts to acclimatize fish in California waters.

Mr. Arthur G. Fletcher, of the California Fish Commission, furnished information regarding results of planting fish in 1891 in Lake Cuyamaca, California.

The inquiries of the writer and Mr. W. A. Wilcox in the Columbia River were greatly aided by Mr. Frank M. Warren, of Portland, Oreg., who extended special facilities for the examination of the wheel fisheries in the vicinity of the Cascades.

Mr. C. B. Trescott, of Portland, Oreg., furnished plans of his newly constructed fish-refrigerating establishment, located at Goble, Oreg., on the Columbia River, probably the most complete and modern plant of the kind in the United States.

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U. S. COMMISSION OF FISH AND FISHERIES,
JOHN J. BRICE, Commissioner.

REPORT

OF THE

REPRESENTATIVE OF THE U. S. FISH COMMISSION

AT THE

COTTON STATES AND INTERNATIONAL EXPOSITION AT ATLANTA, GEORGIA, IN 1895.

BY

W. DEC. RAVENEL.

Extracted from Report of Commissioner for 1896. Appendix 1, Pages 147 to 167, Plates 11 to 21.

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PLATE 11.

UNITED STATES GOVERNMENT BUILDING, ATLANTA EXPOSITION.

I.—REPORT OF THE REPRESENTATIVE OF THE UNITED STATES FISH COMMISSION AT THE COTTON STATES AND INTERNATIONAL EXPOSITION AT ATLANTA, GEORGIA, IN 1895.

By W. deC. Ravenel.

Under the act of Congress approved August 18, 1894, providing for the participation of the Executive Departments, the Smithsonian Institution, the National Museum, and the Fish Commission in the Cotton States and International Exposition at Atlanta, Ga., for the purpose of illustrating the functions of the several Departments and Bureaus, the Commissioner designated Dr. Tarleton H. Bean, assistant in charge of the division of fish-culture, as the representative of the Commission on the board of management. Upon the resignation of Dr. Bean, May 23, 1895, to accept the position of superintendent of the aquarium at Castle Garden, New York, W. deC. Ravenel was designated as his successor.

PLAN AND SCOPE OF THE EXHIBIT.

The plan of the exhibit, as laid out by the representative and approved by the Commissioner, was as follows:

(1) The scientific investigation of the Commission to be illustrated by models of the vessels employed, with full-sized forms of the apparatus used; by charts illustrating the results obtained and publications covering the different investigations; by casts of fish colored from life; collections of sponges, corals, oysters, and other shellfish, crabs, lobsters, sea lilies, sea-pens, and various other material obtained by dredging and trawling apparatus.

(2) The fish-cultural operations to be shown by models and photographs of hatching stations; models and full-size specimens of apparatus used in the collection, transportation, and hatching of eggs; apparatus used in the transportation of fish; charts showing a summary of work done since the organization of the Commission; results obtained with reference to special fisheries and results at the different stations of the Commission during the fiscal year 1894–95; also by the practical hatching of eggs of the salmon, whitefish, and trouts.

(3) Methods and statistics of the fisheries, to be illustrated by models of vessels and boats used in the fisheries of the United States, with special reference to the South Atlantic and Gulf regions; models and full-size specimens of seines, gill nets, pound nets, lines, trawls, spears, and accessories; charts showing the extent and value of the fishing

industry, besides illustrations of the various fisheries by means of photographs, oil paintings, etchings, etc.

(4) An aquarium for showing the economic food and game fishes of the South Atlantic and Gulf States and the fishes reared by the United States Fish Commission at its various stations, including some of the ornamental fishes and other marine life of the Gulf of Mexico.

PREPARATIONS FOR THE EXHIBIT.

As soon as practicable after the formal organization of the board and allotment of funds and space had been made, steps were taken to prepare the plans for the aquarium, which was the most difficult and expensive part of the exhibit. Mr. H. Von Bayer, the architect of the Commission, was detailed to assist the representative, but owing to pressure of other duties he was unable to give his time to the work and it became necessary to employ L. F. Graether as architect. He, with the assistance of Mr. Von Bayer, prepared the plans, which were approved May 1, 1895.

In April the work of collecting, preparing, and packing the material for the exhibit was begun, and a building was rented as a temporary workshop and storehouse. Mr. W. P. Sauerhoff, fish-culturist, was detailed to take charge of the preparation of fish-cultural material and the packing of the exhibit, and by the end of July most of it had been prepared and shipped to Atlanta.

The material for illustrating the scientific investigations of the Commission was designated by Mr. Richard Rathbun, assistant in charge of the division of scientific inquiry, and prepared for exhibit by Mr. James E. Benedict.

Dr. Hugh M. Smith, assistant in charge of the division of statistics and methods of the fisheries, assisted by Mr. W. H. Abbott, designated and prepared the material illustrating the methods and statistics of the fisheries.

INSTALLATION.

Messrs. W. P. Sauerhoff and John L. Leary left Washington for Atlanta on August 11 for the purpose of unpacking the material and placing the cases in position. On September 1 the representative arrived and commenced the installation, with the assistance of W. H. Abbott, to whose ingenuity and skill in exposition work much of the success attained is due. The total space allotted to the Commission was 8,000 square feet in the southwest corner of the Government building. Two-thirds of this was occupied by the aquarium and the balance by fish-cultural apparatus and material illustrating scientific investigation and methods of the fisheries, as shown by accompanying floor plan. It was not deemed necessary to prepare a complete descriptive catalogue of the material exhibited, as it is described in the various publications of the Commission, but the plan and scope of the several sections are shown by the following synopsis:

SEA LIONS, LOOKING FROM SOUTH AISLE.

SYNOPSIS OF THE FISH COMMISSION EXHIBIT.

Scientific Inquiry Section.

1. *Laboratories for marine exploration:*
   Illustrations of zoological stations: Laboratory at Woods Hole, Mass. (two views).
2. *Exploring vessels:*
   Models: Steamer Albatross. Steamer Fish Hawk. Schooner Grampus.
   Illustrations: Steamer Albatross. Steamer Fish Hawk. Schooner Grampus.
3. *Collecting apparatus:*
   Nets: Seines. Beam trawls. Towing nets.
   Dredges: Naturalists' deep-sea dredge. Naturalists' boat dredge. Chester rake dredge. Oyster dredge.
   Tangles.
4. *Accessories for dredging and trawling:*
   Dredge rope: Steel-wire dredge rope. Splices in dredge rope.
   Weights for beam trawl.
5. *Apparatus for assorting collections:*
   Sieves: Table sieves. Hand sieves.
6. *Apparatus for preserving collections:*
   Tanks, jars, etc.
7. *Apparatus for deep-sea sounding:*
   Sounding machine: Tanner sounding machine. Tanner intermediate towing net.
8. *Apparatus for physical observations:*
   Thermometers: Deck thermometer. Professor Baird's protected thermometer. Miller-Casella deep-sea thermometer. Negretti & Zambra thermometer.
   Thermometer cases and accessories: Wooden cases. Brass cases.
   Salinometers: Hilgard salinometer.
9. *Results of explorations:*
   Charts.
   Collections.
   (1) Marine animals in alcohol:
   (*a*) Deep-sea animals: Crinoids, corals, crabs, sea-pens, starfish, sea-urchin, etc.
   (*b*) Surface animals: Entomostraca, etc., forming food of fish.
   (*c*) Shallow-water animals: Mollusks, crustaceans, etc.
   (2) Marine animals, dry: Foraminifera. Sponges. Corals. Mollusks, etc.

Division of Fish-Culture.

10. *Transportation apparatus:*
    Apparatus for collecting and carrying eggs: Models and specimens: Wroten bucket, improved. Collins's can. McDonald crate. Atkins's egg box. Clark's egg case. Clark's whitefish crate. Clark's foreign egg case. Mather transportation can. Trout boxes used in 1872.
11. *Apparatus for transporting fry:*
    Models and full-sized apparatus:
    (*a*) Models: Car No. 1.
    (*b*) Specimens: Stone's transportation can. Automatic transportation can. McDonald trout can. Carp transportation pail. Carp transportation kettle. Wood-bound can, full size. Messenger's complete outfit. Bucksport transportation can. Ferguson's transportation can. Fish Commission transportation can. Stranahan's transportation keg. Box for native food-fishes.
    (*c*) Accessories: Siphon strainer. Siphon tube, bag, and cage. Dip nets of various sizes. Water bucket.

12. *Hatching apparatus:*

Models and specimens:

(*a*) For floating eggs: Chester cod box. McDonald cod box. McDonald hatching bucket. Ferguson's submerged bucket.

(*b*) For semibuoyant eggs: Wroten's bucket. Green's shad box. Brackett's shad box. Ferguson's submerged bucket. Bell-Mather shad cone. Models of cones and buckets. Chase's whitefish jar. McDonald jar, old style. McDonald universal hatching jar. Clark's jar.

(*c*) For heavy eggs: Garlick's hatching box. Stone's charred trough. Cost's hatching grills. Stone's salmon basket. Bucksport hatching trough. Holton's hatching box. Clark's hatching trough. Mather's hatching trays. Atkins's hatching crate.

(*d*) Working models:

Whitefish table, 8 feet long, 3 feet wide, and 3 feet high, fitted with 12 McDonald hatching jars for hatching whitefish eggs.

Two hatching troughs, 8 feet long, 12 inches wide, and 8 inches deep, equipped for hatching quinnat-salmon and lake-trout eggs.

(*e*) Accessories: Spawning pans. Spawning buckets. Page's egg scale. Egg funnels for whitefish and shad. Series of nets from Central Station, Washington, D. C. Series of nets from Northville Station, Michigan. Series of nets from Battery Station, Maryland. Nippers, brass and wood. Dippers. Strainer dippers. Hume's spawning box. Pan for washing eggs. Salmon dip net. Tray for washing eggs. Siphon bags. Siphon cages. Siphon tubes. Aquaria.

13. *Hatching and rearing establishments:*

Models of hatching establishments—

(*a*) Hatching houses at Put-in Bay, Leadville, and Havre de Grace.

(*b*) Floating hatchery. Hatching barge.

Illustrations of hatching stations, showing buildings, exterior and interior, methods employed in collecting, hatching, rearing, and distributing fish, fry, and eggs.

(*a*) Green Lake. Grand Lake Stream. Bucksport and Craig Brook, Maine. Gloucester cod station and Woods Hole, Mass. Central Station and Fish Commission fish ponds, Washington, D. C. Battery Station, Havre de Grace, Md. Bryan Point shad station, Md. Wytheville Station, Va. Duluth Station, Minn. Alpena and Northville stations, Mich. Put-in Bay Station, Ohio. Quincy Station, Ill. Neosho Station, Mo. Leadville Station, Colo. Fort Gaston, McCloud, and Baird stations, Cal. Clackamas Station, Oreg.

(*b*) Floating stations: Hatching barge. Steamer *Fish Hawk*.

14. *Methods and results of fish-culture:*

Models—

(*a*) Lay figure illustrating method of taking salmon eggs.

Charts—

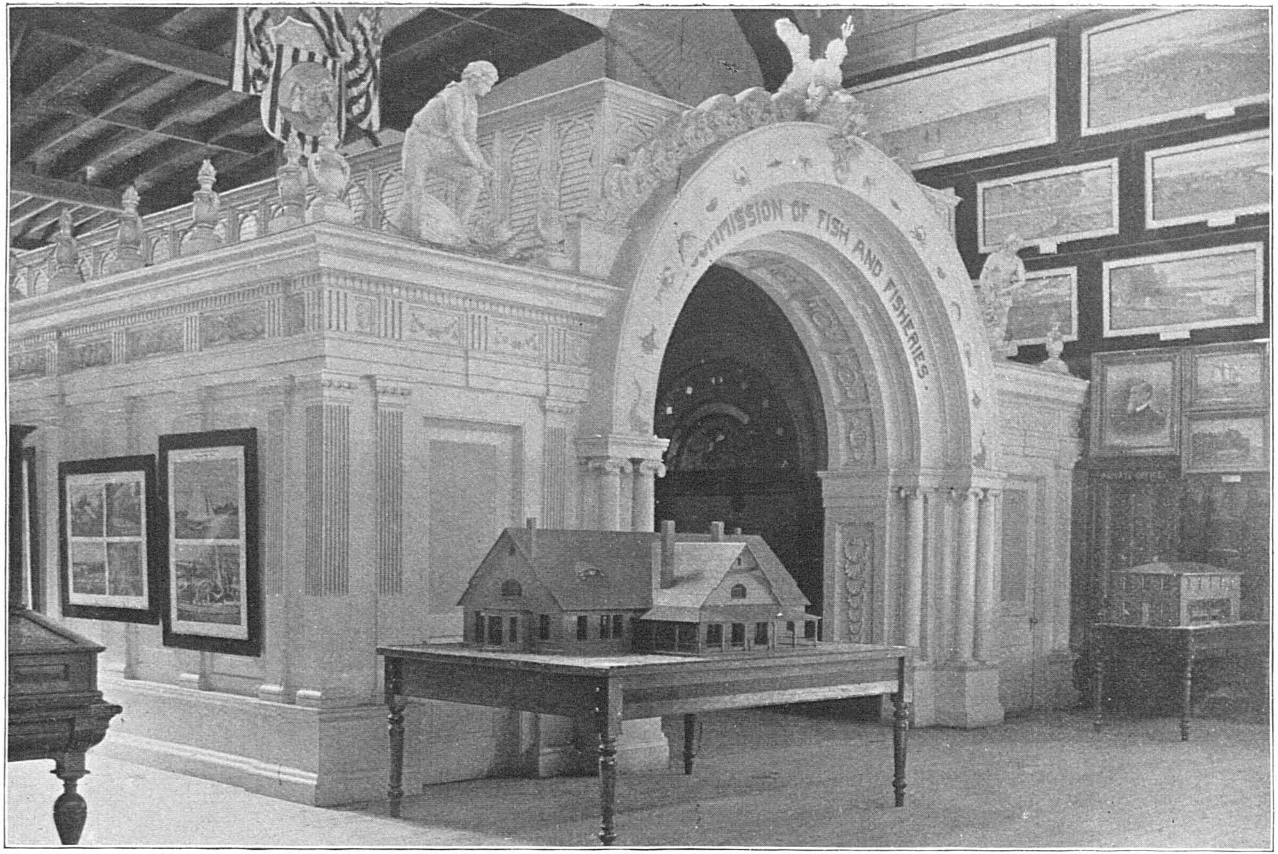
(*a*) Giving names and locations of stations and output of each for the fiscal year 1894–95.

(*b*) Showing work of the Commission from 1872 to 1892.

(*c*) Showing effect of fish-culture on the shad fishery.

Painted casts of fishes reared by the Fish Commission—

(*a*) Brook trout one, two, three, and four years old; Von Behr trout one, two, three, and five years old; Loch Leven trout one, two, three, and six years old; lake trout one and two years old; landlocked salmon one year old; rainbow trout one and four years old; whitefish five years old; carp, tench, goldfish, black bass, etc.



ENTRANCE TO GROTTO FROM WEST AISLE.

FISHERIES SECTION.

15. *Objects of the Fisheries:*

Mammals—

(1) Sirenians. Manatee (cast).

(2) Cetaceans.

(*a*) Dolphins: Blackfish (cast), head. Grampus (cast), head. Harbor porpoise (casts), young.

(*b*) Sperm whales: Sperm whale (models).

(3) Carnivores:

(*a*) Earless seals: Harbor seal (mounted group).

(*b*) Eared seals: Northern fur-seal (mounted group). Steller's sea-lion (mounted group).

Batrachians—

Frogs: Bullfrog (cast). Green frog (cast). Pickerel frog (cast).

Fish—

Casts of 150 species of marine and fresh-water food-fishes.

Drawings of and notes on the important fishes of the Southern States.

Living marine and fresh-water fish in aquarium.

Invertebrates—

Living sea-anemones, starfish, crabs, lobsters, mollusks, algae, etc., in aquarium.

16. *Fishery apparatus:*

Vessels—

(1) Series of models showing the development of fishing vessels from settlement of America to the present time.

(2) Models of vessels used in the important fisheries of the South Atlantic and Gulf States.

(3) Pictures of vessels.

Boats: Models of types used in important commercial fisheries.

Canoes: Skin kyak from Alaska used in capture of seals, sea-lions, etc.

Nets: Pounds. Weirs. Pots. Seines. Cast nets. Dip nets. Trawls. Dredges.

Lines: Trawl lines. Hand lines.

Accessories: Disgorgers, hook extractors, etc.

Appliances for seizing: Rakes for oysters and clams. Tongs. Hooks for sponge. Mackerel and squid jigs.

Accessories: Water glass used in sponge fishery.

Appliances for striking: Spears.

17. *Illustrations of fisheries.*

Fishermen. Fishermen's dwellings. Fishing towns.

Special fisheries: Mammals. Reptiles. Fishes. Mollusks. Crustaceans. Sponges.

18. *Statistics of fisheries of the United States.*

CONSTRUCTION OF AQUARIUM.

Proposals for the construction of the aquarium were solicited by advertising in newspapers published in Washington, New York, Atlanta, and Savannah, but when the bids were opened on May 15 they were found to be too high and were all rejected. This was due chiefly to the fact that the class of work required was unusual and not understood by the firms making the bids. As the time was getting short and there was no reasonable hope of getting satisfactory bids by further advertisement, contracts were made with the following parties for the construction of certain portions of the aquarium: Peters & Pahl, of Washington, D. C., for the construction of the wood, mason, and iron work; Koppe Bros. & Steinichen, of Atlanta, for the stuccowork and figures; O. Pause, of Atlanta, for the painting and decoration of grotto. All of the work was to be done under the direction of L. F. Graether and in accordance with accompanying plans and specifications. The contracts provided for the completion of the work by August 10, 1895, but owing to delay in completing the Government building and the difficulty experienced by the contractors in obtaining proper material in the vicinity of Atlanta, they were unable to finish it in the time specified, and it was necessary to extend their contracts. Mr. Graether continued to supervise the work until August 23, when he resigned and was succeeded by Mr. Von Bayer, who remained in charge until its completion.

The machinery and piping for circulating the salt water and air and for filtering the fresh water were put in under the direction of I. S. K. Reeves, passed assistant engineer, U. S. N., who arrived in Atlanta August 4, 1895, and remained until that portion of the plant was completed. Mr. L. G. Harron, superintendent of the aquarium at Central Station, having been detailed by the Commissioner to assist in connection with the exhibit, was ordered to Atlanta on August 6 to assume the superintendency of the aquarium and to arrange for the interior decoration of the tanks and the preliminary installation of salt water, plants, etc. Notwithstanding the numerous delays and difficulties encountered in the construction of the aquarium, it was complete and thoroughly stocked with salt and fresh water fishes and other animals by September 18, when the Exposition was opened.

The space occupied by the aquarium was L shaped, 28 feet wide and 150 feet long. Arched grottoes were constructed the whole length, and a rotunda with a dome connected the two arms of the L. Twenty-eight aquaria were placed in this grotto, 14 for salt-water fish and 14 for fresh-water fish, the sizes being as follows: Two 14 feet long, 3 feet high, and 5 feet across the top; fourteen 7 feet by 30 feet by 5 feet, and twelve 5 feet by 3 feet by 5 feet. The main wall of the Exposition building formed one side of the grotto construction, and the exterior of the other consisted of a handsomely paneled wood partition, separating the grotto from the general Exposition hall.

All light entering the grottoes had to pass through the aquaria tanks, except what little entered through the open end doorways. The main passage in the grotto was 12 feet wide, and between the rear of the aquaria and the exterior of the grotto was a passageway for the use of the attendants to the aquaria. The faces of the tanks were of polished French-plate glass 3 by 7 feet and 1 inch thick, and they were decorated on the inside with white sand, rocks, and aquatic plants.

The exterior partition facing the general Exposition hall was arranged so that it could be used as a picture gallery. Its architecture was of the early renaissance style, constructed as a pilaster treatment,

PLATE 14.

ENTRANCE TO GROTTO FROM SOUTH AISLE.

finished at the top throughout its entire length with a delicately conceived entablature bearing a series of urns. The frieze of this entablature was divided by triglyphs into ornamental panels, in which were inserted bas-reliefs representing aquatic life. Two semicircular archways, one on the south, the other on the west, gave admittance to the grotto. These entrances were flanked on each side by Ionic colonnades and surrounded by paneled and ornamented arches and soffits. The keys to the arches formed a group representing a youthful Poseidon taming an aquatic monster, and the whole was finished at each end above the entablature by statuary representing a fisherman gathering fish and a fisher-maid planting fry in the waters of the country. An ornamental net gracefully suspended between the urns above the entablature spanned the entire front and sides of the grotto, giving final finish to the outside of the structure. The whole of the outside was finished in ivory white and gold.

On entering the doorways a series of grottoes could be seen, forming a passage to the rotunda. The ceilings of these grottoes were formed by groined fan or funnel arches, supported by romanesque columns, pedestals, and brackets. The space between each pair of columns formed a bay for one tank. The bases and sides of these bays were treated in rusticated stonework. The ribs and spandrels of the ceiling were tinted, those of the arched ceiling being blended from a sky blue above to a sea green below. The spandrels formed on the walls were embellished by paintings of aquatic animal and plant life.

The columns, caps, and bases were made of imitation Numidian marble, and the rustic work in imitation of natural stone. The caps to the columns were carved differently, and represented fish, lobster, and other aquatic animals. Over each tank was a semicircular sash containing ornamental cathedral glass of various shades, which permitted only subdued light to enter the grottoes.

The passageway through the grotto led to a large circular rotunda surmounted by a semicircular dome, the soffit of which was embellished throughout with cassettes graduated from the springer line to the eye of the dome. The motive chosen for the ornamented parts of the cassettes was the water lily. A few of the panels were glazed for the purpose of securing a more brilliant light effect on the interior of the dome and the waters of the cascade, and the sides of the rotunda were wainscoted with a richly ornamented pilaster treatment.

The dome contained a large, horseshoe-shaped basin, surmounted in the rear by an imposing arch with relief shell work, from the center of which a cascade issued. The sides of this basin represented regular rustic stonework, and the coping of the basin walls consisted of a bronze cast-iron capping ornamented in water lilies. The cascade was enriched by an arrangement of natural rock and plants, and by artistic representations of manatees, otter, sea gulls, etc., executed in natural size.

One of the important problems in the construction of an aquarium is to arrange so that it will not become overcrowded. Profiting by our experience at Chicago, a passageway 12 feet wide was provided, but people coming in from both ends soon packed it, and it was almost impossible to move either way. This was largely due to the fact that there were fish on both sides of the grotto, and visitors going down one side returned on the other instead of going out. This might have been avoided by placing a partition down the center of the aisle, but it would have marred the architectural effect of the grotto, which was much admired.

FRESH-WATER SUPPLY.

The water for the fresh-water side of the aquarium was supplied from one of the three mains laid to the Government building and connected with the city water supply, which is taken from the Chattahoochee River. Before entering the aquarium this water was passed through a pressure filter of the Jewell pattern, having a capacity of 20,000 gallons per hour, but as it had already been filtered at the city waterworks by the alum coagulated process, it was unnecessary to use the alum provided by the Jewell filter. After passing through the filter the water was conducted to the aquaria through 1½-inch galvanized-iron pipes fitted with ¼-inch brass jet cocks and arranged horizontally above them. The waste water was carried off by means of an overflow pipe placed in the end of the aquaria near the top, and discharged into a trough emptying into a manhole connected with one of the sewers.

SALT-WATER SUPPLY.

The salt water for the aquarium was obtained at Morehead City, N. C., and transported in three tank cars loaned by the Standard Oil Company. It reached Atlanta August 23, and was unloaded as soon as possible and placed in a large tank constructed for it under the aquarium. Its density when shipped was 1.021, temperature 80°; five or six days later its density remained the same, but the temperature had fallen to 78°, and the water was in excellent condition.

SALT-WATER CIRCULATION.

The two pumps used for circulating the water were of the Erwin-Welch pattern, having a power cylinder 4 inches in diameter; pump cylinder, 5 inches; stroke, 6½ inches; suction inlet to pump, 2 inches in diameter; discharge, 1½ inches. The power ends were of brass and the pumping ends of block tin hardened. They were built to operate under a minimum water pressure of 50 pounds, and were so designed as to lift the water through their suction a distance of 10 feet and deliver it to a tank 30 feet above, each pump delivering 900 gallons per hour. The pumps could be operated together or singly, but better results were obtained by operating them together. The water for running them was taken from the main located under the Government building, the average pressure being about 80 pounds per square inch, though it was often as low as 60 pounds and sometimes went as high as 125 pounds.

The salt water was forced from the large reservoir below the floor, by means of the pumps, into the distributing tank located in the southwest tower of the main building 25 feet above the aquaria, from which point it was distributed by gravity through asphalt-lined iron piping fitted with $\frac{1}{4}$-inch hard-rubber jet cocks. The water was fed into the aquaria through $\frac{1}{8}$-inch glass nozzles attached to rubber hose leading from the rubber cocks, which delivered it at the surface and forced air in with it In addition to the surface supplies, each aquarium was arranged so that water could be introduced at the bottom with $\frac{1}{2}$-inch hose.

The overflow was the same as on the fresh-water side, except that it emptied into a filter box connected with the reservoir tank, and was thus filtered over and over again.

The filter was a pine box 7 feet 6 inches long, 3 feet 10 inches wide, and 16 inches deep, filled with gravel of different sizes, varying from 2 inches to $\frac{1}{4}$ inch in diameter, laid in courses, and covered with 2 inches of clean sand. The capacity of this filter was 1,400 gallons per hour.

HEATER.

In November, finding that the temperature of the water was getting too low for the salt-water fishes from the Gulf, a heater was made for regulating it. This was 8 feet long and made of 2-inch galvanized-iron pipe, arranged like the ordinary return-bend steam heater. Under each section of the pipe 16 gas jets were placed, and the entire apparatus was encased in a steel box. The heater was placed in the tower and so connected that all of the salt water could be passed through it before entering the supply tank. By this means there was no difficulty in keeping the water at an even temperature of from 60° to 63° when the air temperature was below the freezing point.

AIR CIRCULATION.

In order to provide the necessary amount of air to the aquarium a vertical hydraulic air-pump or compressor, of the Bishop & Babcock pattern, was erected between two of the aquaria on the salt-water side. The water-power cylinder of this pump is $4\frac{1}{8}$ inches in diameter, the air cylinder (situated above the water cylinder) 6 inches, and the stroke 8 inches. The pumps deliver the air into the galvanized-iron cylinder, where a pressure of about 7 pounds per square inch is maintained, and from there it is fed through a $\frac{3}{8}$-inch pipe along the backs of the aquaria. At the back of each one the pipe is connected with rubber tubing, which passes down the back to the bottom of the tank. At the end of the tubing is a hard-rubber cylinder into which wooden liberators are introduced for forcing the air into the water in minute globules. The air and water circulating plants were so arranged as to be entirely independent of each other, so that in case of the water supply being cut off it was possible to maintain the air circulation.

EMPLOYEES.

In addition to the superintendent, there were employed in connection with the aquarium a machinist to look after the pumps, filters, etc., 2 night watchmen, and 2 laborers to clean the aquaria, wash sand in filter, prepare food for the fishes, etc.

CARE OF THE AQUARIUM.

The aquaria tanks were thoroughly cleaned once a week, Sunday being selected, as no visitors were allowed in the building on that day. In the fresh-water tanks a perforated galvanized iron funnel attached to a rubber siphon was used to draw the waste food and sediment from the bottoms, and about a gallon of Turks Island salt was distributed in each aquarium once a week as a disinfectant, 60 bushels being used for this purpose during the Exposition. In the salt-water aquaria the sediment and other deleterious matter was caught and held in suspension by the sand filter.

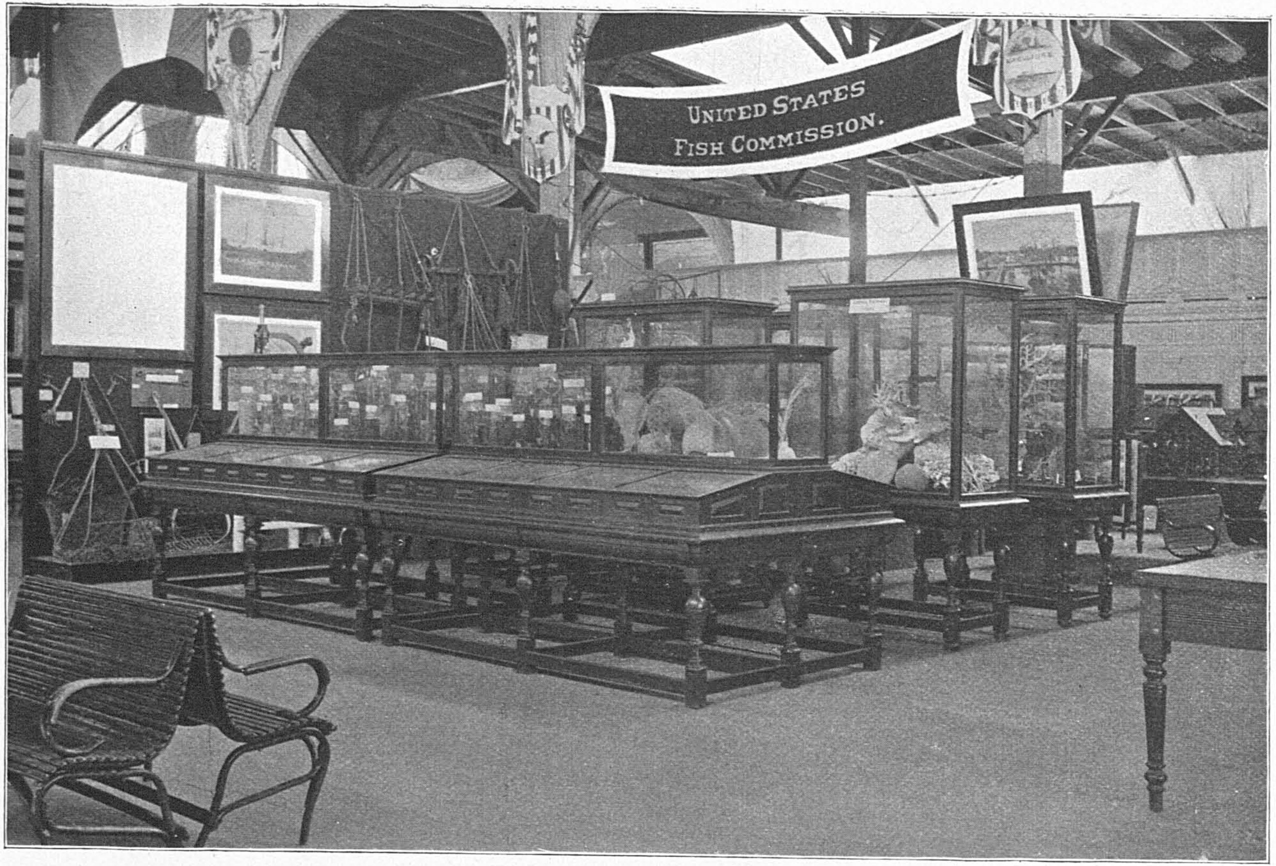
The losses of fresh and salt water fishes were very small after the opening day, when a very heavy loss occurred, owing to the high temperature of the water and the insufficient supply, caused by opening up all of the fountains on the grounds.

The heaviest losses of salt-water fishes usually occurred just after their arrival, and were caused, apparently, by bruises received in transportation, though many specimens that were received in a badly bruised condition recovered entirely and were alive when the aquarium was closed on December 31. A sudden fall of temperature from 65° to 52° in the latter part of October caused the loss of all the pompano and a number of red snappers, spade-fishes and cow-fishes. This defect in the aquarium was cured by the fitting up of the heater.

COLLECTION OF FISHES FOR THE AQUARIUM.

Marine fishes.—The primary object being to show the commercial fishes of the South, the collecting points chosen were Morehead City, N. C., and Pensacola, Fla., as they are important commercial fishing centers and accessible by rail. Mr. F. P. Hagan, who had had a valuable experience in the collection and transportation of fishes for the World's Columbian Exposition, Chicago, Ill., made the collections at Morehead City and transported successfully all the specimens secured at that point and at Pensacola. Lieut. Franklin Swift, U. S. N., in command of the United States Fish Commission steamer *Fish Hawk*, furnished two excellent loads from Pensacola. Arrangements were also made for securing supplies of anemone, lobsters, starfish, and other marine life from Woods Hole and Gloucester, through the superintendents of the stations at those points. These were shipped by express, carefully packed in seaweed or moss, and arrived in fairly good condition, considering the temperature existing at the time of shipment and the length of time they were en route—from four to six days.

Fresh-water fishes.—The majority of the fresh-water fishes were furnished from the U. S. Fish Commission stations at Quincy, Ill., and



VIEW FROM WEST AISLE.

Wytheville, Va., and from the fish ponds at Washington, D. C. Collections were also made from the Neuse River at Newbern, N. C., and from the Chattahoochee River in the vicinity of Atlanta. Hon. John D. Edmundson, superintendent of the fisheries of Georgia, also furnished specimens from a lake near Luluton, Ga. Fungus developed on those obtained from the Neuse and Chattahoochee Rivers very shortly after their arrival, and most of them died in a few days.

Following is a list of fishes and other aquatic animals collected and exhibited during the Exposition.

Species.	Number.
Fresh-water fish:	
Black bass	156
Crappie	76
Warmouth bass	60
Rock bass	70
Sunfish	67
Yellow perch	61
White perch	22
White bass	10
Pike	35
Brook trout	50
Rainbow trout	28
Black-spotted trout	18
Landlocked salmon	106
Grayling	5
Suckers	83
Carp	75
Golden ide	17
Goldfish	328
Common tench	140
Golden tench	18
Dogfish	21
Catfish	67
Gar pike	60
Total	1,573
Salt-water fish:	
Red drum	15
Black drum	1
Croaker	75
Spot	50
Spotted sea-trout	11
Sheepshead	45
Pinfish	68
Scup	1
Pigfish	68
Red snapper	37
Pensacola snapper	1
Mangrove snapper	2
Sea bass	102
Red grouper	34
Black grouper	17
Squirrel-fish	3
Salt-water fish—continued.	
Striped mullet	34
Kingfish	9
Cavally	43
Pompano	36
Lizard-fish	11
Tautog	3
Remora	1
Spadefish	29
Flounder	27
Hog-choker	4
Tongue sole	3
Mummichog	180
Sea-robin	8
Sea-raven	13
Toadfish	23
Swellfish	10
Burfish	44
Filefish	14
Trigger-fish	18
Cowfish	23
Batfish	1
Salt-water catfish	13
Stingray	7
Skate	1
Total	1,085
Reptiles, crustaceans, etc.:	
Alligator	1
Green turtle	1
Soft-shell turtle	2
Snapping turtle	1
Terrapin	7
Lobster	18
King-crab	9
Hermit-crab	90
Blue crab	42
Spider-crab	3
Conch	25
Starfish	20
Sea-anemone	102
Total	321
Grand total	2,979

From time to time supplies of fish were brought in from the stations of the Commission and the field-collecting stations, so that there was no perceptible change, except that as the water became cooler the supply and varieties of trouts were largely increased.

The average temperatures of salt and fresh water for September, October, November, and December are given in the following table:

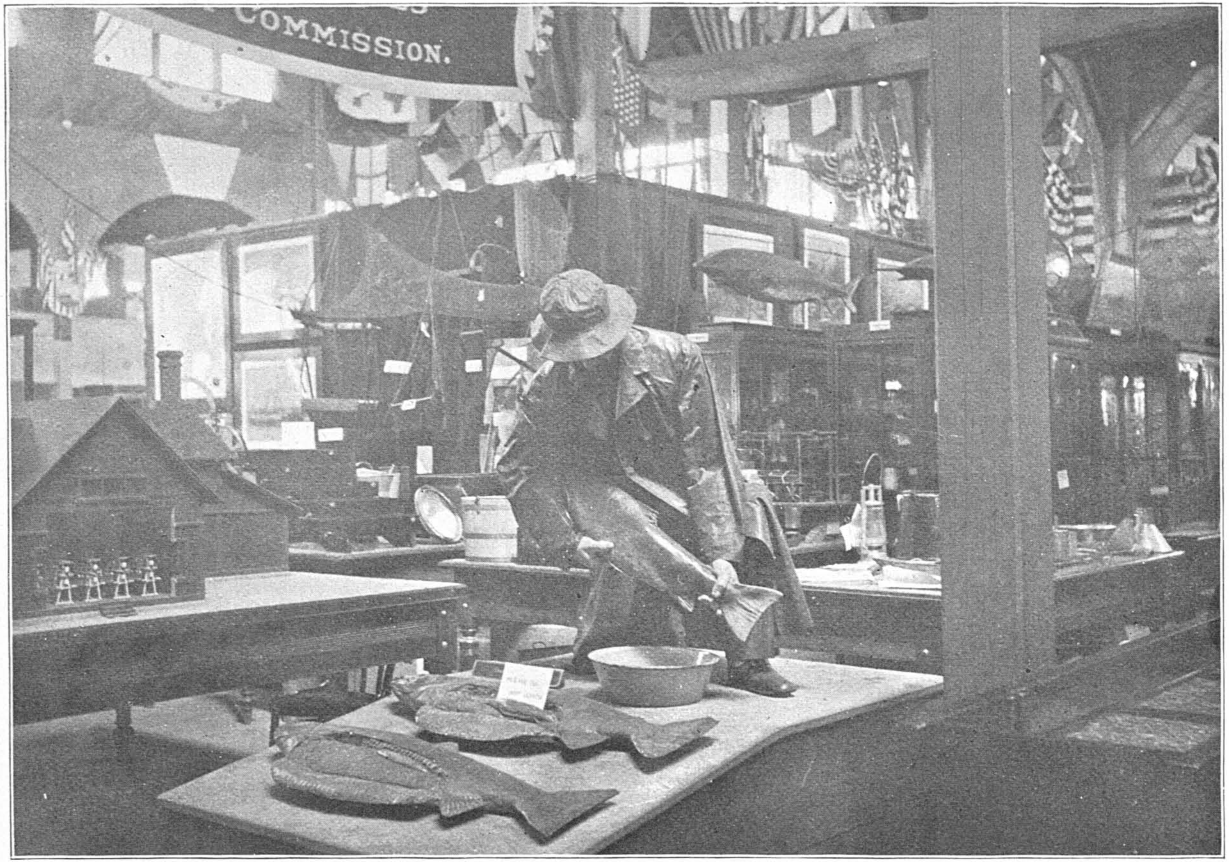
Month.	Salt.			Fresh.		
	Maximum.	Minimum.	Mean.	Maximum.	Minimum.	Mean.
September	75	65	70	81	77	79
October	63	53	58	76	63	69.5
November	63	53	58	62	56	59
December	63	58	60.5	56	48	52

FOOD.

The food used was round beefsteak, beef livers, clams, and fiddler-crabs. The beef and liver were cut into small pieces and care was taken to remove all of the fat and sinews. All of the marine species except the trigger-fishes and file-fishes took the beef readily, especially if it was slightly salted. The trigger-fishes and file-fishes were fed entirely on clams. The fiddler-crabs intended for food were shipped by express from Pensacola by Lieutenant Swift from time to time as they were needed, and no difficulty was experienced in keeping them for an indefinite period in a box of slightly moistened sand. The fish were fed regularly once a day, except Sunday, and seemed to thrive after they became accustomed to confinement.

PRACTICAL FISH-CULTURE.

To illustrate practically the methods employed at the various stations of the Commission, two hatching troughs were fitted up, one with gravel for the hatching and rearing of trout, one with trays for salmon, and a table with 8 McDonald jars for whitefish and other similar eggs. It was hoped that it would be possible to do practical work throughout the Exposition, but owing to the high temperature of the water all the eggs shipped to Atlanta previous to December 4 died after being in the troughs and jars from 2 to 6 days. A consignment of 10,000 lake-trout eggs received on that date from Alpena, Mich., hatched on the 15th, with a loss of only 300, thus showing that the previous losses had been due to the temperature of the water and not to the use of alum in its filtration. The water temperature was 54° on the day they were received, but it fell to 45° by the time they had finished hatching. The fry resulting from the eggs were held until the sac was absorbed and then planted in a pond near Atlanta, belonging to Mr. T. J. Barnard. A shipment of 10,000 quinnat salmon eggs received from Baird, Cal., on the 10th



SPAWN-TAKER STRIPPING SALMON.

attracted a great deal of attention during the closing days of the Exposition, and added greatly to this feature of the exhibit. The fry hatched from them were planted in Clara Meer, a lake in the Exposition grounds, about 30 acres in area.

The following statement shows the numbers and kinds of eggs received and the results obtained from them:

Date.	Source of supply.	Species.	Number of eggs received.	Water temperature when received.	Number of eggs and fry lost.	Number of eggs hatched.	Remarks.
				Deg.			
Sept. 22	Baird ...	Salmon	10,000	81	....	....	Sept. 23; all dead.
Oct. 7	....do ...	.....do	5,000	73	....	....	Nov. 8; all dead.
Oct. 21	Alpena .	Lake trout.	10,000	66	....	....	Nov. 16; all dead.
Nov. 1	....do ...	.....do	10,000	62	....	....	Nov. 15; all dead.
Nov. 15	....do ...	Whitefish..	800,000	60	....	....	Nov. 16; all dead.
Dec. 4	....do ...	Lake trout.	10,000	54	1,000	*9,700	Dec. 15; hatched.
Dec. 10	Baird ...	Salmon	10,000	51	429	†9,771	Jan. 1; hatched.

* Nine thousand fry delivered to Mr. Barnard. † Fry planted in lake at Piedmont Park.

CLOSING OF THE EXPOSITION.

At the close of the Exposition the fresh-water fishes were planted in public and private waters in the vicinity of Atlanta; the majority of the salt-water fishes were transferred to Washington and exhibited in the aquarium at Central Station. No attempt was made to remove the grotto, as it would have been seriously damaged in taking apart and transporting; besides this, the Commission had no facilities for storing it in Washington. The aquaria, pumps, piping, supply, and reservoir tanks, were taken down and shipped to Washington, and afterwards turned over by the Acting Commissioner to the Commissioners of the Zoological Park. As soon as arrangements were completed for the disposition of the aquarium, the representative returned to Washington, leaving W. P. Sauerhoff in charge of the packing and reshipment of all exhibits. This was completed in February, and all material borrowed from the Smithsonian Institution was returned in good condition.

The aquarium proved the most important and attractive exhibit on the grounds, and was always crowded to its fullest capacity, even when the attendance at the Exposition was small.

ACKNOWLEDGMENTS.

To the diligence, intelligence, and experience of the employees of the Commission detailed to assist at Atlanta, the Commission owes much of its success, especially to Mr. L. G. Harron, who was in general charge of the exhibit during the absence of the representative, and Mr. W. P. Sauerhoff, who had charge of fish-cultural work and who superintended the packing and shipping of all material exhibited.

The Commission is indebted to the Secretary of the Smithsonian Institution for loan of material and cases forming part of its exhibit; also to the following parties, who contributed largely toward its success:

Hon. J. D. Edmundson, superintendent of fisheries for Georgia, for assistance rendered in collection of fishes for the aquarium.

Col. R. H. Payne, secretary Union Tank Line Company, for loan of tank cars for hauling salt water from Morehead City to the Exposition.

Judge Hillyer, president Atlanta Water Works, for permission to take fish from lake controlled by his company, and for aid in keeping a uniform pressure of water for operating the pumps.

Capt. E. L. Tyler, chief of transportation, for loan of water carts for hauling salt water.

M. M. Sullivan & Son, Savannah, Ga., for assistance in collecting fishes and gift of turtle.

To the director general and supervising architect of the Cotton States and International Exposition, for assistance rendered in connection with the installation of the aquarium.

W. H. Baldwin, jr., second vice-president Southern Railroad Company, for free transportation of tank cars containing salt water, and special facilities provided for their movement without delay; also for free transportation of U. S. Fish Commission Car No. 4, and crew from Washington to Goldsboro, N. C., thence to Atlanta and return.

Gen. George C. Smith, president and general manager of the Alabama, Atlanta and West Point Railway, for hauling car and crew from Atlanta to Montgomery and return, two trips.

Hon. Milton H. Smith, president Louisville and Nashville Railroad Company, for hauling car from Montgomery to Pensacola and return, two trips.

The South Carolina Railroad Company, for free transportation over its line to Branchville, S. C., and return.

Mr. F. J. Jette, superintendent of transportation, Central Railroad of Georgia, for transportation of car and crew from Atlanta to Albany, Ga., and return.

The total cost of preparation, maintenance, and return of the exhibits of the Commission, including the aquarium, was $20,689.80. The following statement shows the objects for which the money was expended:

Items.	Amounts.
Exhibits and furniture	$605.12
Transportation	2,475.95
Installation and maintenance	1,367.48
Packing and repacking	1,935.22
Miscellaneous expenses	191.52
Construction of aquarium	10,898.78
Installation and maintenance of aquarium	2,372.35
Stocking of aquarium	843.38
Total	20,689.80

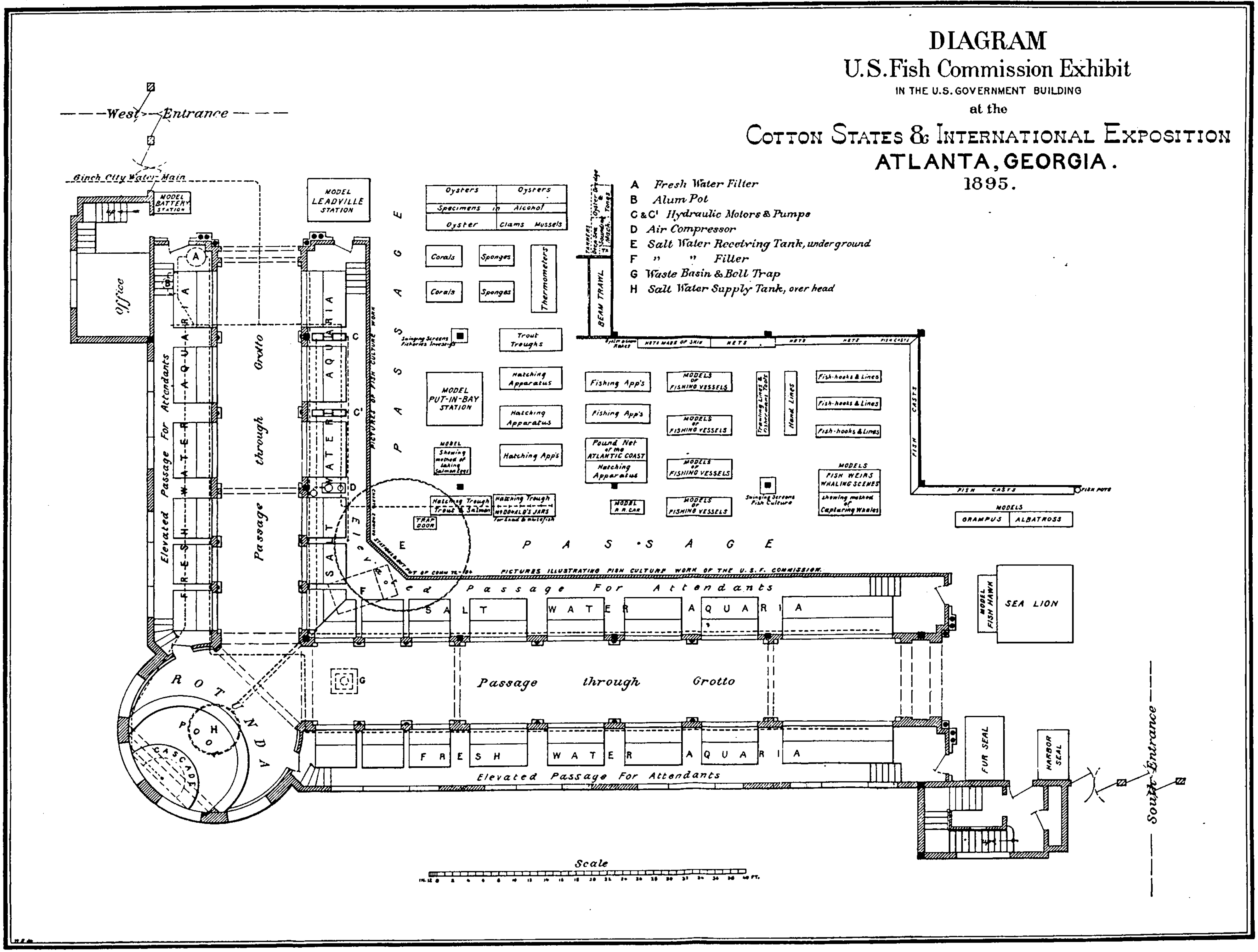
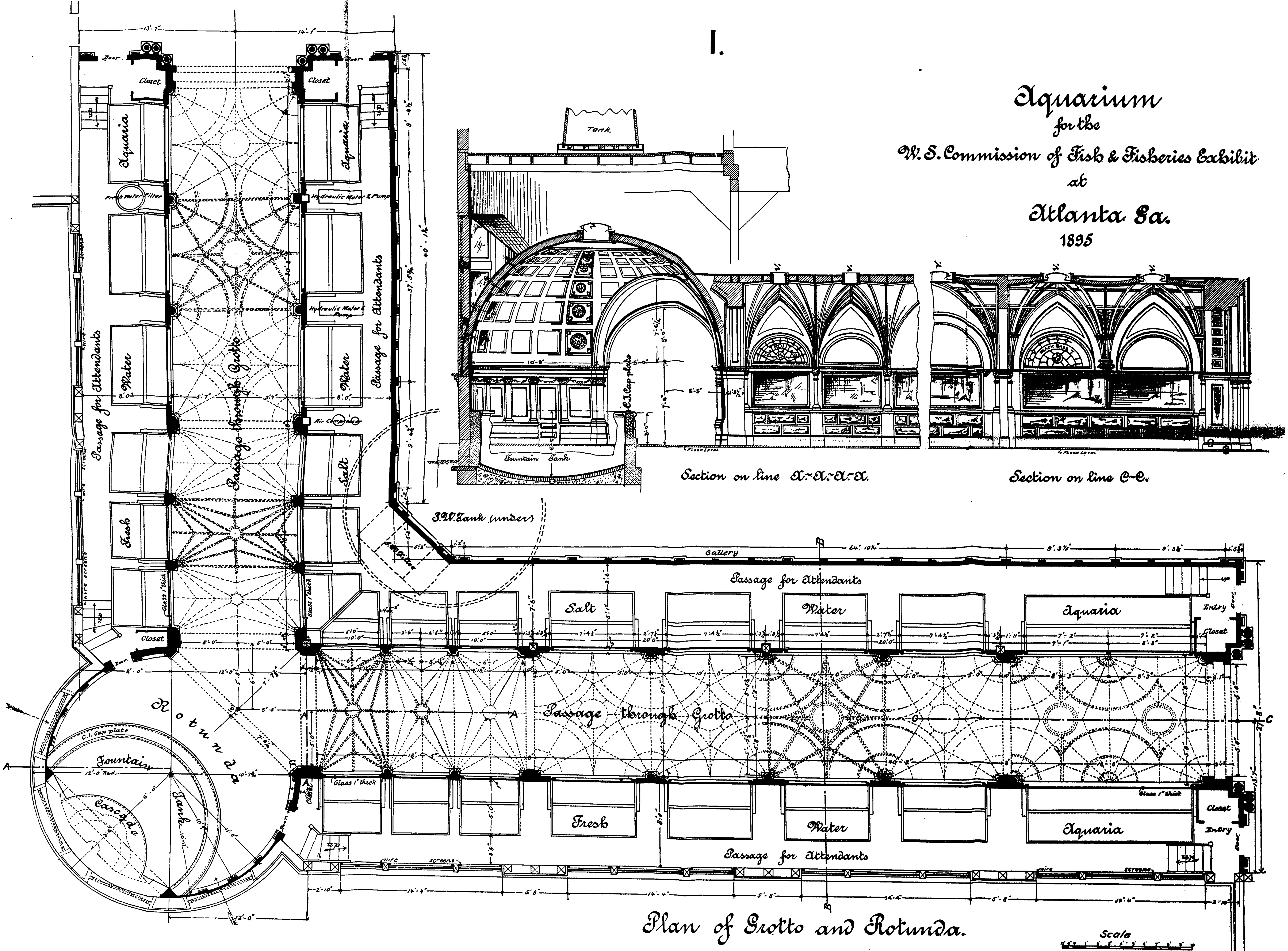


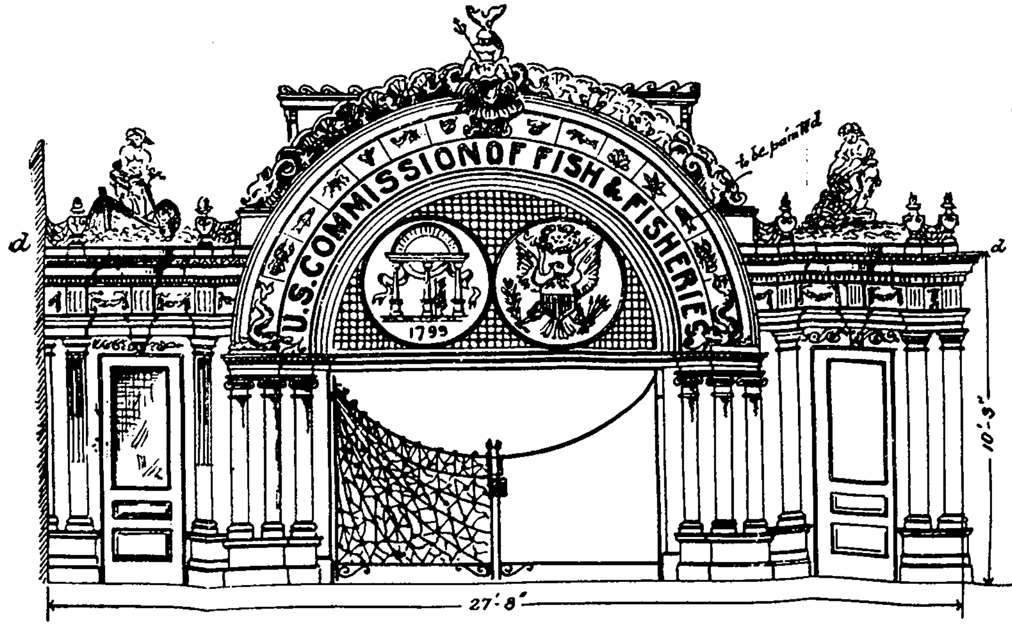
DIAGRAM
U.S. Fish Commission Exhibit
IN THE U.S. GOVERNMENT BUILDING
at the
COTTON STATES & INTERNATIONAL EXPOSITION
ATLANTA, GEORGIA.
1895.
A Fresh Water Filter
B Alum Pot
C & C' Hydraulic Motors & Pumps
D Air Compressor
E Salt Water Receiving Tank, underground
F " " Filter
G Waste Basin & Bell Trap
H Salt Water Supply Tank, over head
West Entrance
South Entrance
Office
MODEL BATTERY STATION
MODEL LEADVILLE STATION
MODEL PUT-IN-BAY STATION
Elevated Passage For Attendants
FRESH WATER AQUARIA
SALT WATER AQUARIA
Passage through Grotto
PASSAGE
ROTUNDA
CASCADE
POOL
Oysters
Specimens in Alcohol
Oyster
Clams Mussels
Corals
Sponges
Thermometers
BEAM TRAWL
Trout Troughs
Hatching Apparatus
Hatching App's
Hatching Trough Trout & Salmon
TRAP DOOR
Fishing App's
Pound Net of the ATLANTIC COAST
MODEL R.R. CAR
MODELS OF FISHING VESSELS
Hand Lines
Fish-hooks & Lines
NETS
FISH CASTS
MODELS FISH WEIRS WHALING SCENES
MODELS GRAMPUS ALBATROSS
MODEL FISH HAWK
SEA LION
FUR SEAL
HARBOR SEAL
PICTURES OF FISH CULTURE WORK
PICTURES ILLUSTRATING FISH CULTURE WORK OF THE U. S. F. COMMISSION.
Scale

Aquarium for the U. S. Commission of Fish & Fisheries Exhibit at Atlanta Ga. 1895



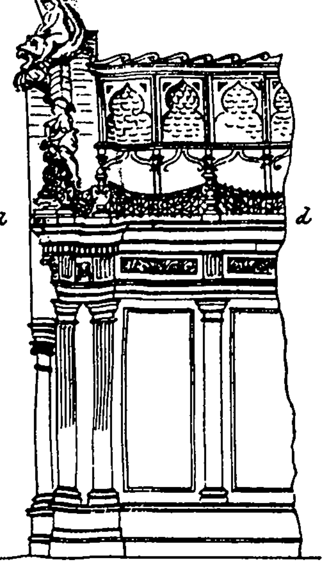
Plan of Grotto and Rotunda.

2.

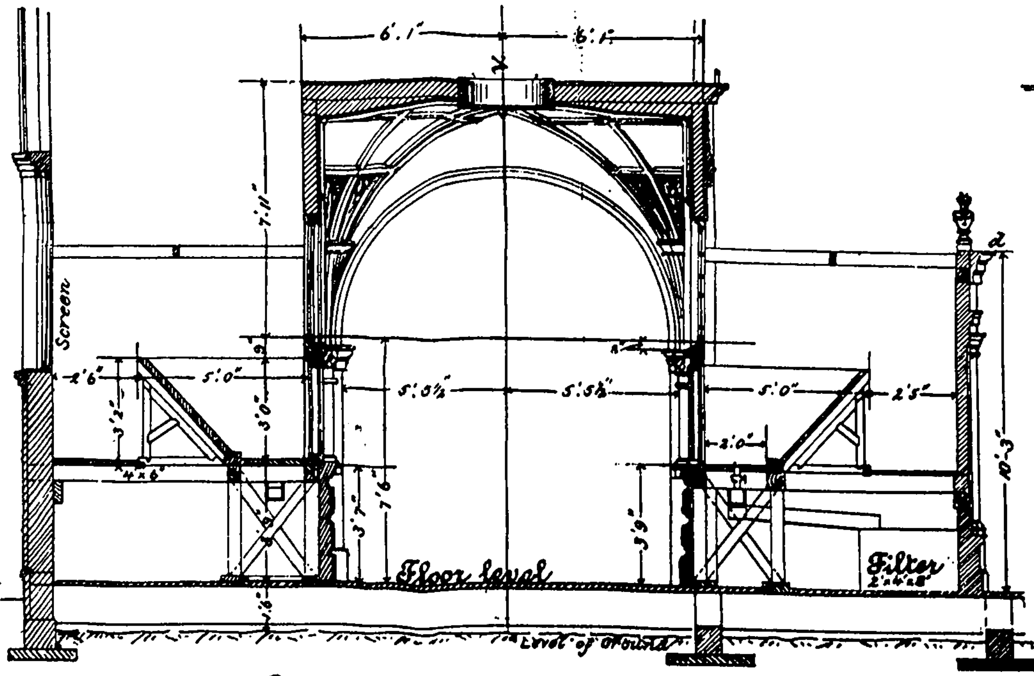


East Entrance

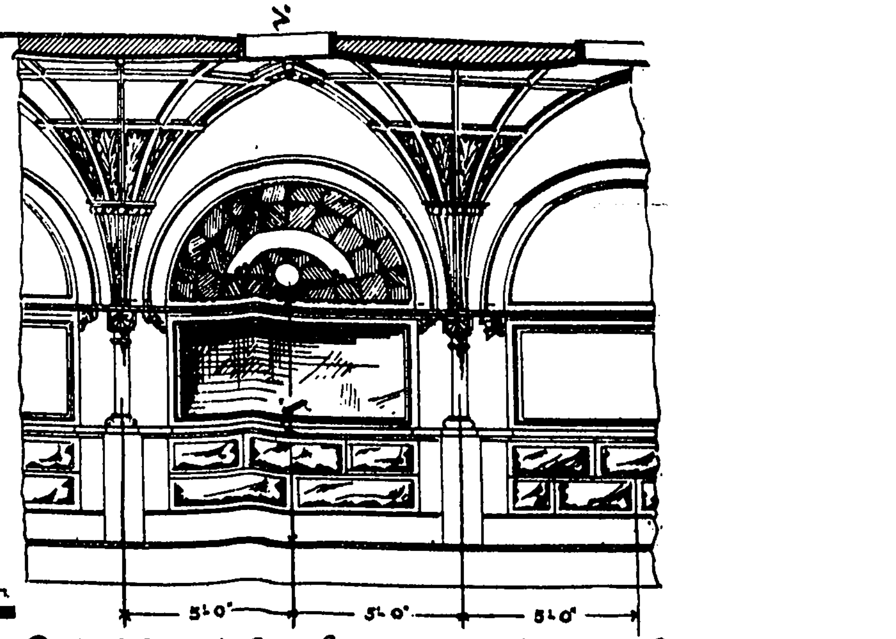
North entrance to be accurately the same, with the exception of the Medallions; these to show the reverse side of Coats of arms



N.E. part of Gallery.

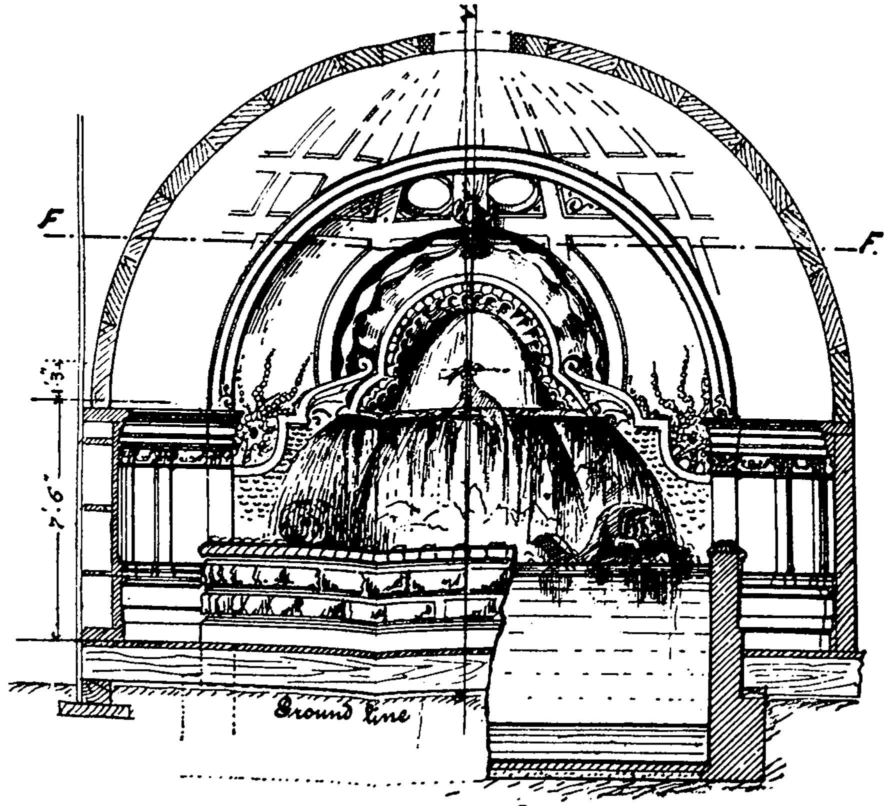


Cross Section on line B-B.

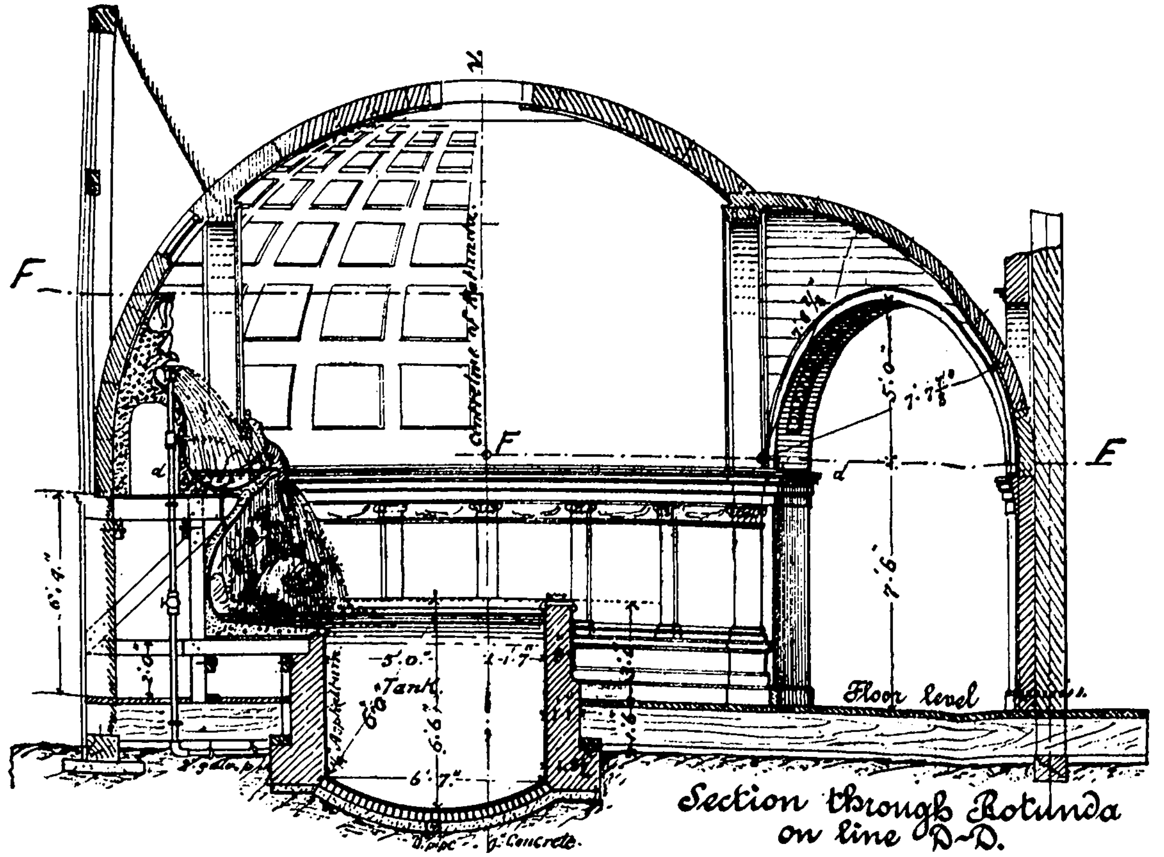


Part of longitudinal section on line A-C.

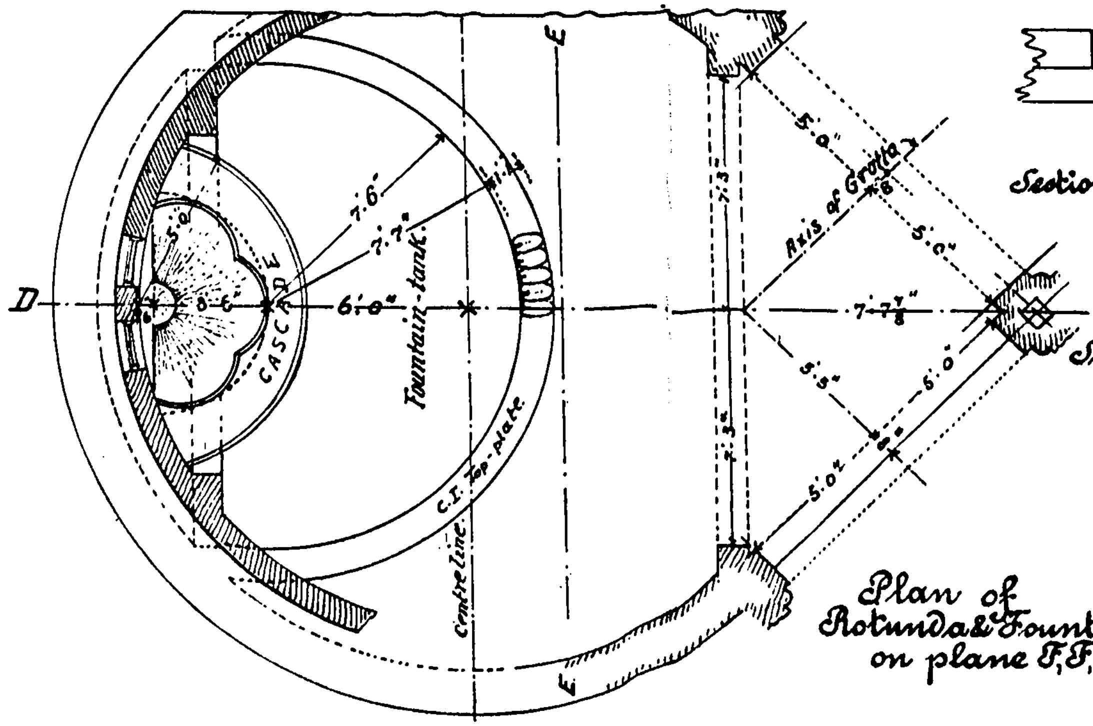
Scale



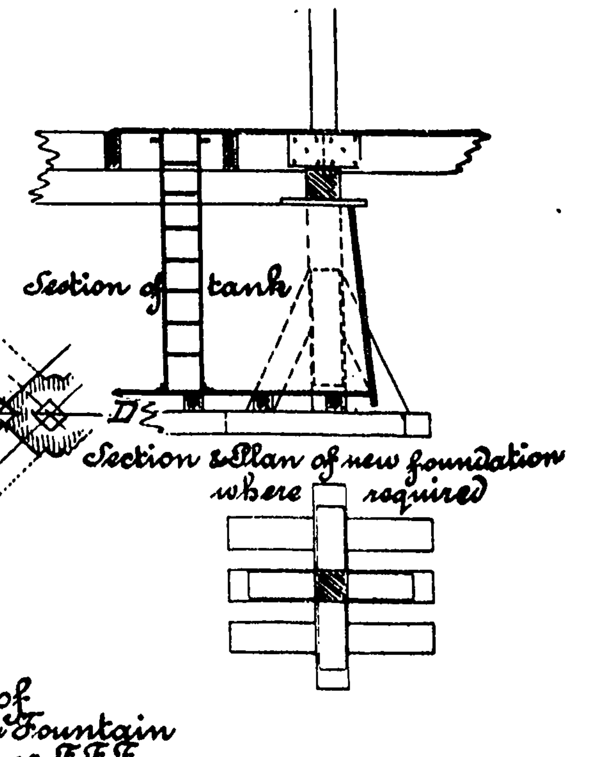
Section through Rotunda on line E-E.



Section through Rotunda on line D-D.



Plan of Rotunda & Fountain on plane F.F.F.



Section & Plan of new foundation where required

SPECIFICATIONS FOR CONSTRUCTING THE AQUARIUM.

DESCRIPTION.

The construction of the aquarium herein specified consists of the following principal parts: An arched grotto containing thirty aquaria, two entrances thereto; a rotunda with dome, containing a fountain; an extensive gallery in panelwork, and all other minor details, as shown on the drawings.

Excavation, removal of earth, etc.—Excavate the ground for the salt-water tank, tank for fountain, for laying sewer and other pipes, and for new foundations under main posts of Exposition building, etc., and do all other excavation required by the drawings and as directed by architect in charge and required to complete the work.

Remove all surplus earth and rubbish off the premises to places designated by the superintendent, and level off as will be directed.

MASON WORK, ETC.

Concrete.—Prepare and lay for foundation walls and bottom of fountain tank and waste basin a bed of concrete 6 inches thick, and fill between the walls of salt-water tank and ground with concrete made of best native Portland cement and clean, sharp, grit sand and broken limestone (stone to pass a ring of 2 inches diameter in clear) in parts: 1, cement; 2, sand, and, 3, broken stones, properly mixed and laid in the best manner. Do all other concreting required by the drawings and necessary to complete the job.

Brickwork.—The tanks for fountain and waste basin, as shown, to have their walls and bottoms built with best hard-burnt brick laid in best hydraulic (Portland) cement mortar; except where otherwise specified the joints to be completely filled with mortar throughout and thoroughly grouted.

Asphaltum.—The inner linings of the aforesaid tank and basin, and also the bottom of the same, to be built with brick boiled in best Trinidad asphaltum, laid while hot, and properly bonded with the other brickwork; the bottom of the tank to have the bricks set on edge, laid in herring-bone fashion, as per design, to have a pitch so as to drain toward sewer inlet; the entire sides and bottoms of the tank and basin to be lined with pure Trinidad asphaltum ½ inch thick throughout.

The aquaria (30 in number), as shown on plans, to have ½ inch best asphalt coating throughout their inside surfaces, as will be directed; all metals, pipes, bolts, nuts, etc., coming in contact with salt water to be also thoroughly coated with asphaltum while hot. All this work must be done as directed by the architect in charge.

Do all other mason work required to complete the job and as directed by the architect in charge.

Carpenters' and cabinet-makers' work.—The materials used throughout to be of good merchantable quality, free of any defects, rot, knots, etc., and to be well seasoned throughout. The workmanship must be the best of its kind throughout; the general drawings and details furnished and directions given by the architect in charge must be strictly followed, and the whole work must be constructed and put up in a substantial and careful manner.

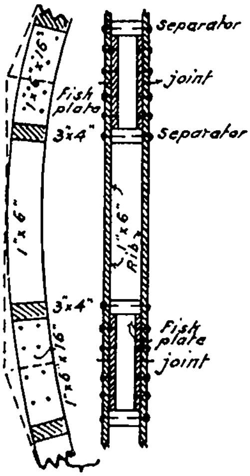
The framing of the entire structure is to be done with good quality of native (Georgia) pine, free of any defects; the timber must be sawed square, straight, and true, and to be thoroughly framed together as shown and directed.

The foundation for main posts of Exposition building shall be carefully lowered to such a depth and in a manner as and where shown on drawings. The gallery partitions are to be made in sections of 3 panel widths, mortised and tenoned together, and to be securely framed together as shown, put up in sections, so that they can be easily taken down, sections to be screwed together in a substantial manner and as directed; the grotto and rotunda walls and partitions to be framed together and substantially spiked, braced, and nailed; all partitions to have 3″ x 4″ studs, 16 inches on centers, framed to 3″ x 4″ top and bottom plates, to be held together on top with 2″ x 6″ ceiling joists, four to each bay, with 2″ x 4″ diagonal ties, all thoroughly toenailed, etc., all complete.

Groined ceilings of arches *a* and *b* and *c* each to have an eye at the apex, made with a circular drum in two sections of four pieces each, of 1″ x 10″ boards, joints framed and toenailed to curved ribs as shown; the curved ribs for groins to be made in two sections of 1′ x 4″ each, sawed to shape, joints broken, all thoroughly nailed with steel wire nails.

The curved main ribs to be spiked to 3½-inch turned uprights, around which plaster columns are built, extending from floor to ceiling, and to circular drums; to have horizontal and other curved ribs cut between as shown; the ribs to be well braced to uprights.

The curved ribs of the rotunda and the arches of entrances to be constructed of 1″ x 8″ boards, cut to shape in four sections (see diagram) to each rib, nailed to 1″ x 6″ x 16″ fish plates, and separated by blocks of 3″ x 4″ stuff, nailed with 10-penny steel-wire nails, clinched on the inside, 8 nails to each joint, all as shown; the ribs to be toenailed to curb plate and eye drum of dome, the drum to be made, in a similar manner as specified above, of 2 circular sections, each section to be of 4 pieces of 1″ x 10″ stuff, joints broken; the horizontal ribs to be made in a similar manner and cut between main ribs, etc., all complete, and all nailed with 10-penny steel-wire nails.



The platform supporting the aquaria to be constructed as shown, well braced, braces to be bolted to the uprights and horizontal pieces, etc., as directed, all complete.

The foundations for salt-water tank, filters, and pumps to be made as shown; parts of the flooring and floor joists of Exposition building floor are to be cut and taken up, these parts to be relaid in a proper manner, as directed.

The frames for the front entrances to be made, as shown, of substantial construction, similar to the other vaulting.

The carpenter is to do all cutting for other craftsmen, is to provide centers for vaulting and arches, scaffolding, and is to do all furring required to complete the job.

Front entrances, gallery, and rotunda walls to be faced from floor up to a line *d d d* (top of entablature) with ⅞-inch dressed best white poplar (*Liriodendron tulipifera*) or canoe wood, as shown and according to details; the pedestals, bases, columns, pilasters, panels, and entablatures to be faithfully carried out according to design; all to be fastened with screws to the studding so that they can be easily removed when desired; the caps of columns and pilasters, ornamental friezes and panels, and all others up to lines *d d d d* to be made of composition material (such as "Decoreo" or similar good compositions), according to details furnished or selections made from *catalogues;* the network and vases, etc., above entablature, as shown, to be also made of aforesaid composition material. The statuary and arches, including their ornamentation, will be of stucco, as specified below. All this work must be perfectly smooth, sandpapered to a proper surface, and made ready for a No. 1 ivory and gold finish.

The outside walls of the grottoes, seen from the interior of the Exposition building, shall be ceiled, shingled, and trimmed as shown on drawings, and finished for an ivory or white-zinc finish, as directed.

Flooring of ⅞ inch by 6 inch joined, square edge and milled stuff, to be laid on floor joists of aquaria passages and between aquaria, as shown; portions of said floors to be left loose, as directed. Do all other flooring required to complete the job.

Closets in aquaria passages to be made of one-inch milled stuff, tongued and grooved, one battened door to each, hung with substantial hinges and provided with substantial and neat closet rim lock and keys; the closets to have shelves and hooks, as directed.

Doors for front entrance and rotunda to be of white poplar 1¾ inches thick, hung to proper frames, to be made as shown, to have wired ground glass in the upper panels. Hang each with two loose-joint butts and fasten with 3-inch mortise lock, brass escutcheons, and knobs. These doors must be prepared to receive best ivory finish.

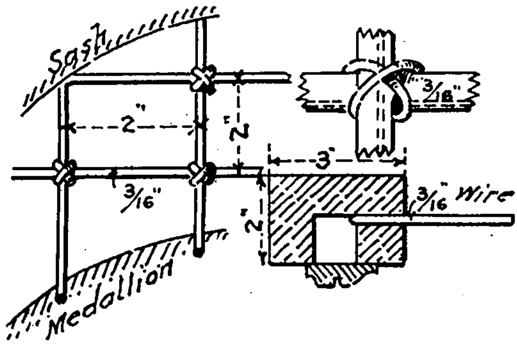
Semicircular windows to grottoes.—Frames to be made similar to ribs of groined vaulting, to be rabbeted to receive sash. Semicircular sash to be of 1¾-inch poplar, ogee molded. All these sash to have central molded frames and sash for inscriptions, etc., as shown. The central segment sash to be made and fastened so that it can be removed at any time. The windows shall be glazed with domestic cathedral glass of different tints, as per designs, laid in flat lead. The windows in dome of rotunda to have ogee molded 1¼-inch sash, glazed with ornamental ground glass, one plate to each; sash to be set in rabbeted and molded frames.

Screens of close-wired netting to be set to all outside windows; sash to be molded on the outside, etc., all as shown.

The roof of rotunda and extrados of entrance arches where exposed to the eye and as directed to be prepared for plastering.

Ventilators "V" of galvanized iron and of ornamental pattern to be put to all vaulting, rotunda, etc.

Semicircular grill, with medallions in tympana over main entrances.—Provide proper rabbeted frames for 2″ x 3″ semicircular molded sash made as shown, sash to be grooved to fasten $\frac{3}{16}$ wire grill-work of 2″ mesh thereto, wires to pass through suitable rings, 2 rings to each crossing, thus:



The medallions to be of No. 30 sheet iron, 11 oz. per square foot, and must have neatly molded frames, to which the sheet iron and vertical and horizontal wires are fastened, etc., complete in every particular, made ready for the painter.

The aquaria to be made as per details; sides, bottoms, and ends to be of a clear 2″ dressed cypress; the several pieces must be bolted together with ½″ wrought-iron bolts, as shown in details, the whole to be put together with white-lead joints and to have ¼-inch coat of best Trinidad asphaltum in the best manner. The fronts of the aquaria, of the best polished plate glass, 1″ in thickness, will be furnished by the U. S. Government and delivered in the Exposition building at Atlanta. The glass is to be set in a rolled steel frame, constructed of Carnegie "Z" bars, No. 19, 4½ lbs. to the foot, riveted together, countersunk to sides and bottom of aquarium and packed with two layers of ⅛-inch thick vulcanized rubber between said steel frames and glass. The double aquaria will have at their centers, where the two plate-glass fronts meet, a mullion of rolled steel "T" bar, Carnegie's No. 69, 10.9 lbs. to the foot, and to be properly connected to the "Z" frames.

Eighteen plates are required, each 3′ 0″ by 7′ 0″, and 12 plates each 3′ 0″ by 5′ 0″.

These aquaria to be provided with overflow and waste, etc., etc., as directed. The aquaria must be very carefully set up, warranted water-tight, and the glass must be protected during the progress of the work in a thorough manner, and the whole must be done according to details furnished and directions given. A neat ornamental frame of thin sheet iron is to be fastened around each glass front, as shown. Build frame for cascade, as shown, in a substantial manner.

The carpenter is to do all other carpenter work, such as bracketing for stucco and cement work, etc., required by the drawings and as directed by the architect in charge, and is required to complete the job.

CEMENT AND STUCCO WORK, WIRE LATH, ETC.

Wire lathing.—The walls of the grottoes, rotunda, and arches over entrances and all such parts of the walls not ceiled to be covered with good wire lathing in a thorough, workmanlike manner. Do all wire lathing for groins, cornices, ribs, and cassettes in rotunda, etc., all complete. The extrados of dome of rotunda is to be lathed with sound lath, properly nailed to top of ribs, to receive two coats of plain plastering.

CEMENT AND STUCCO WORK.

Slate.—The base in grottoes to be throughout 1¼-inch rubbed gray slate, 12 inches high, square finished; back up with plaster and properly fasten to framework.

Keen's cement and stucco.—From base up to springer line throughout put to a brown coat one good coat of pure Keen's cement, and from springer line up put one coat of finish, composed of one part of Keen's cement and three parts of best plaster of paris; all put to a well-floated brown coat. The stucco and cement putty for the walls and spandrils, also for the ribs of vaulting and ribs of cassettes of rotunda, for soffits and moldings of archivolts and stucco ornaments, caps, etc., are to be colored in mixing the various tints as directed by the architect in charge.

The molded work must be executed in artistic and first-class manner, sharp and true. All ornamental work and other enrichments must be of a high, artistic grade and of bold and realistic character. Models of clay of the various ornaments, statuary, etc., must be submitted for approval to the architect in charge before they can be executed.

The archivolts, moldings, and various ornamentations of the main entrances to be also executed in stucco, of the same material, and finished as grotto and rotunda, etc. The statuary, as shown, to be also of stucco; to be of a highly artistic finish and bold execution.

The several bidders are required to submit with their estimate a sample of stucco finish, about 6 inches square.

Portland cement work.—The cascade and fountain to be executed in best English Portland cement mortar (one part of cement and three parts of sand), according to designs. The exterior face of wall of fountain tank to be made in imitation of stone, as shown. The figures representing manatees and otter and other ornaments, rock, basins, etc., shall all be executed in cement after the models have been approved.

A model representing one of the bays of the vaulting can be seen at the United States Fish Commission office, in Washington.

All imperfections, either in execution of the designs and workmanship or damages from whatever cause, must be remedied and made good to the entire satisfaction of the architect in charge before the work will be considered complete.

Ironwork.—Provide rolled-iron T and Z bars, bolts, nuts, as shown on details for aquaria. Over large 14-foot aquaria provide and hang beams, where shown, to roof timbers, with 1-inch diameter wrought-iron rod, substantially put up, etc., all complete.

Provide substantial spikes, bolts, clamps, etc., wherever required to complete job.

Semicircular transoms of main entrances to be wired with medallions of No. 30 galvanized sheet iron, inserted as shown.

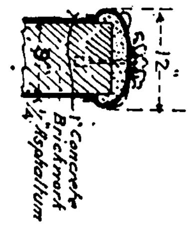
The doors for main entrances to be grill work of very light construction, as per design, representing network, etc., to be hung to jambs, with substantial brass butts fastened with neat locks and furnished with brass knobs, etc., all complete.

A cast-iron cap plate to be put to top of wall around tank for fountain in six sections, ½-inch metal, firmly bolted with three ½-inch expansion bolts, 8 inches long, to each section, to be of ornamental design, "Bower Barff" process (motive water lilies), as shown. See also diagram. Rosettes of cast iron representing water lilies, to be fastened, as shown, to top of cap.

A rail made of 2-inch gas pipe to be built around gallery, as shown, substantially made and fastened to floor, etc. This rail to be bronzed by painter.

Painting.—The painter's work will be executed in the very best manner and must be of a high artistic grade. The woodwork for gallery, main entrances, rotunda, etc., will receive a pure-white ivory color, semi-glossy, finished as follows: One coat of liquid filler as a primer, all imperfections filled with white-lead putty, then given two coats of French zinc-white, thinned with half and half boiled oil and turpentine, with patent drier to harden; the last coat to be smoothed up with sandpaper and the work brought up with two coats of flake white, ground in japan, thinned with Damar varnish. Three days must be allowed between the last two coats and four days after the last coat before rubbing. This work must be rubbed with pumice stone and water, left with a clean, fine surface.

Top View of Cap Plate.



The network on top of cornice, the several ornaments, caps, statuary, etc., to be picked out with gold-leaf gilding. The panels of the doors and moldings around panels and architraves to have a ½-inch strip of gold-leaf gilding. The ornamentation of the archivolts of the main entrances and rotunda, the caps of columns, the vases, statuary, etc., will be picked out in gold, as directed by the architect in charge. Put to the facia of the archivolts of main entrances flat ornaments, in colors and designs as chosen by the architect.

The medallions on entrances shall be emblazoned in a highly finished manner with the obverse and reverse coats of arms of the United States and the State of Georgia, as directed. The statuary will be painted in delicate tints and in such a manner as will be directed.

Grottoes.—The spandrils of the groined arches will be enriched with such ornaments and tints as to give a marine effect, etc. The dome of the rotunda and the cascade to have the cassettes, ribs, etc., tinted in different colors, as will be directed. The spandrils of the archivolts in the rotunda and panels will be painted so as to represent still-life scenery.

Do all other painting requisite to finish the work complete in every particular.

Final.—All plumbing for the aforesaid aquarium forms no part of this contract.

Specifications of material to be provided and of work to be done for and in the construction of an aquarium for the United States Commission of Fish and Fisheries exhibit at Atlanta, Ga.

The whole is to be done in accordance with these specifications and accompanying plans, prepared under the architect of the United States Fish Commission, and no deviation therefrom will be permitted unless authority in writing is first obtained from the representative of the United States Commission of Fish and Fisheries.

Any change of plans, etc., involving any difference in cost from that proposed by the contract must be agreed upon by the parties to this contract, with statement in writing as to the difference in price from that originally agreed upon.

Should it be deemed desirable during the construction of the proposed aquarium to make any additions to it or to do any extra work not contemplated or provided for by these plans and specifications, an agreement in writing, stating the nature and cost of such additional or extra work, must be entered into between the representative of the United States Commission of Fish and Fisheries and the contractor before such work is commenced. No claim for extra work or materials, excepting as above specified, will be considered.

Should it be deemed desirable to make any change from the plans and specifications during the progress of the work, which does not involve any additional expense to the contractor for labor and material, he will be expected to make such change without extra charge.

The work will be under the direction of the architect or other duly appointed agent of the board of management, United States Government exhibit, and in case any disagreement should arise between the agent in charge and the contractor as to the meaning or intention of any portion of these plans and specifications, the decision of the representative of the United States Commission of Fish and Fisheries upon said disputed point or points will be final

The work is to be commenced within ten days after signing of contract and is to be carried forward at such rate as shall insure its completion on or before August 10, 1895,

And it is understood and agreed by and between the parties hereto that if the contractor shall fail to comply with the terms of this contract which relate to the time within which said work is to be completed, the said contractor shall be subject to forfeit of fifty dollars per day for each and every day thereafter until the completion of the work by him, enforcement of the same to be made in the discretion of the representative of the Commission of Fish and Fisheries, which sum shall be deducted from any amounts which may be due the contractor; and if amount due contractor be not sufficient to meet the forfeit, then contractor to pay the difference or the money to be retained out of the bond given by the said contractor and his bondsmen.

Any failure to commence work within the specified time or to prosecute it thereafter at the rate and in the manner required will be considered as allowing the United States to annul the contract and declare a forfeiture of all reserved percentages and other dues or as allowing the United States, at the option of the representative of the United States Commission of Fish and Fisheries, to carry on the work at the expense of the contractor and as rendering him and his bondsmen liable for any increase of cost over that proposed and agreed upon.

In case the lowest price be named by two or more bidders, these bidders must agree between themselves, within twenty-four hours after notification, as to who shall have the award. If the question be not settled within the time stated, and the representative of the Commission of Fish and Fisheries so informed, he may select either of them to do the work at his discretion at said price.

Payment for the work will be made as follows, viz: After the end of each month, if the progress of the work is satisfactory, part payments will be made upon the written certificate of the agent in charge, reserving twenty per centum of the amount due, which will be retained until the final completion and acceptance of the work by the representative of the United States Commission of Fish and Fisheries. Within thirty days thereafter final payment for the work will be made.

The "instructions for bidders," as far as they may be applicable, are to be considered essential parts of these specifications.

The tools, scaffolding, etc., used by the contractor must be suitable for the work and satisfactory to the agent in charge. The scaffolding will be left in place until a written order for its removal is given by the agent in charge.

The contractor will protect the work and materials from damage during the progress of operations, and will clear, from time to time, as may be necessary, all dirt and rubbish resulting from the work. On completion, he will thoroughly clean all floors and windows, remove all débris, and have the premises in good order, ready for use, and satisfactory in every respect to the superintending Government officer, to whom he will then turn over the entire aquarium.

The contractor shall furnish all necessary plants, materials, and labor. He shall allow agent of Fish Commission in charge of the work full access to all parts of the work at all times, and shall give the agent any and all assistance which he may need.

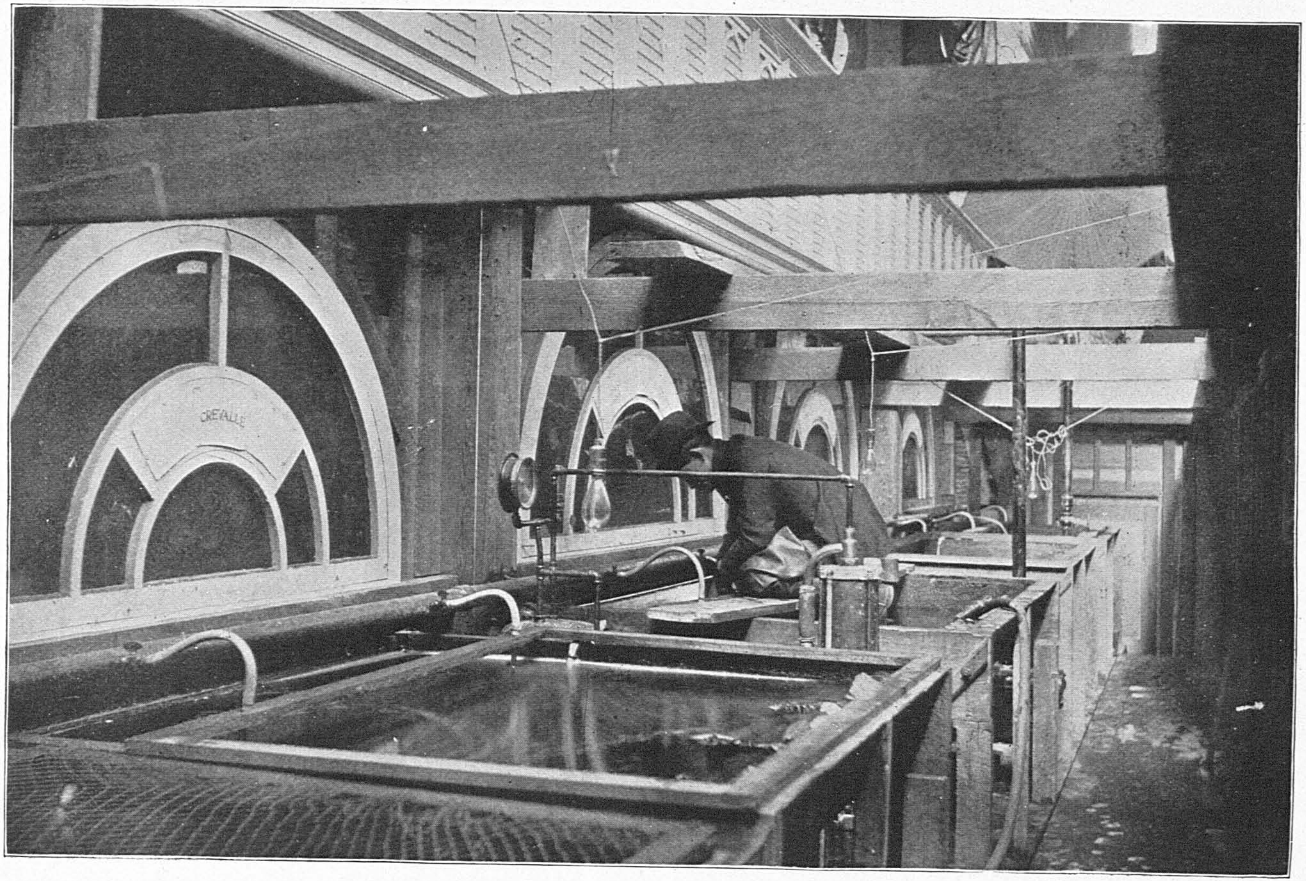
All materials furnished for the work must be first class of their kind and satisfactory to the agent in charge. Any materials not satisfactory will be condemned, and must be removed from the location of the work and not be again brought upon the ground.

All workmanship must be first class, and any work not so must be corrected immediately upon the request of the Government agent in charge.

Except when otherwise specified, the lumber and timber used will be well seasoned and of the best kind and quality used for similar purposes at or near the locality where the aquarium is to be built, all subject to approval of superintending officer.

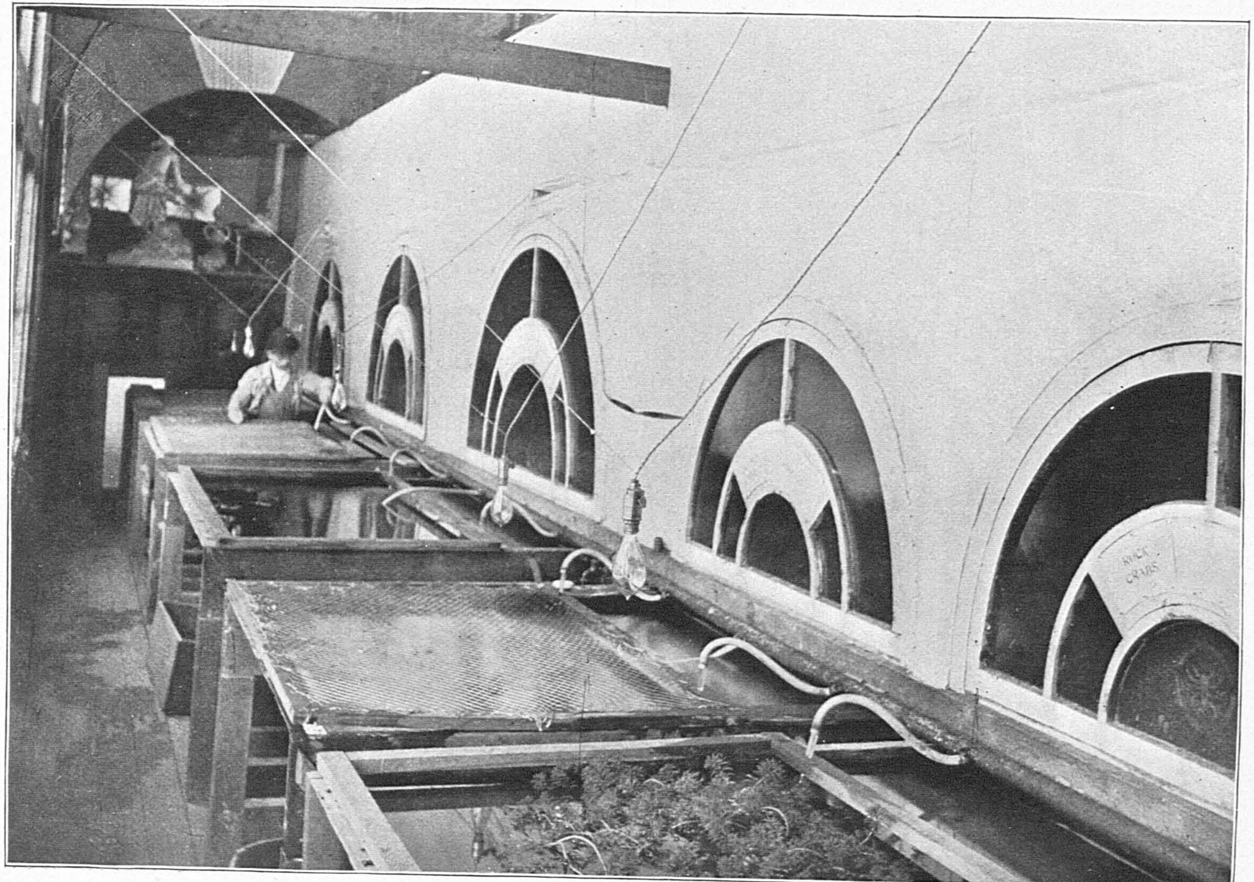
Where figures are given in the drawings they will be followed; otherwise scale dimensions will be the guide.

The contractor shall, in the fulfillment of this contract, take no advantage of any omission or incompleteness in these specifications or in the accompanying plans, as full explanations and detail drawings will be furnished him when required.



BACK VIEW OF SALT-WATER AQUARIA, SHOWING AIR-PUMP, ETC.

PLATE 21.



BACK VIEW OF FRESH-WATER AQUARIA.

Report U. S. F. C. 1896. (To face page 168—2.)

U. S. COMMISSION OF FISH AND FISHERIES,
JOHN J. BRICE, Commissioner.

NOTES

ON THE

EXTENSION OF THE RECORDED RANGE OF CERTAIN FISHES OF THE UNITED STATES COASTS.

BY

HUGH M. SMITH and WILLIAM C. KENDALL.

Extracted from Report of Commissioner for 1896. Appendix 2, Pages 169 to 176.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1897.

2.—NOTES ON THE EXTENSION OF THE RECORDED RANGE OF CERTAIN FISHES OF THE UNITED STATES COASTS.

By Hugh M. Smith and William C. Kendall.

In the Bulletin of the United States Fish Commission for 1894 notes were presented on nine marine and fresh-water fishes, the extension of whose known distribution on the Atlantic coast we were able to record. The present paper, which is based on collections and observations by assistants of the Fish Commission, is intended to embody similar information for nineteen additional fishes inhabiting the Atlantic and Pacific coasts of North America.

Tetronarce occidentalis Storer. *Torpedo; Crampfish.*

This large and curious electric ray has an assigned range on the eastern coast of North America from Cape Cod to Cuba. Drs. Goode and Bean have noted[1] its occurrence near Thatcher Island, off Cape Ann, Massachusetts, and at Lanesville, Mass. On several occasions it has been observed farther north and east than Cape Ann. Mr. F. S. Conley, first mate of the United States Fish Commission schooner *Grampus*, states that about 1880, while on a mackerel vessel off Seguin, on the coast of Maine, in longitude 69° 40′ W., he saw a torpedo caught in a purse seine with mackerel. The fish was about 3½ feet long, and severely shocked a fisherman who attempted to handle it. Mr. G. F. O. Hanson, second mate on the *Grampus*, says that in the summer of 1890, while on a vessel on La Have Bank, off Nova Scotia, in longitude about 64° W., a torpedo was taken on a line set for cod. Mr. Charles Pye, of Wood Island, Maine, states that in 1894 he caught a torpedo in his trap, and that not infrequently torpedoes have been taken in traps at Bald Head and vicinity.

Myxine glutinosa Linnæus. *Hagfish; Slime Eel.*

This fish-like vertebrate inhabits the North Atlantic Ocean, and is found on the northern coast of both Europe and America. On the shores of the United States the recorded southern limit of its range is Cape Cod, Massachusetts, although Dr. Goode states that in deep water it may occur even farther south. During the tilefish investigations of the *Grampus* in 1892 a specimen of hagfish was taken off the coast of Delaware in September. The fish was caught on a trawl line set in about 75 fathoms, in latitude 39° and longitude 72°.

[1] Amer. Jour. Sci. and Arts, XVII, 1879, p. 48.

Scarus cœruleus (Bloch). *Parrot-fish.*

This species is common in the West Indies. A single young specimen has been taken at Key West, Fla.* The blue parrot-fish, like other members of the family, inhabits chiefly tropical waters, ordinarily lives about coral reefs, and attains a large size. Its northern range heretofore recorded is southern Florida. It is now possible to record its capture as far north as Chesapeake Bay and the Potomac River.

In the latter part of August, 1894, a pound net set in the Potomac River off St. George Island, Maryland, took a parrot-fish that weighed about 8 pounds. The fish was seen by a number of Washington people, and Dr. A. S. Helton, of that city, has given a description of the life colors. The upper parts were of a dark greenish blue, the belly white, which color extended to and included the beak; the fins were dark green, almost black. Mr. H. C. Hazard, of Washington, presented the jaws of the specimen, and stated that the fish had a dark-bluish back, somewhat like the Spanish mackerel, and white underparts. This fish was unknown to the fishermen of this region, who had never seen it before. It is reported, however, that two years before a similar fish was taken on a hook.

The jaws of this fish were sent to Prof. David S. Jordan for examination; from their shape and color and from the description of the fish he identified the specimen as *Scarus cœruleus.*

Thinking that as this fish had been found in the Potomac River it would also be taken in some of the numerous pound nets in the lower part of Chesapeake Bay, an illustration of a parrot-fish and an inquiry whether any had been caught in that region were sent to Mr. J. E. N. Sterling, of Cape Charles City, Va. He replied that from 6 to 10 fish resembling the figure and corresponding with our description were obtained in pound nets between Cape Charles and Hunger Creek in August and September, only one being caught at a time.

Kirtlandia laciniata (Swain). *Silverside; Silver-fish.*

This species, formerly designated as *Menidia vagrans laciniata*,† is now regarded by Jordan & Evermann as distinct from *vagrans* and has been included with the latter in the newly constituted genus *Kirtlandia* of these authorities in their current work on the fishes of North and Middle America,‡ the proof sheets of which have been examined. *Kirtlandia* is distinguished from *Menidia* by the presence of laciniate or gashed body scales and of scales on the anal and dorsal fins. The habitat of the species is given § as Virginia to South Carolina, the genus being represented on the Gulf coast by *K. vagrans*. The range of this fish is

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*Proc. U. S. Nat. Mus. 1884, p. 137.
†Synopsis of the Fishes of North America, by Jordan & Gilbert. Bull. 16, U. S. Nat. Mus., p. 908.
‡Bulletin 47, U. S. National Museum.
§Loc. cit.

now extended northward to Delaware Bay. In May, 1895, a number of specimens were taken at Cape Henlopen, Delaware, which are now in the Fish Commission collection.

Epinephelus niveatus (Cuvier & Valenciennes). *Snowy Grouper.*

Three small groupers collected at Woods Hole, Mass., in 1895, by Mr. V. N. Edwards, of the United States Fish Commission, are identified as *Epinephelus niveatus*. Mr. Edwards writes that during the summer of 1895 he saw 8 or 10 other specimens that had been caught in lobster pots at Cuttyhunk, Menemsha, and Edgartown. In his long-continued observations in the Woods Hole region he had never known of the previous occurrence of this species in that vicinity.

Two of the foregoing specimens, 2¾ and 1¼ inches long, respectively, taken September 23, 1895, are now before us. The larger example presents the following colors in alcohol: Body and head, reddish brown; body with 4 longitudinal rows of small pale-blue spots (smaller than pupil), one row along base of dorsal fin, one along lateral line, and two below line; caudal and pectorals white, anal and dorsal dark, ventrals black. The body color of the smaller fish is very dark brown, almost black; the pale spots are scarcely distinguishable; the anal, ventral, and dorsal fins are jet black, with the exception of the edge of the soft dorsal, which is white; caudal and pectoral fins white.

Mr. Edwards contributes the following note on the life colors of the specimens collected or observed by him; the body spots, which Mr. Edwards states are lemon yellow, have heretofore* been referred to as light blue or bluish white in color, which is the case in alcoholic specimens: Body, chocolate brown; pectoral and caudal fins, lemon yellow; a large black spot on caudal peduncle; spots on body, lemon yellow; on some specimens there were 16 to 18 spots, on others 35 to 40; in some examples there were twice as many spots on one side of the body as on the other.

This is a tropical species. Its normal range is the West Indies to Brazil. On a number of occasions, however, it has been obtained in Rhode Island waters. In 1861, under the name *Hyporthodus flavicauda*, Dr. Gill described† a young specimen of this species taken at Newport, R. I. In 1879 Drs. Goode and Bean recorded‡ the capture of another specimen at the same place in 1877.

Three additional specimens of this species from Rhode Island are in the United States National Museum; one (No. 32320), 2½ inches long, is from Tiverton, the other two (No. 39161), 3 and 3¼ inches long, were taken at Point Judith.

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* Synopsis of Fishes of North America, by Jordan & Gilbert.—Catalogue of the Perciform Fishes in the British Museum, by G. A. Boulenger.

† Proc. Acad. Nat. Sci. Phila. 1861, p. 98.

‡ Amer. Jour. Sci. and Arts, XVII, 1879, p. 45.

Centropristis striatus (Linnæus). *Black Sea-bass; Blackfish.*

The assigned distribution of this species is Cape Ann, Massachusetts, to northern Florida.* The range is now known to reach the western part of the coast of Maine. On July 7, 1896, a specimen was obtained in a trap at Wood Island, Casco Bay, Maine, and Mr. Charles Pye, the owner of the trap, reports that he catches more or less sea bass each year. It is possible that this species ranges as far south as Key West. A fish locally known about that place as "tallywag" or "tallowag" has been identified by Dr. Jordan and several other persons as a sea bass; it is said by the fishermen to be very rare.

Seriola dumerili (Risso). *Amber-fish; Amber-jack.*

The range of this species in the western Atlantic Ocean is given* as West Indies north to Key West and Pensacola. The Fish Commission collection contains two specimens of *Seriola* from Woods Hole, Mass., which Professor Evermann concurs with us in identifying as *dumerili.*

The larger example, 13 inches long, was collected August 15, 1892. It presents the following features, some of which serve to distinguish this species from *S. lalandi*, the fish it most closely resembles: Depth 3, head 3½, eye 4¾. D. VII–I, 32; A. II–I, 19. Head longer than deep, the profile not steep. Dorsal and anal not falcate. Color in alcohol: body faint dusky above, pale yellowish below, fins all plain.

The smaller specimen, 7¾ inches long, was taken September 12, 1892. Depth 3¼, head 3½, eye 5½. D. VII–I, 32; A. II–I, 19. Color in spirits: dark on back, pale below; 6 broad black vertical bands across body, the first behind gill opening, the last on caudal peduncle; a broad dark band from front of eye to dorsal; a dark area on margin of preopercle; spinous dorsal black; portion of soft dorsal above second pale interspace and third dark crossband black with pale-tipped rays; other part of soft dorsal and anal pale, with fourth and fifth vertical body bands continued on them; pectorals pale; ventrals black, with white rays; caudal dusky yellowish at base, grading into black on lobes, the latter with pale tips.

Bothus maculatus (Mitchill). *Window-pane; Sand Flounder.*

A specimen of this fish was taken in a weir at Freeport, Me., Casco Bay, in the fall of 1891. It was seen and identified by one of the writers, but was not preserved. In July, 1896, a dozen or more specimens were obtained in traps at Wood Island, Casco Bay. The fish is known as "plaice" in that vicinity. The range usually ascribed to it is the Atlantic coast of the United States from Cape Cod to South Carolina.† It appears, however, that as early as 1873 specimens now in the National Museum were collected in Casco Bay (U. S. N. M. No.

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*A Check-list of the Fishes of North and Middle America, by Jordan & Evermann. Report U. S. Fish Commission, 1895.

†See a Review of the Flounders and Soles (Pleuronectidæ) of America and Europe. By David S. Jordan and David K. Goss. Rept. U. S. Fish Com. 1886, pp. 225–342.

13911) and later at Bucksport, on the Penobscot River (No. 22273); and it is reported that in 1880 a specimen was taken in Passamaquoddy Bay.*

Pseudopleuronectes americanus (Walbaum). *Winter Flounder; Mud Dab; Common Flatfish.*

The recorded range of this species is Labrador to Chesapeake Bay.† It is very abundant on the coast of southern Massachusetts and the Middle States, but not common in the Chesapeake. Dr. Goode states that "small quantities are brought to Washington in winter from the mouth of the Chesapeake."

The Fish Commission has recently received from Messrs. J. F. Miller & Son, of Asheville, N. C., a specimen of winter flounder about a foot in length, which was shipped to them in February from Newbern, N. C., among a lot of other food-fishes taken in the vicinity of that place. Newbern is on the Neuse River, about 30 miles above its entrance into Pamlico Sound.

This species has previously been reported from Beaufort, N. C., by Dr. H. C. Yarrow.‡ Mr. Barton A. Bean, assistant curator of fishes in the United States National Museum, states that there is in the museum collection a specimen (No. 5271) of this species from Savannah, Ga., collected by Prof. L. Agassiz.

Diodon hystrix Linnæus. *Porcupine-fish.*

This inhabitant of the tropical seas has not heretofore been recorded north of Florida on the Atlantic coast. On August 12, 1895, Mr. V. N. Edwards, of the United States Fish Commission station at Woods Hole, Mass., took a specimen in Buzzards Bay, near the station. This example, which is now at hand, is 9½ inches long.

Spheroides maculatus (Bloch & Schneider). *Puffer; Swell-toad; Blower.*

Two specimens of this puffer taken in trap nets in Casco Bay, Maine, on June 26 and July 12, 1896, were observed by W. C. Kendall. Cape Ann, Massachusetts, is the northern limit of the range of this fish heretofore given.§

Alosa sapidissima (Wilson). *Shad.*

As the result of plants of shad fry made in the Sacramento and Columbia rivers a number of years ago, this fish has become distributed along practically the entire west coast of the United States. Within a few years it has appeared in the rivers of British Columbia, where it is annually becoming more numerous; in 1891 the first shad was

* Fishery Industries of the United States, Section I, p. 199.
† Ibid., p. 182.
‡ Proc. Acad. Nat. Sci. Phila., 1877.
§ Check-list of Fishes of North and Middle America. Rept. U. S. F. C. 1895.

taken in Fraser River; in 1892 the fish was reported from Rivers Inlet in latitude 51° 30′.

The further extension of the shad's range to the north and west may be recorded. Mr. John C. Calbreath, of Fort Wrangell, Alaska, in a letter to the special agent of the Treasury Department for the protection of the Alaskan salmon fisheries, refers to the taking of two shad in the Stikine River in 1891. The mouth of this stream is near Wrangell Island in latitude 56° 30′. Mr. C. H. Townsend, naturalist on the United States Fish Commission steamer *Albatross*, informs us that in 1895, while at Sitka, a specimen of shad was received that had been obtained at Fort Wrangell; whether taken on Wrangell Island or in the Stikine River could not be ascertained. This specimen is now in Washington. It is a female, in fine condition, 15½ inches long and weighing 2 pounds.

While the existence of the shad on the Pacific coast is due to the fry planted in the Sacramento River about twenty-five years ago, the distribution of the fish from the original stream has been natural, and it seems proper to notice in this place the remote point to which the shad has voluntarily migrated. The fish has been taken as far south as San Pedro, in Los Angeles County, Cal. The Stikine River and San Pedro are about 2,700 miles apart.

Roccus lineatus (Bloch). *Striped bass; Rockfish.*

This species falls in the same category as the shad. Artificially introduced into the Sacramento River in 1879 and 1882, it has gradually extended its distribution north and south of the Golden Gate, although much less widely than the shad. On the north the limit of its range seems to be the Russian River, although there is no reason to doubt that in time it will be found along the entire coast of Oregon and Washington. For many years Monterey Bay marked the southern extreme of the distribution of the striped bass on the Pacific coast. In September, 1894, however, two, weighing 6 pounds each, were taken in a seine at Redondo Beach, in Los Angeles County, this point being over 350 miles south of Monterey Bay, following the coast line. The known range of this fish now embraces about 575 miles of the California coast.

Rhombus triacanthus (Peck). *Butter-fish.*

This species, the common butter-fish of the Atlantic coast, has an ascribed habitat extending from Maine to Florida. No account of its occurrence on the coast of Nova Scotia has been met with, and therefore the following information is believed to considerably extend the known range of the fish. On May 17, 1895, the United States Fish Commission schooner *Grampus* took two small butter-fish in a tow net, about 14 miles south of Liverpool, in latitude 43° 50′ N., longitude 64° 39′ W. They were about ¾ inch and 1 inch long, respectively. They were retained alive on the vessel for some time, but were accidentally devoured by some isopods (*Idotea*) taken at the same time.

Apeltes quadracus (Mitchill). *Four-spined Stickleback.*

In his Catalogue of the Fishes of the East Coast of North America,* Dr. Gill gives the range of this species as New Brunswick to Florida. Jordan, in his Manual, states that it is found from New Jersey to Labrador. The taking of any specimens that indicate its occurrence as far south as Florida or anywhere south of Chesapeake Bay is not known; the most southern point from which it has heretofore been recorded is the Patapsco River, Maryland, at the head of Chesapeake Bay. Uhler & Lugger † state that this fish runs in the Patapsco River some distance beyond the tide, and cite specimens in the collection of the Maryland Academy of Sciences. This record seems to have been overlooked by recent writers.

We now record the taking of specimens of this fish by W. C. Kendall at two points in the lower Chesapeake. On July 18, 1892, numerous examples were collected at the mouth of Windmill Creek, near the mouth of Rappahannock River, Virginia. In March, 1893, the fish was found to be abundant in salt-water creeks about Hampton, Va.

This species is usually regarded as inhabiting only salt water. It is seen, however, to occur in the fresh waters of the Patapsco, and in parts of Maine it is also found in fresh water. Thus, on August 24, 1895, several specimens were obtained on Chickawaka Lake, which supplies water to Rockland; and in Meadow Brook, the outlet of the lake, numerous specimens were taken over 2 miles from salt water.

Stenotomus chrysops (Linnæus). *Scup; Scuppaug; Porgy.*

Dr. Goode, in his Natural History of Aquatic Animals, says that the "northern scup rarely pass the boundary of Cape Cod; in 1878, however, 37 were taken at the Milk Island weir off Thatcher Island, Cape Ann, Massachusetts, and they appear to be increasing in abundance."

In 1895 a few scup were caught in a mackerel trap in Gloucester Harbor, and several were also reported to have been taken the previous year. Prior to that time, however, none had been observed for many years, according to the testimony of the local fishermen.

During the months of June and July, 1896, scup were common near Small Point, Casco Bay, Maine, and specimens were also taken daily between June 25 and July 14 in traps.

Prionotus carolinus (Linnæus). *Sea-robin; Common Gurnard.*

Between July 4 and 14, 1896, more than 25 specimens of this fish were observed by W. C. Kendall in trap nets in Casco Bay, near Small Point, Maine. It is known as "robin" in that region. No species of sea-robin has heretofore been reported from the Maine coast. It has previously been obtained as far north as Cape Ann, Massachusetts,

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* Rept. U. S. Fish Com. 1871-72.
† List of Fishes of Maryland. Report Maryland Fish Com. 1876, p. 121.

whence it ranges to South Carolina. None of the other representatives of this genus found on the eastern coast of the United States (*P. scitulus, alatus, strigatus, evolans, tribulus*) is recorded north of Cape Cod.

Siphostoma louisianæ (Günther). *Pipefish.*

The range of this species was formerly given as Virginia to Texas.* In their recent revision of the pipefish family,† Jordan & Evermann assign *Siphostoma louisianæ* to the coast section between North Carolina and Texas, although it now appears that the occurrence of the species in the Chesapeake Basin has been determined. Two specimens obtained by the schooner *Grampus* on July 19, 1892, in Kings Creek, at Cape Charles City, Va., are in the Fish Commission collection.

Cryptacanthodes maculatus Storer. *Wrymouth or Ghostfish.*

A specimen of this rather rare fish was taken at Woods Hole, Mass., on December 18, 1896. It is 18 inches long and presents the typical coloration and markings. The southern limit of its range given in recent literature is Cape Cod.‡ The species was described by Storer in 1839 from a specimen taken on the Massachusetts coast. Linsley§ gives the fish in his Catalogue of the Fishes of Connecticut, and remarks that a spotted wrymouth 13 inches long was taken at Bridgeport in 1842. This record seems to have been overlooked in recent references to the fish.

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* Synopsis of the Fishes of North America, 1882.
† Fishes of North and Middle America, 1896.
‡ Ibid.
§ Silliman's Journal, vol. xlvii.

U. S. COMMISSION OF FISH AND FISHERIES,
JOHN J. BRICE, Commissioner.

NOTES

ON THE

FOOD OF FOUR SPECIES OF THE COD FAMILY.

BY

WILLIAM C. KENDALL.

Extracted from Report of Commissioner for 1896. Appendix 3, Pages 177 to 186.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1897.

3.—NOTES ON THE FOOD OF FOUR SPECIES OF THE COD FAMILY.

BY W. C. KENDALL, A. M., M. D.,
Assistant, United States Fish Commission.

INTRODUCTION.

The relation of animals to their food supply offers a problem to the student of natural history the solution of which would contribute much to the knowledge of animal distribution. It is this relation that brings animals most intimately into touch with each other, and the influence of even one species is so far-reaching that an ever-widening field is opened to the view of the investigator.

The food supply is one of the most important factors affecting the abundance of fishes in any locality, whether they be the so-called migratory and anadromous fishes or the more or less permanent residents. The phenomena of the withdrawal of certain fishes from a region where they have been abundant, the presence of large numbers one year and their scarcity the next, their disappearance for long periods and their sudden reappearance, might be explained by a study of the food and feeding habits of the species.

In the investigations which the United States Fish Commission has been conducting for a number of years relative to the food and feeding habits of the mackerel, menhaden, and other marine fishes, considerable knowledge has been acquired; yet the conditions and influences are so manifold and complicated that much remains to be learned. To the writer, however, there seems no doubt that the effect upon the food of mackerel of prevailing winds, varying currents, and temperature determines to a great extent whether their movements be in or off shore, at the surface, or some distance beneath.

The occasional absence of menhaden for several years from a given section and their sudden return, though at present attended with some mystery and ascribed to various causes, is a problem which can best be solved by the study of their food and the conditions which influence it.

In short, it seems reasonable to believe that the food supply is a controlling power, modified more or less by other forces, affecting directly or indirectly the movements and abundance of all fishes.

This paper treats of the food of a few of the more important members of the cod family—commercially the most valuable group of fishes found on the Atlantic coast of North America—and consists chiefly of a record of an examination of the stomach contents of numerous specimens taken on the shores of the New England States and the Canadian maritime provinces.

THE COD FAMILY.

The cod family or *Gadidæ* is principally represented on the Atlantic coast of the United States by the following species, which have the stated geographical range in the Western Hemisphere:

Cod. *Gadus callarias* Linnæus. Greenland to Virginia.
Tomcod; Frostfish. *Microgadus tomcod* (Walbaum). Labrador to Virginia.
Pollock. *Pollachius virens* (Linnæus). Atlantic coast, south to New Jersey.
Spotted Codling. *Phycis regius* (Walbaum). Atlantic coast, south to Cape Fear.
White Hake. *Phycis tenuis* (Mitchill). Atlantic coast, south to Virginia.
Squirrel Hake. *Phycis chuss* (Walbaum). Atlantic coast, chiefly northward.
Chester's Hake. *Phycis chesteri* Goode & Bean. Off the Massachusetts coast.
Earll's Hake. *Phycis earlli* Bean. Off coast of South Atlantic States.
Cusk. *Brosmius brosme* (Müller). Polar regions south to Cape Cod.
Haddock. *Melanogrammus æglifinus* (Linnæus). North Atlantic coast, south to Middle States.
Four-bearded Rockling. *Rhinonemus cimbrius* (Linnæus). North Atlantic, south to New England coast.

A number of other species, mostly of small size and inhabiting the deep seas, occur in the western Atlantic and are sometimes taken on the United States coast, but they are of no commercial value.

The more important economic species are the cod, white hake, haddock, pollock, cusk, and tomcod.

The species of the cod family, though not usually classed with migratory fishes, have movements from one feeding-ground to another, and in some localities a winter bathic movement.

How far the cod may go in search of new feeding-grounds is not known. There are a few observations which show that occasionally, at least, they may travel long distances, but the reason therefor can not be positively stated. Thus in "The Fishery Industries of the United States"* reference is made to the occurrence of a large school of cod on the New England coast, especially at Cape Ann during the winter of 1877–78. In some of the fish caught were found hooks differing from any used by New England fishermen, but identical with those used by French trawl fishermen on the Grand Banks.

Mr. F. S. Conley, first mate of the United States Fish Commission schooner *Grampus*, states that during the winters of 1892–93 and 1893–94, while taking cod eggs at Kittery Point, Me., he saw the same kind of French trawl hooks taken from the stomachs of cod caught in Ipswich Bay, Massachusetts, and was told that this was not an uncommon occurrence. This would indicate that for some reason the fish had migrated from the Grand Banks to Cape Ann, a distance of about

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* Section I, Natural History of Aquatic Animals.

800 miles. Since these hooks were galvanized, it would be impossible to form any estimate of how long they had been in the fish. It is hard to conceive of any reason for these migrations, other than the search for food.

It would be interesting to know to what extent the winter movement of cod into deeper water is due to the effect of a change of temperature directly upon the fish or to the change of food conditions.

The cod and haddock are more commonly found on the rocky and hard bottoms, the so-called banks and ledges. Hake are considered to prefer mud bottoms, and it is true that at certain seasons they resort to such, but do not confine themselves to the bottom, very frequently approaching the surface, which habit is common to nearly all bottom fishes. Surface-swimming animals are frequently found in their stomachs.

FOOD OF THE COD, HADDOCK, HAKE, AND POLLOCK.

During the summer and fall of 1893, while a party consisting of Mr. H. F. Moore, of the University of Pennsylvania, Mr. B. L. Hardin, of the United States Fish Commission, and the writer were stationed at Eastport, Me., the habits of the various fishes of this locality were studied. Through the kindness of Mr. Spear, a local fish-dealer, it was possible to examine many stomachs of cod, haddock, hake, and pollock, brought to the Eastport fish market, chiefly from Quoddy Bay, West Quoddy, between Campobello and Grand Manan, and Cochran Ledge in Eastport Harbor. Cod, haddock, and pollock were also caught at Eastport by members of the party and their stomachs examined. The greater number of stomachs of adult fishes were empty, but when food was present it did not differ materially in kind or quantity in the fishes from the several localities.

The diet of the cod and haddock was much alike, though frequently enough difference existed to distinguish the species of fish. Often both fishes had made a hearty meal upon pieces of herring, probably gleaned from the fishermen's hooks. The animals most frequently found in cods' stomachs were crabs, mollusks, and young fishes; in the haddocks' stomachs there usually was a preponderance of brittle stars, small sea-urchins, and mollusks, though both contained more or less of the same species. Particular attention was paid to the food of the young of any of the cod family that could be obtained. The food of young cod and hake 2 or 3 inches long consisted principally of small crustaceans, such as amphipods and copepods, while young pollock were found to subsist almost wholly upon shrimp-like crustaceans (*Thysanopoda*).

Of the species enumerated in the appended list only the larger crustaceans, mollusks, brittle stars, and small sea-urchins were found in any degree of abundance. The smaller forms consisted of only a few individuals which were probably ingested with the larger and more noticeable objects. Cod and haddock, however, may browse upon algæ, hydroids, etc., for the sake of the small crustacea, mollusks, and worms attached to them.

Protective mimicry seems of little avail against these fishes, as the ophiurans, which so much resemble in color the rocks, sand, and algæ among which they live; the caprellas, almost indistinguishable from the hydroids and algæ; and fishes that simulate the color of the rocks and plants are frequently obtained from cod stomachs. Foreign objects, too, are occasionally found in the stomachs and are a source of wonder to the fisherman. Rocks, pieces of wood, etc., are not uncommon; a piece of rope was found in a cod stomach, and the entire globe of an incandescent electric light was removed from the stomach of a pollock.

The pollock examined had been feeding almost exclusively upon a shrimp-like animal (*Thysanopoda*) and prawns. The thysanopodas were very abundant at Eastport during the season mentioned and large schools of pollock of nearly all sizes were very numerous, feeding upon them. If at any time the crustacean disappeared from a place the large pollock disappeared also. The small fish remained in large numbers about the wharves.

The contents of the hake stomachs examined consisted almost uniformly of thysanopodas and prawns (*Pandalus*).

The amphipods were identified mainly by the aid of Stimpson's "Invertebrates of Grand Manan," the nomenclature in that paper being adopted, with the exception of a few species identified by the means of Verrill's "Invertebrates of Vineyard Sound." Doubtless some of these names have become synonyms, but it is thought that anyone desiring to know the recent names of the amphipods enumerated in the list will be able to find them.

Thanks are tendered Mr. James E. Benedict, assistant curator of marine invertebrates of the United States National Museum, for verifying the identifications of the crabs and for identifying the annelids; and to Mr. Charles T. Simpson, of the National Museum, for verifying the identifications of some and identifying others of the mollusks.

The following list of the animals found in the fish stomachs comprises the technical name of the species, the name of the fish in which it was found, the locality where the fish was caught, and the date when taken. Notes are also added upon the stomach contents of a few cod and haddock caught by the United States Fish Commission schooner *Grampus* in 1894 and 1895 on the New England and Nova Scotia coasts and in the Gulf of St. Lawrence.

List of animals found in fish stomachs, showing technical name of species, name of fish in which it was found, locality where fish was caught, and date when taken.

EASTPORT COLLECTION.

Hydroids.

Sertularia, sp.
Sept. 12, haddock, market.
Oct. 6, 11, haddock, Cochran Ledge.

Sertularia argentea.
Sept. 23, cod, market.

Hydroids were frequently found in the stomachs, but in such condition that no attempt at identification was made.

Echinoderms (Starfishes, Sea-urchins, etc.).

Pentacta frondosa. Sea-cucumber; Pumpkin.
Aug. 28, haddock, market.
Oct. 18, cod, Quoddy Reef.

Strongylocentrotus dröbachiensis. Sea-urchin; Sea-egg.
Aug. 3, haddock, between The Wolves and Grand Manan.
Aug. 7, haddock, Head Harbor.
24, haddock, Head Harbor.
24, haddock, Eastport.
28, haddock, market.
Sept. 1, haddock, Cochran Ledge.
Sept. 2, haddock, Eastport.
4, haddock, West Quoddy.
12, haddock, Eastport.
12, cod, market.
Oct. 6, haddock, Cochran Ledge.
Oct. 11, haddock, Cochran Ledge.
Oct. 17, haddock, Quoddy Bay.
23, haddock, Keat Harbor.
25, haddock, Storer Ledge, between Harbor De Lute and Cherry Island.

Asterias vulgaris. Starfish.
Aug. 24, haddock, ———.
Oct. 17, haddock, Head Harbor.

Cribrella sanguinolenta.
Aug. 17, haddock, Eastport.

Solaster endeca.
Sept. 2, haddock, Eastport.

Crossaster papposa.
Oct. 24, haddock, Head Harbor.

Ophiopholis aculeata. Feather star; Brittle star; Serpent star.
Aug. 24, haddock, Eastport.
28, haddock, The Race, Eastport.
Sept. 1, haddock, Cochran Ledge.
2, haddock, Eastport.
4, haddock, West Quoddy.
———, cod, Eastport.
5, cod, Cochran Ledge.
12, cod, market.
12, haddock, Eastport.
23, cod, market.
Oct. 6, cod, Cochran Ledge.
6, haddock, Cochran Ledge.
6, haddock, The Race.

Echinoderms (Starfishes, Sea-urchins, etc.)—Continued.

Ophiopholis aculeata—Continued.
Oct. 11, haddock, Cochran Ledge.
11, haddock, The Race.
17, haddock, Eastport.
17, haddock, Quoddy Bay.
20, cod, Head Harbor.
21, cod, Yellow Rock.
23, haddock, Head Harbor.
24, haddock, Head Harbor.
25, haddock, Storer Ledge, between Harbor De Lute and Cherry Island.

Ophiopholis elegans. Brittle star.
Aug. 3, haddock, between the Wolves and Grand Manan.
Aug. 17, haddock, Eastport.
24, haddock, Eastport.
28, haddock, market.
Sept. 1, haddock, Cochran Ledge.
2, haddock, Eastport.
4, haddock, West Quoddy.
Oct. 17, haddock, Quoddy Bay.
23, haddock, Head Harbor.
24, haddock, Head Harbor.
25, haddock, Storer Ledge.

Ophioglypha sarsii. Serpent star.
Aug. 3, haddock, between The Wolves and Grand Manan.

Of echinoderms, the most common forms found were, first, *O. aculeata*, and second, *S. dröbachiensis*. Holothurians were very scarce and other species of starfishes were uncommon.

Mollusks.

Saxicava arctica.
Oct. 6, haddock, Cochran Ledge.

Cardium islandicum.
Sept. 4, haddock, West Quoddy.

Cardium pinnulatum.
Sept. 1, cod, Cochran Ledge.
2, haddock, Eastport.
4, haddock, West Quoddy.
Aug. 3, haddock, between The Wolves and Grand Manan.
Aug. 17, haddock, Eastport.
24, haddock, between Campobello and Grand Manan.
Aug. 28, cod, market.

Cardita borealis.
Aug. 17, haddock, Eastport,
Oct. 28, haddock, market.

Nucula tenuis.
Aug. 3, haddock, between The Wolves and Grand Manan.
Aug. 7, haddock, between Campobello and Grand Manan.
Aug. 17, haddock, Eastport.
28, haddock, market.

Yoldia sapotilla.
Oct. 24, haddock, Head Harbor.

List of animals found in fish stomachs, showing technical name of species, name of fish in which it was found, locality where fish was caught, and date when taken—Continued.

EASTPORT COLLECTION—Continued.

Mollusks—Continued.

Modiola modiolus. Mussel.
Oct. 2, cod, Yellow Rock.

Modiolaria discors. Mussel.
Oct. 17, haddock, Quoddy Bay.

Modiolaria nexa. Mussel.
Oct. 6, haddock, Cochran Ledge.

Anomia aculeata.
Sept. 4, haddock, West Quoddy.
12, haddock, Eastport.
Aug. 3, haddock, between The Wolves and Grand Manan.
Aug. 17, cod, Eastport.

Terebratulina, sp. Lampshell.
———, cod, market.
———, haddock, market.

Chiton ruber.
Sept. 2, haddock, Eastport.
Oct. 6, haddock, Cochran Ledge.
25, haddock, ledge between Harbor De Lute and Cherry Island.

Chiton albus.
Oct. 20, haddock, Storer Ledge.
20, haddock, Cherry Island.

Puncturella noachina.
Aug. 17, haddock, Eastport.

Margarita cinerea.
Sept. 1, cod, Cochran Ledge.
Oct. 28, haddock, market.

Margarita undulata.
Oct. 17, haddock, Quoddy Bay.
23, haddock, Head Harbor.

Velutina haliotoidea.
——— cod, Market.

Velutina zonata.
Sept. 12, haddock, Eastport.
23, cod, market.
Oct. 17, haddock, Quoddy Bay.
23, haddock, Head Harbor.

Natica clausa.
Aug. 3, haddock, between the Wolves and Grand Manan.
17, haddock, Eastport.
Sept. 4, haddock, West Quoddy.
Oct. 17, haddock, Eastport.

Lunatia islandica.
Aug. 3, haddock, between the Wolves and Grand Manan.

Buccinum undatum. Whelk.
Sept. 2, haddock, market.
Oct. 21, cod, Yellow Rock.

Cemoria noachina.
Aug. 17, haddock, Eastport.

Trochus occidentalis.
Sept. 1, cod, Cochran Ledge.
Oct. 28, haddock, market.

Annelids.

Lepidonotus squamatus. Scaly worm.
Oct. 6 to 11, haddock, Cochran Ledge.

Harmothoë imbricata. Scaly worm.
Oct. 6 to 11, haddock, Cochran Ledge.

Annelids—Continued.

Nephthys, sp.
Oct. 24, haddock, Head Harbor.

Nereis pelagica.
Sept. 2, haddock, Eastport.
———, haddock, Storer Ledge.
Sept. 23, cod, market.
Oct. 23, haddock, Head Harbor.

Nereis, sp.
Oct. 6 to 11, haddock, Cochran Ledge.
Oct. 17, haddock, Quoddy Bay.

Thelepus cincinnatus.
Sept. 2, haddock, Eastport.

Brada sublævis.
Sept. 4, haddock, West Quoddy.

Brada granosa.
Aug. 17, haddock, Eastport Harbor.

The annelids were very difficult to identify, owing to their natural softness, which rendered them easily broken and quickly destroyed by the juices of the fishes' stomachs.

Crustaceans.

Caprella, sp.

Found in both cod and haddock from various localities, often formed into small or medium-sized wads in the fishes' stomachs.

Idotea phosphorea. Isopod.
Oct. 6, haddock, Cochran Ledge.
18, cod, Quoddy Reef.

Idotea robusta. Isopod.
Aug. 17, haddock, Eastport.

Leucothoë grandimanus. Sea flea.
Oct. 23, haddock, Head Harbor.

Unciola irrorata. Sea flea.
Aug. 7, haddock, between Campobello and Grand Manan.
Aug. 17, haddock, Eastport.
Sept. 12, haddock, Eastport.
Oct. 17, haddock, Quoddy Bay.
24, haddock, Head Harbor.

Cerapus rubricornis. Sea flea.
Oct. 6 to 11, haddock, Cochran Ledge.

Lysianassa spinifera. Sea flea.
Sept. 1, haddock, Cochran Ledge.

Amphithonotus. Sea flea.
Sept. 1, haddock, Cochran Ledge.
Oct 17, haddock, Quoddy Bay.

Pteilocheirus pinguis. Sea flea.
Aug. 7, haddock, between Campobello and Grand Manan.
Aug. 17, haddock, Eastport.
28, haddock, market.
Sept. 1, haddock, Cochran Ledge.
12, haddock, Eastport.
12, cod, market.
Oct. 24, haddock, Head Harbor.

Nymphon grossipes. Sea flea.
Aug. 24, haddock, Eastport.
Sept. 1, haddock, Cochran Ledge.

List of animals found in fish stomachs, showing technical name of species, name of fish in which it was found, locality where fish was caught, and date when taken—Continued.

EASTPORT COLLECTION—Continued.

Crustaceans—Continued.

Nymphon grossipes—Continued.
Oct. 6, haddock, Cochran Ledge.
6, haddock, the Race.

Thysanopoda inermis?
Aug. 2, hake, between Campobello and Grand Manan.

At all times found in pollock. Very abundant in this region during the season.

Eupagurus pubescens. Hermit crab.
Sept. 5, cod, Cochran Ledge.

Not many found in fish stomachs, but not an uncommon species in this region.

Eupagurus bernhardus. Hermit crab.
Sept. 1, cod, Cochran Ledge.
5, cod, Cochran Ledge.
Oct. 18, cod, Quoddy Reef.

This species is not rare in this region, but only a few were found in fish stomachs.

Eupagurus kröyeri. Hermit crab.
Aug. 3, haddock, between the Wolves and Grand Manan.
Aug. 17, haddock, Eastport.
Sept. 23, cod, market.

Not uncommon.

Hyas coarctatus. Spider crab.
Aug. 3, cod, between the Wolves and Grand Manan.
Aug. 17, cod, Eastport.
21, cod, Yellow Rock.
23, cod, West Quoddy.
28, haddock, market.
Sept. 5, cod, Cochran Ledge.
12, cod, market.
Oct. 6, cod, Cochran Ledge.
19, cod, Quoddy Bay.
20, cod, Head Harbor.

Many of the crabs had *Anomia aculeata* attached to them. This crab is the most frequent and abundant animal found in the cod's stomach.

Cancer irroratus. Rock crab.
Aug. 23, cod, West Quoddy.
Sept. 12, cod, Eastport.

This species common in this region, found in cod stomachs with *C. borealis*.

Cancer borealis. Jonah crab.
Aug. 23, cod, West Quoddy.

Crustaceans—Continued.

Cancer borealis—Continued.
Sept. 12, cod, Eastport.

Found only in cod stomachs; quite numerous in the above two instances.

Pandalus annulicornis. Prawn.
Aug. 2, hake, between Campobello and Grand Manan.
Aug. 3, cod, between the Wolves and Grand Manan.
Aug. 17, cod, Eastport.
Sept. 12, cod, market.
Oct. 20, cod, Head Harbor.
Oct. 21, cod, Yellow Rock.

Quite plentiful, especially in hake stomachs. Another prawn, which could not be identified, was found in a cod stomach.

Pycnogonum littorale,
Aug. 17, haddock, Eastport.
Oct. 24, haddock, Head Harbor.
Oct. 25, haddock, Storer Ledge.

Very few specimens found.

Fishes.

Acanthocottus, sp. Sculpin.
Sept. 5, cod, Cochran Ledge.

Too much digested for identification.

Acanthocottus scorpius grœnlandicus. Sculpin.
Oct. 18, cod, Quoddy Reef.

Acanthocottus or Hemitripterus. Sculpin or sea raven.
Oct. 6–11, cod (fragments), Cochran Ledge.

Liparis liparis. Sea slug.
Oct. 21, cod, Yellow Rock.

Murænoides gunnellus. Rock-eel; butter-fish.
Sept. 5, cod, Cochran Ledge.
Oct. 20, cod, Cochran Ledge.
Oct. 21, cod, Yellow Rock.

Clupea harengus. Herring.
Oct. 18, cod, Quoddy Reef.
Oct. 18, cod, Quoddy Reef.
Oct. 21, cod, Yellow Rock.

These were fragments. Pieces of herring were frequently found in the stomachs of all fishes examined, but when they had unmistakably been used for bait and picked from the hook by the fish no account was taken of them.

List of animals found in fish stomachs, showing technical name of species, name of fish in which it was found, locality where fish was caught, and date when taken—Continued.

GRAMPUS COLLECTION.

May 30, cod. Station 333, lat. 46° 19′ 15″ N., long. 59° 51′ 45″ W.
Hyas coarctatus, several.

July 19, 1894, cod.
Hyas coarctatus, numerous.
Pandalus annulicornis. Prawn. One specimen.
Natica clausa, one specimen.
Aphrodita aculeata. Sea mouse. One specimen.
Trophonia, sp., one specimen.
Young sculpin, one specimen, northern edge of Brown's Bank.

July 25, 1894, cod. North side of Prince Edward Island, N. by E. 6 or 7 miles from East Point.
Cancer irroratus. Rock crab. Few young.
Homarus americanus. Lobster. One young, 4 inches long.

July 26, 1894, 50 cod. Stations 588 and 589, Bradielle Bank, Gulf of St. Lawrence.
Hyas coarctatus. Spider crab. Numerous.
Chionœcetes opilio. Spider crab. Numerous.
Pandalus annulicornis. Prawn. Common.
Glycimeris siliqua. Bank clam. Numerous.
Yoldia sapotilla. One specimen.
Holothurian. One specimen.
Serpula tube. One specimen.
Worms. Several.

July 27, 1894, 60 cod. Stations 599, 600, and 601, Orphan Bank, Gulf of St. Lawrence.
Hyas coarctatus. Numerous.
Chionœcetes opilio. Numerous.
Eupagurus kröyeri. Hermit crab. Two specimens.
Pandalus annulicornis. Few.
Glycimeris siliqua. Numerous.
Holothurians. Numerous.
Priapulus caudatus. Numerous.
Nereis, sp. Clam worm. One specimen.
Small fishes. Two species, two specimens.
Clupea harengus. Herring. Several.

August 8, 1894, 2 haddock. Station 699, latitude 47° 8′ N., longitude 61° 53′ 30″ W.

These two fish contained considerable algæ, in which were many small white worms and several species of amphipods (the identification of which was not attempted), some fine sand, and the following species:

Hyas coarctatus. One specimen.

August 8, 1894—Continued.
Echinarachnius parma. Sand dollar. Young, from the size of a pin head to three-fourths inch in diameter.
Liocyma fluctuosa. Thirty-eight specimens.
Yoldia sapotilla. Four specimens.
Aphrodite grœnlandica. Two specimens, young.
Spisula ovalis. Sea clam. Nine specimens, young.
Spisula solidissima or *ovalis*. Six, very young.
Cylichna alba. One specimen.
Crenella pectinata. One specimen, young.
Polinices grœnlandica. Three specimens.
Margarita cinerea. One specimen, very young.
Cyprina islandica. One specimen, very young.

May 16, 1895, cod. Georges Bank, Station 258, latitude 43° 50′ 45″ N., longitude 64° 39″ W.
Eupagurus bernhardus. Hermit crab. Several.
Aphrodita aculeata. Sea mouse. One specimen.

June 17, 1895. Tignish, Prince Edward Island.

Several cod stomachs were examined at the fish-packing establishment of Mr. Myrick. One large cod contained 3 cunners (*Tautogolabrus adspersus*) from 6 to 10 inches long; others contained from 4 to 6 cunners each. One stomach contained nothing but a mass of lobster eggs (about 1 pint), others contained considerable purple membranaceous alga with a lot of some kind of spawn amongst it. Mr. Myrick once found in the stomach of a 71-pound cod 63 large herring, 3 good-sized flounders, and 1 lobster.

July 12, 1895, cod. Station 574, latitude 40° 33′ 45″ N., longitude 69° 15′ 30″ W. "Pollack Rips."
Cancer borealis. Jonah crab. Many, small.
Cancer irroratus. Red crab; rock crab. Few.
Pentacta frondosa. Sea cucumber. Few.
Aphrodita aculeata. Sea mouse.
Tautogolabrus adspersus. Cunner.

One cunner, about a foot long, was removed from a 14-pound cod. Some of the crabs had hydroids, bryozoa, and *Anomia glabra* attached to them.

Summary showing the animals found in the stomachs of each of the gadoid fishes named.

EASTPORT COLLECTION.

Species.	Cod.	Haddock.	Hake.	Pollock.
Hydroids:				
Sertularia, sp		x		
Sertularia argentea	x			
Echinoderms:				
Pentacta frondosa	x	x		
Strongylocentrotus dröbachiensis	x	x		
Asterias vulgaris		x		
Cribrella sanguinolenta		x		
Solaster endeca		x		
Crossaster papposa		x		
Ophiopholis aculeata	x	x		
Ophiopholis elegans	x	x		
Ophioglypha sarsii		x		
Mollusks:				
Saxicava arctica		x		
Cardium islandicum		x		
Cardium pinnulatum	x	x		
Cardita borealis		x		
Nucula tenuis		x		
Yoldia sapotilla		x		
Modiola modiolus	x			
Modiolaria discors		x		
Modiolaria nexa		x		
Anomia aculeata	x	x		
Chiton ruber		x		
Chiton albus		x		
Puncturella noachina		x		
Margarita cinerea	x	x		
Margarita undulata	x	x		
Velutina haliotoidea	x			
Velutina zonata	x	x		
Natica clausa		x		
Lunatia islandica		x		
Buccinum undatum	x	x		
Comoria noachina	x	x		
Trochus occidentalis		x		
Annelids:				
Lepidonotus squamatus		x		
Harmothoë imbricata		x		
Nephthys, sp		x		
Nereis pelagica	x	x		
Nereis, sp		x		
Thelepus cincinnatus		x		
Brada sublævis		x		
Brada granosa		x		
Crustaceans:				
Caprella, sp	x	x		
Idotea phosphorea	x	x		
Idotea robusta		x		
Leucothoë grandimanus		x		
Unciola irrorata		x		
Corapus rubricornis		x		
Lysianassa spinifera		x		
Amphithonotus ?		x		
Ptelocheirus pinguis	x	x		
Nymphon grossipes		x		
Thysanopoda, sp	x		x	x
Eupagurus pubescens	x			
Eupagurus bernhardus	x			
Eupagurus kröyeri	x	x		
Hyas coarctatus	x	x		
Cancer irrorata	x			
Cancer borealis	x			
Pandalus annulicornis	x	x	x	x
Pycnogonum littorale		x		
Brachiopods:				
Terebratulina, sp	x	x		
Fishes:				
Acanthocottus, sp	x			
Acanthocottus scopius grœnlandicus	x			
Murænoides gunnelus	x			
Liparis liparis	x			

Summary showing animals found in stomachs of each of the gadoid fishes named—Cont'd.

GRAMPUS COLLECTION.

Species.	Cod.	Haddock.	Hake.	Pollock.
Crustaceans:				
Cancer borealis	x			
Cancer irroratus	x			
Hyas coarctatus	x	x		
Chionœcetes opilio	x	x		
Pandalus annulicornis	x			
Homarus americanus	x			
Eupagurus kröyeri	x			
Eupagurus bernhardus	x			
Mollusks:				
Glycimeris siliqua	x			
Natica clausa	x	x		
Liocyma fluctuosa		x		
Yoldia sapotilla		x		
Aphrodita grœnlandica		x		
Spisula solidissima or ovalis		x		
Spisula ovalis		x		
Cylichna alba		x		
Crenella pectinata		x		
Polinices grœnlandica		x		
Margarita cinerea		x		
Cyprina islandica		x		
Anomia glabra	x			
Echinoderms:				
Pentacta frondosa	x			
Echinarachnius parma	x	x		
Annelids:				
Aphrodita aculeata	x			
Trophonia, sp	x			
Serpula, sp	x			
Priapulus caudatus ?	x			
Nereis, sp	x	x		
Other worms	x			
Fishes:				
Cunners and herring	x			

U. S. COMMISSION OF FISH AND FISHERIES,

JOHN J. BRICE, Commissioner.

REPORT

OF A

Survey of the Oyster Regions of St. Vincent Sound, Apalachicola Bay, and St. George Sound, Florida.

BY

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4.—REPORT OF A SURVEY OF THE OYSTER REGIONS OF ST. VINCENT SOUND, APALACHICOLA BAY, AND ST. GEORGE SOUND, FLORIDA.

By Lieut. FRANKLIN SWIFT, *U. S. Navy.*

INTRODUCTION.

Having completed the work of supplying the aquarium of the U. S. Fish Commission exhibit at Atlanta, Ga., with specimens of the Gulf fishes, I received instructions, dated September 30, 1895, from the United States Commissioner of Fish and Fisheries, to proceed to Apalachicola Bay, Florida, with the steamer *Fish Hawk* and the party under my command, and begin an oyster survey of the adjacent waters, the waters to be covered being St. Vincent Sound, Apalachicola Bay, and St. George Sound.

The object of the survey was to determine:

(1) The positions, outlines, characteristics, and richness or productiveness of all oyster beds located in the waters named.

(2) The positions, outlines, and characteristics of all areas of the bottom in the same waters, suitable for the planting of oysters, either in their natural condition or after preparation.

Projections were furnished in three sheets covering the areas to be surveyed. These projections were made from data obtained from the United States Coast and Geodetic Survey Office, and are on [illegible] scale, giving the location of the triangulation points and showing the shore line from the original survey. A description of the triangulation points was also furnished. The work to be undertaken called for all that is required of a hydrographic party in the Coast Survey, besides all the work that is peculiar to an oyster survey.

In the former surveys in which this vessel has been engaged a large part of the work was carried on by civilian assistants sent especially by the Fish Commission, but no such assistance was available in this case, and the survey had to be made entirely by the officers and crew of the vessel. On the Coast Survey vessels there are usually several commissioned officers, who, together with the crew, are trained in hydrographic surveying; at the beginning of our work there was only one officer besides myself, Mate J. A. Smith, U. S. N., who had had any experience in hydrography. Much credit is due Mr. Smith for the ability he displayed in running the lines of soundings and in all other work connected with the survey.

Mate L. M. Melcher, U. S. N., joined the vessel November 15, 1895, and although he was inexperienced in the work at first, he soon became, by zealous attention, a very fair observer.

Some time was occupied in training members of the crew to become observers, recorders, and polemen, but by constant effort we were able, at an early date, to work two different parties. Quartermasters Charles Winters and J. W. Savage showed especial ability and zeal.

Up to December 27 I was obliged to do all the plotting myself, and in order to keep the work up to date was compelled to neglect other duties. The services of Mr. Eugene Veith were therefore secured, and his long experience as draftsman, as well as observer and recorder in the Coast Survey, especially fitted him for the work. After having plotted the results of the survey on the projections sent by the Fish Commission it was found necessary to construct a complete new sheet, embracing all the work presented in proper form for publication. Every detail of the work, including the plotting of the characteristic soundings out of 80,000 soundings, was performed by Mr. Veith in the most excellent manner.

Tidal observations were taken during the season at the main tide gauge by Mr. Hugh Brown, who was employed by the Commission for the purpose. He was a faithful and intelligent observer and gave complete satisfaction. Auxiliary tide gauges were tended by members of the crew.

Due time and attention were given to the collection of information from the oystermen of Apalachicola, and for this purpose a regular form of interrogatories was prepared. Without exception these excellent and intelligent men did all in their power to assist us, and gave us much useful information.

I am especially indebted to Mr. J. G. Ruge, of the firm of Ruge Bros., engaged in oyster-canning at Apalachicola, for much valuable information. This gentleman has been in the oyster business for years, and has made a special study of the oysters of the vicinity. The facts concerning the history of oyster beds, the oyster business of Apalachicola, the spawning habits, etc., that appear in the report after the description of the beds, were obtained mostly from Mr. Ruge. The facts and figures, however, were compiled from all sources, and were the average of all information obtained, giving due weight to each particular source.

Thanks are due to Mr. C. H. Lind and Mr. Domingo Segree, oyster-dealers of Apalachicola, for their kindness in furnishing information. Both of these gentlemen took much trouble and spent much time in our behalf without remuneration.

A good deal of bad weather was experienced during the season, and during the days that the rain or rough sea prevented the boats from working, the time was utilized in building signals, when possible, or in office work on board ship. The boats used were the ship's flatboats and steam launch, until near the end of the season, when the launch was lost in the hurricane on the night of February 5. The launch was very old and was worn out in service, and had previously been condemned.

During February, 1896, a good deal of sickness was experienced by the party, there being sometimes as many as six men on the sick list at one time. This caused either suspension of part of the work or double labor for those who remained in good health, as the efforts of every officer and man on board were taxed to their utmost throughout the season.

The work was begun on November 12, 1895, and continued until March 28, 1896, without intermission, except from December 23 to December 28, 1895, when a run to Pensacola was necessary to replenish the coal supply. On March 17 I received instructions from the acting Commissioner to close the work in time to arrive in the Delaware for the season's shad hatching. By this time all work of importance had been finished, and there only remained to survey a few oyster beds in St. George Sound, which were of little account, as no marketable oysters are obtained from them.

A report by Mr. H. F. Moore, assistant, United States Fish Commission, upon the specimens collected from the oyster beds, is appended (pp. 218-220).

GENERAL SCHEME AND METHODS OF WORK.

The work, in accordance with the instructions given, was not to be a mere reconnoissance or examination of a few important beds, but a complete survey of every bed and area where oysters were found, as well as a thorough examination of the bottom of the whole region covered, in order to determine its suitability for oyster-planting. Therefore it was necessary to adopt a scheme of hydrographic surveying, in which the lines of soundings should be close enough together to insure the detection of every oyster reef, however small, and show the character of the bottom in every locality, and at the same time not to run the lines unnecessarily close, so that the work might be pushed on as quickly as possible. The local oystermen, although able to give the approximate location of the more important beds, could not, of course, be depended upon to give the limits of all regions where oysters were found or to give the locations of the smaller beds. These facts could only be determined by actually running the lines, keeping an accurate record, and plotting the resulting development on the projection. However, the elaborate development of the bottom, as generally required in the Coast Survey work, was not here necessary, and the ground could be covered more quickly, as far as the hydrographic part was concerned. But, in addition to the hydrographic work, there were many other considerations. Of the first importance was the question of density or salinity of the water, the determination of which alone would show to a great degree the suitability of any locality for cultivating purposes.

The questions of the physical observations on the beds and the examinations of the oysters themselves were of the greatest importance. It was necessary that sufficiently accurate current observations should be taken to establish the approximate velocity and the general set of ebb and flood tides, as such data is essential in connection with the food supply of the oyster and the amount of silt or mud deposited on the beds.

As the spawning habits of the oyster depend to a great extent on the temperature of the water, the temperature observations were important. Information in regard to the spawning was to be collected from local sources and from a study of the specimens preserved.

The first matter of consideration was the location and establishment of the tide gauge. A position was chosen for the main gauge, which was centrally located with regard to the whole area to be covered, and at the same time in a location where the tides would be normal as far as possible, and where the density and temperature observations would give good average results for a large area. The gauge was established on the north side of Apalachicola Bay, between Green Point and Apalachicola. Auxiliary gauges were used and compared with the main gauge whenever a difference of level or difference in the time of high or low water existed. At the end of the season several different bench marks were established, that the result of the long series of observations might be useful in the future.

Density, temperature, and current observations, as well as all the usual observations required by log, were taken at the ship regularly, as well as at the main gauge, so that at many localities a long series of observations were obtained.

The triangulation points given were those determined and marked at the time of the original survey in 1858. As may be supposed, many could not be recovered, and in some cases their sites had been washed away by the encroachment of the sea. In Apalachicola Bay and St. George Sound so few were recovered that it was necessary to triangulate a considerable area, by use of the theodolite, in order to establish the signals. In St. Vincent Sound, owing to its remote position, nearly all the triangulation points were recovered. Signals were built on the triangulation points when recovered, and other signals built and located along the shore and on the reefs of the sounds.

The waters of Apalachicola Bay and the adjacent waters are very shoal, and a good deal of time was lost on that account, as the *Fish Hawk*, drawing 8 feet, could only navigate in certain channels, and then only, in some cases, at high water. St. Vincent Sound could not be reached from the eastward, on account of shoal water, and the scene of work was too far off to send the boats. Therefore, an attempt was made to get the ship into Indian Pass, which proved successful after first surveying and buoying the channel. The channel was very narrow, but deeper water was found than was shown on the Coast Survey chart. An inspection of the chart accompanying this report will show a few other channels surveyed that were apparently not necessary to the work, as, for example, the cut across Cat Point Shoal and the cut and channel to Apalachicola, but in every such case these surveys were made for convenience in navigating the ship.

The work of running lines of soundings was begun at Indian Pass and continued toward the eastward. Many of the oyster reefs of St. Vincent Sound are very narrow and small, and therefore the lines had to be run quite close together.

The scheme of sounding lines in general consisted of one system of lines running in a north-and-south direction, these lines being connected with the shore by a system of zigzagging. The lines were run from 50 to 100 meters apart, according to the nature of the bottom, and as the oyster reefs or areas of scattered oysters were discovered they were developed by additional lines, and the physical observations and close examination of oysters and beds were made, as will be explained hereafter.

The position of the boats on the lines, and at all times, was determined by the adoption of the three-point problem in the same manner as commonly employed in hydrography. Therefore the contour of the bottom and delineation of reefs are as accurately shown on the sheet as they would have been had the survey been a hydrographic one purely; and, on account of the long series of tidal observations, lasting 4½ months and including 122 low-waters, an excellent plane of reference was established for reducing the soundings to the plane of mean low water. In running the lines advantage was taken of the shoalness of the water and softness of the bottom to place and locate poles with flags for ranges. Throughout the survey the lines were run on these ranges thus established, and the accuracy of the work considerably increased in consequence.

On account of the shallowness of the water in localities where oysters were found, it was impossible to use the ship for dredging purposes. The oystermen employ tongs entirely, and tongs were found to be more serviceable than the boat dredge for our purpose. In estimating the number of oysters to the stated given area—as for instance, a square yard, the comparison generally used in former surveys—the boat was moored, and the oysters on the bed were tonged and counted within the limits covered by the bottom of the boat, and the result reduced to square yards. Any method employed for this purpose, although correct enough for the particular locality where used, would, of course, only give a rough approximation for the whole oyster region, unless an almost infinite number of such observations were made. Still this method gives a standard to which observations made in future surveys may be compared, and thus show the increase or decrease from time to time in the number of oysters on the beds.

The shoalness of the water allowed the use of poles in taking soundings and obtaining the character of the bottom. A sounding pole was constructed on board ship that was particularly well adapted for the work in hand; it consisted of the pole proper, made of juniper—the lightest wood obtainable—and a metal disk fitted on the end of the pole, connected with it by a copper wire. This wire was simply to prevent the loss of the disk in case of the breaking of the pole, and was inlaid in a groove in the side of the pole. The disk was of brass, 3 inches in diameter, and slightly concave on its lower surface. It was attached by means of a screw cap to a 3-inch length of 1-inch piping, into which the pole was fitted and riveted.

These poles were 1¼ inches in diameter at the lower end, and slightly tapering to the upper end. They were 14 feet long, and, constructed as described, were light, well balanced, and strong. By their use the presence of oysters could be immediately detected, not only by the "feel" of the pole to the poleman, but also by the ringing sound given out on striking shells, easily heard by the officer in charge of the boat. At first, observations were taken and examinations made whenever the oysters were discovered in running the lines; later, it was found better to run the lines first, plot the position of oyster beds, and then to revisit the beds, occupying different stations previously marked out on the sheet. This latter method secured uniformity, and was more thorough, as it prevented the too hurried observations that were likely to occur. All oyster reefs and areas of scattered oysters were carefully located, the reefs composed solely of old shells, as well as those of live oysters, and whether of the raccoon type or not.

Full notes were kept in the record books of the result of the examinations—the type of oyster, shape, size, and appearance of the shell, whether single or in clusters, growth on shell, appearance of spat or young growth, flavor and condition of oyster, number of oysters to stated area, proportion of live oysters to dead shells, appearance of bed, growth and cleanliness of bed. A careful lookout was kept for enemies of the oyster, as starfish, drumfish, drills, conchs, sponges, etc., and their presence noted. At each observation point the probe was used to determine the different layers at different depths of the bed. An especially constructed probe, with a steel drill point and connected by lengths of piping, was used, and in some instances was driven to a depth of 12 feet. At each observation point specimens of oysters were preserved, and these specimens at the end of the season were turned over to a Fish Commission expert at Washington for examination, and a report made upon them. The result of the examination appears in this report.

In considering the question of bottom suitable for the planting of oysters, those areas were recorded favorable when the bottom was sufficiently hard to prevent the oyster from sinking, and, at the same time, possessing sufficient cohesion to resist the shifting action of the waves, all other conditions being also favorable. Very soft, muddy bottoms were considered unsuitable, but those of a somewhat firmer consistency it was considered possible to make suitable by covering them with layers of stones or shells.

When working in St. Vincent Sound the ship was some 18 miles from Apalachicola and it was necessary to send the steam launch to that town once a week for provisions and mail. Later, when the work had progressed to the eastward, a return to an anchorage about 3 miles off Apalachicola was made on Saturday afternoons for the same purpose. The vessel could not, without danger of delaying the work by waiting for high water, make an anchorage nearer the town, on account of the shoal water. When the work had reached the eastern part of Apalachicola Bay, the ship was moved every day to the scene of work, that as little time as possible might be lost in going to and returning from work. These short runs were made under one boiler in order to save coal, and although the vessel was under way nearly every day an average of only six-tenths of a ton of coal was used per day.

As is usual in hydrographic work, each position of the boat was plotted on the boat sheet, in order that the officer in charge of the boat might know his exact location and direct his course accordingly.

The work was kept plotted up to date on the smooth sheet, the draftsman each day plotting the work of the day previous from the record. At the close of the season a large amount of work remained to be done by the draftsman to complete the sheet, and prepare a new one in such form that it could be photolithographed for publication.

SUMMARY OF WORK.

Area surveyed, square miles	88	Number of low-waters observed for establishing plane of reference	122
Area of oyster beds located, in acres—thick growth	1,786	Total number of observations for density	598
Area of oyster beds located, in acres—scattering growth	3,569	Total number of observations for temperature	598
Area of good planting ground located, in acres	6,859	Number of times current observations were recorded	792
Number of soundings taken	75,125	Number of specimens preserved	40
Number of angles taken	7,815	Time in which survey was made, November 12, 1895, to March 28, 1896.	
Number of miles of sounding and determinations of the bottom	914.8		

Answers to a series of questions were obtained from all oystermen and dealers.

GENERAL DESCRIPTION OF THE AREA COVERED BY THE SURVEY.

The area covered includes an extent of about 21 miles in an east-and-west direction and at its widest part about 6½ miles in a north-and-south direction. It consists of Indian Lagoon, St. Vincent Sound, Apalachicola Bay, East Bay, and the western end of St. George Sound.

Apalachicola Bay is the largest and most important of these bodies of water, and is bounded by the mainland to the northward and by St. Vincent Island, Sand Island, and St. George Island to the westward and southward. It is entered from seaward through West Pass.

The extension of Apalachicola Bay to the eastward is called St. George Sound. This sound is inclosed by St. George Island and the mainland from Cat Point to the eastward.

East Bay is a shallow body of water adjoining Apalachicola Bay to the northeastward.

St. Vincent Sound is formed by the island of that name. It narrows toward its western end and communicates with the sea at Indian Pass.

Indian Lagoon is a small, shallow body of water formed by Indian Peninsula, and having only one narrow inlet at Indian Pass.

ST. VINCENT SOUND.

General description.—St. Vincent Sound contains about 15 square miles and extends in a general east-and-west direction for about 9½ miles, and varies in a north-and-south direction for about 2½ miles at its eastern end, to ¾ of a mile at its western end. The eastern part of the sound is quite shoal. Only about 4 feet at low water can be carried from Apalachicola Bay. The western part is connected with the sea by Indian Pass, through which 8 feet can be carried at low water under favorable conditions. After entering the pass a narrow and comparatively deep channel extends about 2 miles to the eastward.

Indian Lagoon, a small, shallow body of water, nearly landlocked, is connected to the western end of St. Vincent Sound by a narrow, crooked channel. A material difference was found in the shore lines of the sound when the present survey was compared with the original, the sea having encroached on the shores of both the mainland and St. Vincent Island. At some localities the shore line of the latter had receded nearly one-fourth of a mile.

It also appeared that the oyster reefs exposed at low water, and now composed of only dead shells, have changed considerably since the original survey. A peculiar hydrographic feature of the sound is a deep hole or basin which is found about 2 miles from the western end of the sound. At this point the waters of the sound are compressed between two long, narrow oyster reefs, which make out from either shore. These long oyster reefs are dry a greater part of the time, and seem to form a natural division between the different types of oysters of the sound, as well as the sound itself. For convenience this place was designated as the Bulkhead. The sound carries off a part of the fresh water from Apalachicola River and also receives a small fresh-water supply from the various runs on the mainland and from the creeks of St. Vincent Island.

As might be expected, the densities of the sound vary considerably. The eastern part of the sound has the greatest fresh-water supply, and has an average density of 1.0106, with an average temperature of 53° F. There is probably very little difference in density at the times of ebb and flow until the Bulkhead is reached. Just to the westward of the Bulkhead the density averages 1.0197, and temperature 53° F.

At Indian Pass the water is quite salt at all stages of the tide, the average density being 1.0234, the average temperature 57° F.

In Indian Lagoon the density at the eastern part is 1.0217, the temperature 61° F.; at the western part the density is 1.0219, the temperature 60° F. These observations, however, were single ones and not the average of many, as the locality was not considered of sufficient importance to take a series of observations.

In former years a large part of the oysters brought into Apalachicola were taken in St. Vincent Sound. During the season of the survey only one vessel—a small schooner with three men—was engaged in oystering there, while the fleet of oystermen had changed the location of their work to the eastward.

The Bulkhead forms a natural division between the oyster beds of good quality and those of the raccoon type.

Oyster beds of Indian Lagoon.—Indian Lagoon, as far as surveyed, contains five-eighths of a square mile. It is very shoal, having only about 2 feet of water at low water, and it is difficult for even a small boat to navigate it, although 4 feet can be carried in by the channel at the entrance. The lagoon, being nearly an inclosed body of water and having its entrance so near the pass and the ocean, is naturally ill-fitted to support oyster life of the highest type, and it was found that most of the oysters were of the raccoon type.

There are about 10 acres of a very scattered growth of oysters along the south shore, and the whole area between the reefs on the northern side and at its entrance contains about 20 acres. These reefs extend out from the shore for about half a mile, and are composed of dead shells, which are exposed, except at very high tide. These are, as a rule, about 2 yards in width. The whole northern shore of the lagoon is a marshy flat extending back to the woods, fringed at intervals by the reefs, as described. The oysters are found on the edges of reefs, and the intervening spaces between the reefs are composed of very soft mud. The bottom of the whole lagoon, with the exception of one small bank of dead shells near its center and a narrow strip along its southern bank, is composed of very soft mud. There is no area suitable for planting oysters, and the lagoon as a source for obtaining oysters for market is of little importance.

Oyster beds of St. Vincent Sound, between Indian Pass and the Bulkhead.—St. Vincent Sound, between Indian Pass and the Bulkhead, contains 2 square miles, and is mostly shoal, with the exception of a narrow channel extending its whole length. This channel is 20 feet deep at the pass, and 7 feet at low water can be carried to the Bulkhead, where, as before mentioned, there is a deep basin of 32 feet.

Along the shores of this part of the sound are long, narrow reefs of dead shells, dry, except at extreme high water. In some cases these reefs extend out a mile into the sound. They are quite narrow, being from 2 yards to 10 yards or more in width. The reefs forming the Bulkhead were found to have altered in shape considerably since the original survey. Besides the long reefs there are various small reefs and patches on each side of the deep channel.

The oysters are of the raccoon type and are found along the edges of the reefs, close inshore. On the north shore, near the entrance to the lagoon, there is a network of reefs of dead shells, similar to those on the north side of the lagoon. All the oysters in this part of the sound may be classed as scattering, and they cover about 10 acres. Near the center, on the southern side of the channel, is a bank of dead shells of 70 acres, and to the westward of this bank and adjoining it is an area of 84 acres suitable for planting.

The bottom of this location is hard mud and is smooth and clean. The whole planting area extends along the southern edge of the channel for 1½ miles and reaches nearly to the Bulkhead. The velocity of the current in the channel is about 2 knots an hour, setting in the direction of the channel, and the current on the planting area is somewhat less. The density here is 1.0197, which is considerably higher than appears on the best oyster-grounds to the eastward, in Apalachicola Bay and elsewhere. The average temperature for the time of observations was 53° F.—the highest 57° F., the lowest 48° F.

Considering that the Bulkhead acts as a barrier to shut off, not only the supply of fresh water, but also the source of food, it may be said that this planting ground would probably not give as favorable results as other grounds to be described later. This portion of the sound is therefore not of great importance, either as a source of obtaining oysters for market or as planting ground, for, except in the localities mentioned, the bottom is very soft mud and the water is not entirely suitable for oyster life.

Oyster beds of St. Vincent Sound from the Bulkhead to its eastern limit.—St. Vincent Sound between the Bulkhead and its eastern limit covers an area of about 13 square miles, and is about 7 miles long, with an average width of nearly 2 miles. It is generally shoal, and only 4½ feet can be carried through it into Apalachicola Bay.

The fresh-water supply is furnished by the various runs and creeks on both shores and by Apalachicola River to the eastward; the amount of salt water is regulated by the barrier formed by the Bulkhead. The current runs with a gentle flow throughout its length and gives an abundant food supply. The temperatures are not abnormal. About half of the bottom is either hard or soft sand, or hard mud. All the conditions are therefore quite favorable to oyster life, and it was here that in former years a good part of the main supply of oysters was found by the oystermen. Doubtless the only reason that they do not exist now in great numbers is that the supply proved too small for the demand, and thus the overworking of the beds gradually brought about their present condition. However, it seems from the quantity of young growth found, and from the general appearance of the beds, that if they were left undisturbed for a few years they would recover their former productiveness. This is likely to occur, as practically the beds are not worked at present.

Of the thick growth of oysters found in this area, there is a bed containing 50 acres on the north side, just east of the Bulkhead. Near the center of this growth there is a long, narrow reef of dead shells, exposed at nearly all tides and extending in a NW. and SE. direction. The oysters bordering this reef are found more closely together than the outlying ones; they are all single oysters and are of good quality. There is another area of dense growth, of about 13 acres, near the mouth of the large bayou on the north shore of St. Vincent Island. The oysters here are of good quality and are large, single oysters.

The area for 3 miles to the eastward of the Bulkhead, included between the 3-foot curves of either shore, are covered with patches of dense growth of oysters. There are, in all, 19 of these patches, making a total of 38 acres. Of these there are several containing only about 1 acre, and the largest contains 5 acres.

All these small clusters of dense growth of oysters have the same characteristics. The oysters are found surrounding reefs of dead shells, which are usually awash at high water. The reefs are narrow and crescent-shaped, with their concave surface to the eastward, and invariably run in a north-and-south direction. They shoal off gradually on the eastern side and rise abruptly from the deep water on the western side. The oysters extend out, as a rule, about 30 yards to the eastward and about 20 yards to the westward of the reef. They are found singly and are in excellent condition and of good quality. In many instances spat and young growth were noticed. The reefs all arise from a soft, muddy bottom to a height of 8 or 9 feet, in some cases, while over a few of the eastern outlying patches there is a depth of about 2 feet at low water.

The scattered growth of oysters in this part of St. Vincent Sound covers considerable area, there being 1,590 acres. The largest extent of the scattered growth occurs on each side of the sound, inside the 3-foot curve and nearly opposite the area of patches of dense growth before mentioned. Scattered oysters are also found all along the south shore from the Bulkhead to St. Vincent Point, although, except in the locality just mentioned, they form only a narrow band. They are also found some little distance up the bayous of St. Vincent Island. On the north shore they extend as far to the eastward as the beds in the middle of the sound. The oysters are found on bottoms of hard mud and hard and soft sand. They occur in bunches of from 5 to 8 in each bunch, and are good-sized and well-conditioned, except close inshore, where they are smaller and poorer.

On the south side of the sound, just to the east of the Bulkhead, is an area of 162 acres, where there was formerly a bed of oysters, but where now only shells can be found. As no drills, starfish, drumfish, or other enemies of the oyster were discovered, it is probable that the loss of the oysters of this bed, as well as of the bed to the westward of the Bulkhead, was occasioned by one of the various hurricanes which have recently swept this region, the oysters being smothered by the mud deposited, which had been stirred up by the unusual currents and heavy seas.

Planting ground.—In addition to the areas of scattered oysters, there are, in this part of the sound, 1,405 acres of excellent planting ground. The strip along the northern shore extends from the scattered area to Green Point, and makes out from shore about a quarter of a mile, and out to a depth of about 4 feet at low water. This strip covers 665 acres.

The only attempt at oyster cultivation in the area covered by the survey was made by Mr. J. G. Ruge, of Apalachicola, on the north shore of St. Vincent Sound, just to the eastward of the thickest section of the scattered oyster area. There is a good scattered growth there at present, which probably resulted from this planting. Mr. Ruge was unsuccessful, owing, as he states, to insufficient protection by the State law. The planting ground along the St. Vincent Island shore covers 740 acres, and extends from the wide belt of scattered growth to Silva's Bar, and out to a depth of about 5 feet at low water.

The whole eastern portion of St. Vincent Sound is well fitted by nature for the cultivation of oysters. The density and temperatures are favorable, the bottom is smooth and uniform in depth, and the locality is well sheltered from violent storms; it is generally deep enough not to be affected by the freezes which occur during the heavy northers in winter, when the surface of the water is far below mean low-water level. This locality is free from enemies of the oyster, as far as known, and it is not likely to be affected by freshets in the Apalachicola River. Probably the whole eastern part of the sound might be placed under cultivation by covering the soft mud of the bottom with shells or other suitable substances, to which the spat might attach itself.

APALACHICOLA BAY.

General description.—The whole bay covers an area of 63 square miles. It extends about 10 miles in an east-and-west direction and about 6½ miles in a north-and-south direction. It is connected with the sea by West Pass, Sand Island Pass, and New Inlet. The latter two, on account of their shoal water, are of little importance. Through West Pass 13 feet can be carried at low water, and after entering the bay the channel deepens to 16 feet, and this depth can be carried to a position northwest of New Inlet. With the exception of this deep channel, the bay is generally shoal, the depth decreasing as the northern shore is approached. The most noticeable hydrographic feature of the bay is an oyster reef, composed mostly of dead shells, which practically divides the western part of the bay. This reef is called St. Vincent Bar, is very narrow, and extends out from St. Vincent Point in an easterly and southerly direction for about 4 miles. The ship channel is around the south end of this reef, but there is a boat channel through the reef, with 4 feet at low water, about half a mile from St. Vincent Point. Between St. Vincent Bar and Apalachicola are found all the oyster reefs of the western part of the bay. These beds were formerly productive, but are not at present worked.

The central part of the bay is devoid of oyster beds, and only a few beds, mostly of scattered oysters, are found in the eastern part, until St. George Sound is reached.

By far the greater part of the bottom of the central portion of the bay is soft mud. There is a dredged channel to Apalachicola, and also one into St. George Sound. The latter body of water adjoins the bay to the eastward, and a line drawn from Cat Point, south, forms the division. The bay adjoins St. Vincent Sound at a line between Green

Point and St. Vincent Point. The northeast extension of the bay is called East Bay, and is very shallow. It is unimportant as far as oyster interests are concerned. The same is true of Shoal Bayou and Alligator Bayou, the latter being very nearly dry at low water.

Apalachicola River enters at Apalachicola and furnishes the main fresh-water supply to the bay. The shore to the eastward, as far as East Bay, is cut up by the different mouths of the Apalachicola and other rivers. It was noticed that the north part of the bay, near the mouths of the rivers, had shoaled considerably since the original hydrographic survey, and in one case, noticeably, there had been an increase of depth in a locality where there had formerly been a shoal reef. As this occurred in a part of the bay which is a thoroughfare for vessels bound for Carrabelle, and as the channel was not known previous to the survey, this newly discovered channel is of great hydrographic importance. This channel is about 1½ miles north of Cedar Point and nearly in line with Cedar Point and Cat Point. Through it 8 feet can be carried at mean low water, which is half a foot more water than could be carried by the buoyed channel. This new channel should undoubtedly be buoyed.

Many other changes will be noticed by comparing the accompanying map with the Coast Survey chart. This map may be used with the greatest confidence by the navigator, as the hydrographic survey was carried on with the greatest care and exactness.

Densities.—The observations at the mouth of Apalachicola River, extending over a period of two months, gave an average density of 1.0043 and temperature of 53° F. The highest temperature was 62° F., the lowest 48° F. The density between Apalachicola and Green Point (mean of 295 observations) was 1.0057 and the temperature 54°, with maximum 69° and minimum 32°. At a position 1½ miles off shore from the latter locality, the density was 1.0106 and temperature 53° F., with maximum 57° and minimum 49°. Other densities and temperatures are shown on the map, but are not the result of such extended observations.

It must be borne in mind that, as the survey was carried on during the latter part of the winter and early spring months, the densities and temperatures are, of course, quite different from what they would have been in the summer. The densities probably show a maximum freshness, as during the dry summer months they would show a maximum saltness. This was exemplified by the long series of observations taken during the survey, the difference between the first and latter part of the observations being very marked. For days during the latter part of the survey the water was entirely fresh.

An apparent discrepancy exists between the densities shown in the southwest part of the bay and the others near the source of fresh water, the former being lower, or fresher, than the latter. This is accounted for by the fact that during the time the offshore observations were taken, the water at the north shore stations was perfectly fresh. As before stated, there was only a short series of observations taken at the southwest stations, on account of the short space of time available. The ebb and flow of the tides, as well as the force and direction of the wind, seemed to affect the densities to a very small degree at the main station, which was about half way between Apalachicola and Green Point. Off the mouth of the river the density was affected by the wind considerably, a northerly wind bringing low densities.

Observations were taken to establish the relation between the surface and the bottom densities and temperatures, and it was found that no appreciable difference existed; therefore, in taking the observations, a mean depth was generally used. This uniformity is explained by the fact of the shoalness of the water. In the eastern part of the bay the density and temperature observations were carried through considerable periods, and the results may be thoroughly relied upon. The densities decrease from the southern shore towards the northern shore, until, in East Bay and in Shoal Bayou and Alligator Bayou, the densities show the water fresh. In these bodies of water no oysters are found.

The currents.—The currents of the bay are moderate in velocity, but are sufficient to furnish an abundant food supply to the oysters. On account of the shoal water they depend for the direction of their set on the winds. Heavy easterly or northerly winds drive the waters of the bay before them, without regard to the ebb or flow of the tide, and sometimes cause currents of considerable velocity. The heavy northers drive the water out through the passes with considerable velocity, and southerly gales cause strong northerly currents in them, in both cases without regard to the normal ebb and flow of the tides.

At a position about 1½ miles southeast of Green Point, the ebb current runs to the westward and the flood current to the eastward, the velocity in each case varying from half a knot, in light breezes, to 1½ knots or more in strong winds.

Off the beacon, at the entrance to the dredged channel to Apalachicola, the current is just the opposite in the corresponding directions of ebb and flood; here ebb current sets to the eastward and flood to the westward. In calm weather each current runs about half a knot an hour. There are times when a greater rise and fall of the tides give a southerly and northerly direction to the ebb and flow respectively. In strong westerly gales the current runs from 3 to 4 knots an hour to the eastward, as long as the wind continues strong.

Off buoy No. 8, between Cat Point and the beacon, the flood runs to westward and the ebb to eastward.

At a position about three-fourths of a mile to the southward of Cat Point, the flood runs to the westward and the northward, and the ebb to the eastward and southward; the currents have an average flow of about 1 knot an hour. These, of course, are the average currents under normal conditions.

On the southern side of the bay, off Cedar Point, the flood runs to the westward and the ebb to the eastward, each with an average velocity of half a knot per hour. The same general rule seems to apply to the current, with regard to direction of ebb and flow, all along the shore of St. George Island as far as New Inlet. Over the oyster bed known as East Hole the appearance of a mossy growth on the beds would seem to indicate eddying currents at this part of the bay, but this theory was not established by observation on account of lack of time. At a position between the central part of St. Vincent Bar and West Pass, the currents run to the eastward during flood and to the westward during ebb. Flood current has a velocity from 1 to 2½ knots and ebb from ½ to 1 knot per hour.

As in other parts of the bay, the winds govern the currents very perceptibly.

The tides.—The mean rise and fall of the tides, established by continuous observations lasting during the period covered by the survey, was 1.8 feet, but it must be borne in mind that the tidal observations were taken during the winter and early spring, and that a somewhat different result might have been obtained from a series of observations during the summer.

The tides are very much affected by the winds, and this is particularly noticeable during the heavy northers, when the water is driven out of the bay and the tide is very much below the level of mean low water, being in some cases as much as 1.1 feet below. This very low water is usually accompanied by cold, and sometimes by freezing weather, which is very destructive to such parts of the oyster beds as are exposed. Heavy southerly gales cause unusually high tides, and hurricanes and freshets cause disastrous floods.

As is well known, there is usually but one tide in twenty-four hours on this part of the Gulf coast, and the tides are very irregular. At times during the survey the tide would be low for several days together, and then, again, would be high for a considerable period. In fact, the tides are affected by the winds to such an extent as to sometimes almost obliterate the effects of the lunar influences.

WESTERN PART OF APALACHICOLA BAY.

Silva's Bar.—The dense growth of oysters on this bar covers 16 acres, and the scattering growth, surrounding the bar proper, contains about 200 acres. The bar has from 2 to 3 feet of water on it at low water, and extends nearly north from St. Vincent Bar for about three-fourths of a mile, being about 100 yards in width. The scattering growth extends out half a mile beyond the bar, and is over one-fourth of a mile in width.

The oysters of this bar are of excellent quality, and there is only one other bed—Cat Point Bar—which can be compared with it. These oysters also compare very favorably with the best northern oysters. They are most plentiful on the northern portions of the bar, being found here, in number, about 20 to the square yard, and are about equally divided in bunches and single oysters. They average from 3 to 5 in a bunch. The whole area of oyster bottom is quite clear, with very little vegetable growth. The oysters are covered generally with barnacles and mussels, and in some cases with vegetable growth to a small degree. By using the probe on the bed proper, it was found that it was about a foot thick, after which a strata of hard sand was met with, and then soft mud. Considerable quantity of young growth, in different stages of development, was noticed, but no collection of spat. No enemies of the oyster were discovered. The bottom covered by oysters consists of hard sand.

St. Vincent Bar.—This bar is a very long broken one, consisting, for the most part, of dead oyster shells, and extending about 1 mile in an easterly direction and about 3 miles in a southerly direction. Oysters are only found at the northern end, and are not sufficiently close together to be designated as dense growth. The area of scattered oysters covers about 200 acres, and the area of the old bed lying to the southward, consisting only of shells, covers 335 acres. At the northern end of the reef there is a shell bank, out of water about 1½ feet at high water, and extending out from St. Vincent Point half a mile; then comes the boat channel before alluded to, and then another shell bank extending half a mile. From this point, the reef is broken up into patches which are exposed at high water.

A marked peculiarity of this long reef is that it is very steep-to on its southern and western sides, and shelves off gradually on the northern and eastern sides. The oysters are found almost entirely on the latter or shelving side, but they do not extend along the reef more than 1¾ miles. The oysters occur in bunches of from three to six, and are also found singly. They are all of good size and excellent quality, with the exception of those that are on the tops of the reefs, awash at low water, which approach the raccoon type. A good growth of young oysters, in different stages of advancement, was found all along the reef where there are oysters, and the bed seemed to be improving.

No oysters of any marketable value are found on the reef beyond the limit already mentioned. There are, however, some oysters of young growth which give promise, if undisturbed, of forming a bed, in course of time, of some commercial value. Of the enemies to the oyster, one single drill was found at the end of the bar, and this was the only drill found in this part of the bay.

The probable loss of this oyster bed, which in former years was one of the most productive, is due probably to the very severe hurricane which occurred several years ago. At that time the bar was completely covered up by mud, and only of late years has it begun to clear. During the hurricane the southern portion of the bar was more exposed than the northern portion and the beds to the northward, which accounts for the fact that oysters are still found in the latter localities.

It is generally supposed that a swift current is favorable to oyster life; the whole length of St. Vincent Bar is favorably placed in this respect, as the current over it, banked up by the reef, has considerable velocity. The densities here are more influenced by the flow of the tide than in any other locality in this vicinity.

As before remarked, there is apparently no reason why the whole of St. Vincent Bar should not again become a productive bed, and the general appearance of the young growth bears out this opinion.

The shell reefs north of the end of St. Vincent Bar.—A number of shell reefs, with no live oysters on or near them, are found about $1\frac{1}{2}$ miles north of the end of St. Vincent Bar. These former oyster beds are similar to the southern part of St. Vincent Bar in regard to there being no oysters of full size found on or near them. They consist of one large reef with 4 feet of water on it at low water, containing 23 acres, and three other smaller ones, containing altogether 13 acres. They all rise abruptly out of from 8 to 10 feet of water. On these beds the shells occur in clusters of from 8 to 10, and vary in size from $\frac{1}{4}$ inch to $4\frac{1}{2}$ inches in length. The inside of the shell presents a clean appearance, as if the shell had been buried and only lately uncovered; this applied to the smaller as well as to the larger shells. The outsides of the shells were covered with barnacles, and a good many oyster crabs were noticed. A few live oysters of young growth, about half an inch in diameter, were found on many of the shells, but this growth seemed to be confined to the ridges of the reefs proper. The old shells are very closely packed, and a good many are covered with a coating of mud. The probe showed these beds to be about $3\frac{1}{2}$ inches in thickness. Under the beds there is a layer of soft mud for a depth of 2 feet, and then hard sand for about a foot or more. No vegetable growth was found on the beds, and no enemies of the oyster could be discovered. Undoubtedly the loss of these beds was due to the same cause that destroyed St. Vincent Bar—namely, the hurricane before spoken of. The appearance of the beds indicates that they had been buried and only lately uncovered. It is likely that these beds will recover, if not molested.

South Lump.—This is the name given to an oyster bed which lies half way between the end of St. Vincent Bar and Tow Head Island, near Apalachicola, and about half way between them. It contains 35 acres of quite a dense growth of oysters, which are, for the most part, small in size. The reef runs east and west, and is five-eighths of a mile in length, and a little more than an eighth of a mile wide at its widest part. It has over it a depth of from 3 to 6 feet at low water, with a ruling depth of 4 feet. The depth of water surrounding the reef is from 8 to 9 feet at low water, and the reef is more shelving on the north than on the south side. This bed, like the others surrounding it on the north side, was formerly very productive, but it, like the others, was so overworked that it became depleted a few years ago. Since that time, these beds have been left to recuperate, and it seems probable that, if left undisturbed, they will soon recover their former productiveness. At present among the old shells are found some full-grown oysters—about two to a square yard—while all over the bed young oysters are found of all sizes, all in a healthy condition. No enemies to the oyster were discovered. The bed is 2 feet in thickness, and underlying the bed it is hard sand.

Oysters between South Lump and central part of St. Vincent Bar.—A cluster of beds, surrounded by a scattered growth of oysters, occupies a space about half way between South Lump and the central part of St. Vincent Bar. The reefs proper consist of one large crescent-shaped reef, containing 18 acres of dense growth, and two small ones to the east and west of the large one, containing respectively 4 and 3 acres. The large area of scattered growth lies to the westward and northward of the reefs, and contains 145 acres. On the beds there are 4 to 5 feet of water, and the water surrounding them and on the scattered growth is about 7 to 8 feet in depth. There are some full-grown oysters in bunches of from 2 to 4, but the beds consist principally of young growth in all stages of development, most of which seems to be in good, healthy condition.

With regard to the young growth a peculiar circumstance was noted in a few instances: Among the shells tonged up were found attached small shells of 1½ years growth, which had died and were filled with mud. Where the old shells were taken up the mud had a disagreeable odor of tar gas, or something resembling it, which may have caused the death of the oysters. The thickness of the bed was 1 foot, with soft sand underneath. The full-grown oysters are of good flavor and in good condition. They are found on the beds about 8 to the square yard. The young growth was plentiful, there being about half a bushel to 4 square yards.

The area of scattered growth has a bottom of uniform depth, averaging about 7½ feet at low water. The area is covered with old shells imbedded in the sand, to which the young oysters are attached. There are some full-grown oysters, but most of them are of medium and small size. They are in bunches, with small oysters and spat attached, and all are covered with barnacles and mussels. Of the small oysters there are about 3 bunches to a square yard, the bunches varying in the number of oysters in each. As the bottom all along the western and southern edges of this area as far as St. Vincent Bar is suitable for oyster growth, there is no reason why the bed should not expand, in time, to a much greater size. It is fair to suppose that if the beds are not worked for two years they will improve to such an extent as to be again in condition for harvesting.

Oyster reef northwest of South Lump.—A long, narrow oyster reef is found three-fourths of a mile northwest of South Lump, and between it and Green Point. The whole reef contains 5 acres of dense growth and 19 square acres of scattered growth, and extends in a northeasterly and southwesterly direction for three-fourths of a mile, being quite narrow. It has from 4½ to 5 feet of water on it at low water, and rises abruptly from a depth of 7 feet. The foundation of the bed consists of old worn-out shells, on which are found some full-grown single oysters, especially on the eastern part of the reef. Young oysters and spat are found in considerable abundance all over the reef. The number of full-grown oysters is 4 to a square yard, and of the small growth 1 bushel to a space of 4 square yards. The oysters are of good flavor and fat. The young growth occurs in bunches of from three to six. No vegetable matter was found, or enemies of any kind noticed. The bed is 6 inches deep, with soft sand underneath.

This bed in a few years will become one of excellent productiveness.

The reef north of South Lump.—A long, narrow oyster reef, to which no name has been given by the oystermen, begins at a point about half a mile north of South Lump, and extends in a northwesterly direction for over a mile. The reef itself, except at its middle portion, is very narrow, and has only 4½ to 5½ feet of water on it at low water. It rises abruptly from a uniformly soft muddy bottom, on which is a depth of from 7 to 8 feet at low water. The area covered by oysters extends beyond the limits of the reef itself, and measures 67 acres. This bed has the same characteristics as the others in this locality. There is a good growth of young oysters attached to the old shells, and rather fewer full-grown oysters than are found on the neighboring beds. Observations gave about three full-grown oysters to a square yard, and half a bushel of young growth to 4 square yards. The oysters here were rather fresh in flavor, but this was probably due to the low density which existed for some time just before the observations were made. The bed, like the others hereabouts, gives good promise of productiveness.

There is a small outlying patch of about 5 acres lying about an eighth of a mile east of the bed just described, and it has the same characteristics.

Thigpen Bar.—This oyster bed is located near the mouth of the Apalachicola River, and is about half a mile west of the entrance of the dredged channel. It is a narrow bar running in a northwest-and-southeast direction for over half a mile, and the whole oyster area covers 13 acres. There are only 3 feet of water at low water on its shoalest parts, and it has about it 5½ to 6 feet of water and muddy bottom. On this bed there are full-grown oysters of excellent quality, as well as a fine growth of young oysters in different stages of development. The large oysters are found singly and in bunches of from two to five. The full-grown oysters are found about nineteen to the square yard. The depth of the bed is 1 foot, with hard sand underneath.

Thigpen Bar, in common with all the oyster beds of the northern part of the bay, has not been worked for several seasons by the oystermen, as it had been agreed to allow these beds to remain undisturbed for a time, to give them a chance to recuperate from their state of depletion, brought about by the too great demand of a few years previous. It would appear at present that this bar ranks next to Silva's Bar in point of quality of its oysters. It is, however, of small extent.

It seems somewhat strange that this excellent bed of oysters should exist in such close proximity to the entrance of the dredged channel to the river, but it must be remembered that this extrance is fully 2 miles from the mouth of the river, and a very small part of the fresh water of the river is confined to the channel, but overflows in all directions after leaving the mouth. Also, it should be remembered that there is a tidal current at the bar, which tends to remove any deposit of silt which may be brought down by the river.

During the latter part of the survey the dredging of the cut at the entrance of the river was in progress, and all the mud removed was dumped on the west side of this bar. Whether or not this deposit of mud will destroy the bed remains to be proved.

Oyster bed near Thigpen Bar.—A small detached bed lies just east of Thigpen Bar and northwest of black buoy No. 5. It covers 7 acres and has the same characteristics as Thigpen. At the east end of the reef there are only 3¾ feet of water at low water, and this shoal spot is exactly in line with the dredged cut.

Area of good planting-ground.—The area suitable for cultivating oysters includes a long strip extending in a north-and-south direction nearly from the end of St. Vincent Bar to Green Point, and in an east-and-west direction from the edge of the reef to the first cluster of outlying oyster beds. It is 4 miles in length and averages about a mile in width, covering an area of 2,440 acres. In this area there is, opposite Silva's Bar, a small circular space of nearly three-eighths of a mile in diameter where the bottom is soft mud, and therefore unfit for cultivation. The lower half of the southern portion of the planting area has a bottom covered with shell, which, no doubt, some time ago was an area of scattered oysters, and which will become one again in the course of time. All the northern part of the area has a bottom which consists almost entirely of hard sand.

THE EASTERN PART OF APALACHICOLA BAY.

Norman's Bar.—This name is given to the oyster bed lying nearly 1¼ miles to the westward of Cat Point. The bed, although not at present of dense growth of oysters, is quite extensive and covers an area of 285 acres. It extends in a NNW. and SSE. direction for 2½ miles and is about one-fourth of a mile wide, except in its southern extremity, where it gradually narrows. There is a depth at low water of 4½ feet on the central part of the reef, with a depth of 5½ and 6 feet to the westward and eastward of the reef. At all the other parts of the reef there is only a slight decrease in the depth of water from the waters surrounding it. The bed contains no marked ridge, and has a uniform bottom consisting of hard sand.

A peculiarity of this bed is that its crust is thicker than any of the beds thus far spoken of in the western part of the bay, and the old shells comprising it seem to be more closely packed. The probe, with a sharpened steel point, could hardly be driven through the closely packed mass of old shells, and it was found to be 3 to 3½ feet in depth. Soft sand was found underneath.

Over the old shells composing the bottom of the bed is found a scattering growth of oysters, mostly small in size and unevenly distributed, those in the southern portion being more plentiful and of better size and quality than those found at the northern part. At the southern portion the oysters are found in bunches of from two to five, with a good growth of young oysters in different stages of development attached. The oysters here are found about nine to the square yard. Some grass was found growing on them and a few black crabs were noticed.

On the middle portion of the reef the oysters occur in bunches of from three to eight, but fewer bunches are found, the average number of oysters being three to the square yard.

At the north end of the reef the oysters are still more scattering. The oysters on the middle part of the reef seem to be about 2 years old. Some spat was noticed on the shells at the northern part of the reef. The oysters at the north end of the reef were of poor quality compared with those at the southern end. This is to be expected from a study of the densities shown on the map.

Norman's Bar has not been lately worked to any extent, as it had previously been overworked. If the bar is undisturbed for a year or two it can then be worked profitably; the bed can undoubtedly be kept in a productive condition if worked moderately and the undersized oysters culled and thrown over.

The North Lumps.—There are three small detached beds of oysters lying nearly in line between Godley Bluff and the north end of Norman's Bar. The total area of these beds is 10 acres. They lie in about 4 to 5 feet of water, and the eastern, or inshore one, has but 2 feet on it at low water. The middle one has 2½ feet on it, and the western one 4½ feet at low water; the latter lies in about 5 feet of water.

The oysters on the beds are found in quite dense growth, there being thirty to the square yard; they are of good size and fatness, but, owing to the freshness of the water, have the peculiar insipid taste noticeable with oysters growing in water of low density. The thickness of the crust is about 3 feet.

Oyster beds westward of Norman's Bar.—Two small beds lie one-fourth of a mile to the westward of the north end of Norman's Bar. The northern one of these two beds is half a mile long and very narrow; it lies nearly half a mile north of the other, and contains 7 acres. The southern one is circular in shape and contains about 4 acres. The least depth of water on these beds is 3½ feet at low water. The oysters are in bunches of from three to four. They are of medium size, with young growth and spat attached, and, as usual, covered with barnacles and mussels. They are found on the bottom about fifteen to a square yard. As may be expected from their location, they are not of good flavor.

Beds to northward of buoy No. 8.—Two long, narrow beds extend to the northward from buoy No. 8 (present location), and lie on a line between the middle part of Norman's Bar and the entrance to the dredged channel to Apalachicola. The northern reef is particularly long and narrow, having a length of nearly three-fourths of a mile and an average width of only about 50 yards. It covers 15 acres. The southern reef is nearly three-eighths of a mile long, and contains 8 acres. It is separated from the northern by a distance of one-fourth of a mile, the bottom between the two being hard sand and shell.

There is a detached bed, containing 4 acres, lying 200 yards east of the south end of the southern reef, and just northwest of the present position of buoy No. 8. The depth of water on the two long beds is 5 to 5½ feet at low water and on the smaller one 6½ feet.

The oysters of these beds all have the same characteristics—they form a scattered growth, and occasionally are found singly, but more often in bunches. The single ones are the largest, and are of fair quality. There are a large number of small oysters, and it is probable that these beds will rapidly improve if they are worked moderately, and the undersized oysters culled and thrown back on the beds.

Pelican Bar.—This bar lies about half a mile from the southern shore, and about 2 miles to the eastward of Cedar Point. It is nearly three-eighths of a mile long, and contains 10 acres of a moderately dense growth of oysters. It has, on the eastern side, a scattered growth, containing 38 acres. It is very shoal, having only 1 foot of water at low water. The oysters are mostly small, the greater part of marketable oysters having been taken in former years, and the small ones not having had time to grow. They are found in bunches of three to ten. Nearly all have a growth of brown and green grass on the shell. Considerable spat was noticed. No enemies were found. Like other beds, Pelican Bar will improve if worked in moderation.

Oyster bed near Pelican Bar.—A small bed lies about WNW. of Pelican Bar, distant nearly half a mile. The bed is three-eighths of a mile long and one-eighth of a mile wide, and covers altogether 24 acres, of which 7 have a dense growth. The oysters of dense growth are found about seventeen to the square yard, being in bunches of from two to four. Those of the scattered growth have about six to the square yard. The oysters are small and not fat, but of good flavor. Numerous young were noticed, and there was a good collection of spat. On some of the oysters a vegetable growth was found, and all, as usual, were covered thickly with barnacles and mussels.

As the bottom all about this bed is favorable for oyster life, it will probably improve and spread if it is given proper treatment.

This bed and Pelican Bar have been very little worked recently, owing to the fact of there being so few marketable oysters on them, the supply of large ones having been exhausted in former years.

Oyster bed east of Pelican Bar.—A small bed lies about east from Pelican Bar and distant a little over half a mile. It has an approximate area of 7 acres. There are only 2½ feet of water on it at low water.

The oysters on this bar have the same characteristics as Pelican Bar and the bar westward of Pelican Bar.

Area of scattered growth along the south shore.—All along the north shore of St. George Island, from a point 1 mile east of New Inlet, is a narrow strip of oyster growth, more or less scattered, extending out from the shore about an eighth of a mile. Scattering oysters also are found in the small inlets, creeks, and bays along the shore. These oysters are all of inferior quality and are mostly of the raccoon type, those close inshore being exposed at low water. They are not taken for marketable purposes.

Area of old beds where no live oysters are now found.—Between Cedar Point and Norman's Bar, and about WNW. from Pelican Bar, is an area of 285 acres which is covered by old oyster shells, and which was formerly a good oyster bed. This extinct bed extends 1½ miles in a northwest-and-southeast direction, and has a general width of nearly three-eighths of a mile. No oysters are found on this area. The loss of the bed is attributable to the hurricane which destroyed St. Vincent Bar. The present position of buoy No. 8 is in the northern portion of this area, and the channel to Carrabelle, that always has been used, crosses it just south of the buoy. A much better channel, with 8 feet at mean low water, was developed by the survey. It lies just south of this area above described.

Good planting-ground in the eastern part of Apalachicola Bay.—The area best suited for oyster cultivation in the eastern part of Apalachicola Bay extends from the shore of St. George Island, just east of Pelican Bar, to the extinct bed before mentioned, and terminates somewhat beyond it, at a long, narrow oyster bed. It practically covers a long spit or shoal that makes out from St. George Island in a general northwesterly direction for over 4 miles. The planting-ground also covers the area about Pelican Bar and the small oyster beds to the westward and eastward of it. The extinct bed can be included in this planting-ground. The bottom consists almost entirely of hard sand, except over such portions as are covered with shell. The density, temperature, and currents are all favorable to oyster-culture.

Adjoining this ground and extending along the southern shore of the bar to within a mile of New Inlet is another large area that also may be considered suitable for planting, although in a somewhat less degree than the area just described, on account of the greater density of the water. The ground makes out nearly half a mile from shore, except off Cedar Point, where it spreads out for a distance of 1¼ miles. The whole area of ground suitable for planting, inclusive of the extinct bed, is 2,673 acres.

Between Pelican Bar and Norman's Bar is a comparatively small area of hard bottom suitable for planting; it contains 82 acres. Its general direction is east and west for nearly three-fourths of a mile, and it is one-fourth of a mile wide. It is surrounded by soft mud.

Another planting area, containing 175 square acres, surrounds the

North Lumps. It extends east and west for 1 mile and has a width of three-eighths of a mile. This latter area can not be considered as a very advantageous place for cultivating, on account of the low density.

ST. GEORGE SOUND.

The only oyster beds of any importance in St. George Sound, at present, are the large beds at the west end of the sound. There are other beds to the eastward of the limits of the survey, and some of them were formerly productive, but at present none are worked. It is to be regretted that lack of time prevented including these few beds in the survey. The area from Cat Point southeast to St. George Island, for an average width of nearly three-fourths of a mile, forms one large, continuous oyster bed, although different names are given to different parts of the area. It is here that the oyster fleet, consisting of about 32 vessels, has recently been concentrated, and during the season of the survey practically all the oysters brought into Apalachicola were obtained on these beds.

The following is a description of these beds in detail:

Cat Point Bar.—This bed extends from Cat Point southward for about 1½ miles, and is nearly three-fourths of a mile wide, except at its northern part. It adjoins Platform Bar to the southeast, and is separated from Bulkhead Bar by the dredged cut. It contains 485 acres of dense growth of oysters, and 77 acres of scattered growth between the shore and denser growth. It has a least depth of water of 2 feet, while the ruling depth is 3½ feet.

The oysters of this bed, especially those found near the 3-foot curve off Cat Point, are of the very finest quality, and it is probable that no better flavored oysters can be found in any part of the country. They are not only exceptionally good in flavor, but are large and fat. At this part of the reef the oysters are found singly and in bunches of from two to five. The number to the square yard is 19. Numerous young are found attached to the shells, as well as a few barnacles and mussels. No drills, conchs, or other enemies could be discovered, and there was no vegetable growth found on the oysters. The probe showed that the crust of the bed was about 1 foot thick, with hard sand underneath.

About the center of the bed the oysters are even more plentiful, there being as many as 60 to the square yard. There was found a fine growth of young oysters attached, aggregating four to five young on each bunch. All over the bed old worn-out shells are found, and mussels and barnacles in quantities, but no vegetable growth. At the southern part of the bed observations showed the oysters to be quite as numerous as in the middle part, and of good size and excellent quality. Everywhere is a numerous growth of young, but no spat was noticed. The bed seems at all places to have the same thickness of crust. The scattered growth extends from the shore out to the dense growth. The oysters here are not of as good quality as those farther offshore. Close inshore are several raccoon beds which are dry at low water.

Platform Bar.—This is the name given to the southeast extension of Cat Point Bar, and only the western part of this bar is shown on the map. The part included by the survey covers 130 acres. There are very few large oysters on this bed, but there is a fine growth of young oysters, in different stages of development, attached to the old shells, and in bunches of from three to ten. On the old single shells a quantity of spat was found. Very few barnacles were seen, and no mussels. There were no enemies or vegetable growth discovered. The number of bunches of young oysters to the space of 1 square yard is about seven, and these young oysters, when full grown, will make a fine bed. The crust of this bed is 2 feet thick.

Bulkhead Bar.—This oyster bed lies to the southward and westward of the dredged cut, and covers only a comparatively small space when compared to the large beds of East Hole and Cat Point bars. The number of acres of dense growth included is 210, and extending out from its western edge is an area of scattered growth containing 59 acres. The bed contains good single oysters and oysters in bunches of from two to seven, and the average of the observations in different parts of the bed gives thirty-three oysters to the square yard—rather less than was found on Cat Point Bar. At the same time fewer young oysters were found than on Cat Point Bar, and the oysters, although fairly fat, had a somewhat fresh taste. No spat was noticed here, nor was there any vegetable growth. The probe showed the crust to be about 2 feet thick. Underneath was a layer of soft sand 5 feet thick, and then hard sand.

The ruling depth of water on the bed is 4½ to 5½ feet, while the water on the scattered growth to the westward is 7 feet, all at low water. The scattered growth runs out to the westward until it nearly meets the eastern end of Norman's Bar.

East Hole Bar.—This is the name of the large oyster bed of dense growth that extends from Bulkhead Bar in a SE. direction to the shore of St. George Island. It is nearly 2 miles long, with an average width of three-fourths of a mile, and covers 720 acres. It has a depth of water at low water of from 4 to 5 feet, except along its eastern edge, where it has 8 or 9 feet. The oysters on the northern half of the bed are found almost entirely in bunches, usually two to five oysters in each bunch. They average about thirty-five to the square yard. There is a good growth of young in all stages, but no spat was found. On nearly all the bunches of oysters were patches of brown or green grass, from 4 to 9 inches in length. There was the usual collection of barnacles and mussels. No enemies were observed.

The oysters are of fair quality and in rather poor condition. The southern portion of the bed contains a thick growth of full-grown oysters in bunches of from three to eight, with young growth attached of all ages, from tiny spat to a size of 2 inches. A few of the full-grown oysters were found to be of the raccoon type. Besides barnacles and mussels each bunch had more or less brown grass attached. The grass here was from 3 to 10 inches long. The oysters are not of good quality or of good flavor. The average number of large oysters found in a square yard was about half a bushel; thickness of the crust was $1\frac{1}{2}$ feet.

The same general conditions exist as in the northern part of the bed. The thick growth of full-grown oysters extends to the 3-foot curve, when the growth becomes scattering and the oysters merge into the raccoon type.

The grass which has been spoken of as growing on nearly all the oysters of East Hole Bar affects their market value considerably. It is said by those interested in the canning business that, in the steaming process, algæ become mixed with the juice and appear, in the cooked oyster, as small particles of coarse hair; it is said, also, that the gills become discolored. These appearances, however, must be due to the preserving process to which the oysters are subjected, as Mr. Moore's examination of specimens from this bed, given in his report, shows that the algæ could not permeate the body of the oyster.

As a good part of the oysters brought into market are for canning purposes, it follows that the oysters of East Hole are of little value for this use, and the locality is therefore avoided to a great extent by oystermen, especially by those collecting oysters for the canning factories. The fact that the oysters of East Hole are covered with algæ to such an extent is probably due to the small velocity and eddying nature of the currents over the beds; thus, the growth, instead of being carried away by the current, is retained on the bed by the eddies. No grass is found on Cat Point Bar, for the reason that the currents there are sufficiently strong to sweep the beds of all such matter.

GENERAL REMARKS ON THE AREA SURVEYED.

The oysters of the locality surveyed were first taken for the local market in 1836, but were not taken in any quantities until 1850. During the war the beds were left undisturbed, and improved so much that at the end of the war they were in very good condition. After the war the oyster business was again taken up, but it was not until 1878 that it was carried on at all extensively. During the winter of 1893–94 the beds of St. Vincent Sound and Apalachicola Bay were nearly destroyed, and since that time practically no oysters have been taken from those

NOTE.—Mr. J. G. Ruge, of the firm of Ruge Brothers, who have the largest canning business of Apalachicola, makes the following statement in regard to the vegetable growth on the oysters of East Hole vicinity:

"The growth consists of two varieties, one of which is coarse and wiry in appearance and red or black in color. This variety does not injure the oyster for canning purposes. The other is much finer, and is a soft, black, hairy growth, called by local fishermen "whiskers." This variety affects the oysters seriously when steamed, as the meat absorbs numbers of particles of it, and, notwithstanding the steamed oyster may be washed and rewashed, after processing, on opening the cans, myriads of fine hair particles may be readily observed. If these cans are left open for several days and the oysters exposed to the air, they turn a dark green color."

places. The Bulkhead and Cat Point bars have lately furnished about all the oysters brought into market, although some few have been taken at Porter's Bar, to the eastward.

The destruction of the beds in St. Vincent Sound and Apalachicola Bay was due somewhat to their being overworked, but principally to the following causes: The freshet of 1893, the hurricane of October 8, 1894, a very severe freeze in the latter part of December of the same year, and another very heavy hurricane on February 13 and 14, 1895. There had been previously (in January, 1886) a heavy freeze that killed many oysters, so that few were taken the following season, and in 1888 a freshet seriously affected the beds.

It seems to be the general opinion that the beds are deteriorating at Platform, Bulkhead, and Cat Point bars, where oystering is going on at present, and the reason assigned is that the beds are overworked, the demand being too great for the supply. As far as known, there seem to be no enemies of the oyster on the beds, unless the boring clam mentioned by Mr. Moore in his report and the algæ found on the oysters of the East Hole Bar may be called enemies. Mr. Moore's examination of the specimens revealed the fact that the barnacles and mussels, which have been spoken of as being found in great numbers on all the beds, grow with such rapidity and wedge themselves between the shells of the oysters so closely that they must in many instances cause the death of the oyster.

The oysters are affected by long-continued dry weather, becoming salty in taste, and in freshets they become white and milky. Both conditions affect their sale. Heavy gales bury them completely, but otherwise very little deposit of mud or silt is noticed. During the heavy freezes the oysters that, after being frozen, are covered up by water, recover, but those left uncovered die.

Of the beds to the eastward of the limits of the work, Porter's Bar was formerly said to have oysters resembling northern oysters, but it now has very few oysters on it, owing to the fact of its having been covered up in a hurricane. There are very few, if any, oysters on Sneed's Bar or Silva's Bar at present.

The oysters are said to grow better in a depth of water of about 4 feet at low water than at any other depth, and they thrive and grow faster in a tideway than in still water.

Tongs are used entirely in getting oysters, and it is contrary to the State law to use a dredge of any kind. It is estimated in tonging that the average proportion of dead shells to live oysters, taken on the beds worked at present, is about two-thirds of shells to one-third of oysters, and the proportion of the larger to the smaller oysters is one marketable oyster to two small ones. The number of oysters to the bushel brought into market is about 140 to 165. The best age for market is from three to five years, and flavor is not taken into account in the market price, but only size and fatness. It is found that about 2 per cent of the oysters have oyster crabs in them.

The oyster shells are thick and heavy, thus making great bulk to proportion of contents as compared with Chesapeake Bay oysters. As already stated, the oysters formerly on Porter's Bar were an exception to the rule. For canning purposes the Chesapeake Bay oysters yield 50 to 70 ounces of cooked meat to the bushel, and the oysters brought into the Apalachicola market yield 30 to 40 ounces to the bushel. The highest yield known in a day's work was 72 ounces of northern oysters, and of Apalachicola oysters 43 ounces, to the bushel.

MEASURES FOR IMPROVEMENT OF THE BEDS.

There is no room for discussion concerning the comparative harmful effects of the use of the tongs and dredges in Florida waters, as the use of the latter is prohibited by State law. A copy of the laws is appended to the report, and a study of them will show that good laws have been enacted by the legislature to protect the natural beds. It is probable, however, that an improvement would be made by prohibiting the taking of oysters after April 15, or even earlier, as the warm waters of the Gulf cause an early spawning season. It is doubtful whether the law regarding the taking of small oysters and the culling of the oysters—especially the latter—are strictly complied with by the oystermen, yet it is of the greatest importance that they should realize that this law should be strictly obeyed if they wish to maintain the productiveness of the beds and thus insure themselves a livelihood in the future.

In spite of the fact that the demand appears too great for the supply, it seems probable that the beds will at least not deteriorate if the laws be enforced regarding the restriction of tonging during the spawning season, culling at places of tonging and throwing back undersized oysters, and allowing no dredging.

An improvement of the beds would be made by breaking up the clusters of oysters where feasible.

OYSTER BUSINESS OF APALACHICOLA.

During the period from 1836 to 1861 a few thousand barrels of oysters in the shell were shipped each season to Georgia and Alabama. During the war no business whatever was done, but at its close the shipments were resumed and continued to the present time, business having increased in later years.

Before the beds in Apalachicola Bay and St. Vincent Sound were practically destroyed, and at the time the oyster business was at its height, 120 to 150 vessels were employed each season in taking oysters. At present there is a fleet of 12 vessels obtaining oysters for canning purposes, and 20 for raw and shell shipment. There are usually three men, or two men and a boy, in each vessel, although there are some few boats with only one or two men. A profitable day's work in favorable weather, for two men in a boat, working—as is usually done—day and night throughout the twenty-four hours, is 20 barrels.

An idea of the comparative productiveness of the beds at present and formerly is obtained from the fact that under ordinary circumstances three men can now take 100 bushels of oysters in two days and two nights, and formerly the same men could take 100 bushels in twelve hours daylight. At present $1 to $1.25 is paid for a barrel of oysters, including the barrel. Oysters brought to market and not used for canning are shipped in shell to Columbus, Ga., Jacksonville, Fla., Atlanta and Macon, Ga., and are in the raw-shucked state shipped to Chicago and Louisville. Canned oysters are shipped to the Western States mostly. The proportion of the whole catch to that part consumed in Apalachicola is very small.

The canning of oysters was first tried in Apalachicola in 1860, but the experiment was a failure, owing to the lack of knowledge of the degree of heat necessary to preserve the oyster. Canning was taken up again in the fall of 1883 and carried on until 1885, with indifferent success, but in the first year mentioned sufficient experience had been gained to demonstrate the fact that a different number of units of heat were necessary to preserve the oysters than had been used for the Chesapeake oysters. In 1886 the canning plant fell into the hands of the present operators, Ruge Brothers, and was carried on with varying success; in 1887 a second plant was started by the same firm. Mr. T. W. Bamberger, in 1889, started a small plant, which was operated several seasons. In 1891 the Green Point Canning Company built a large plant, and operated one year at a loss. This plant was bought by Ruge Brothers, and merged into their first company. It was run by them one season and has since been idle. The fact that the canning business can not be carried on to any extent for any length of time is due to the fact that the supply of oysters is insufficient to satisfy the demand, notwithstanding the fact that the packers have used every means they could to preserve the oyster beds by refusing to take oysters under proper size, or out of season, or not properly culled, as well as in alternating the use of different beds each season. The oysters and spat have been seriously affected by gales, freezes, and freshets.

The canning business in Apalachicola has been injured during the last four years by the fact that the packing of oysters at Fernandina, Brunswick, Savannah, and Biloxi, has been done at less cost and with lower freight rates than at Apalachicola.

The output of the canning factories of Apalachicola has been as follows: In 1893-94 the Ruge Brothers Canning Company, 63,000 bushels or 400,000 one-pound cans. In the same season T. W. Bamberger & Company's factory's output was 13,000 bushels or 100,000 one-pound cans. In 1895 one plant only was running, and in 4½ months canned 13,000 bushels, or 100,000 cans. Owing to the scarcity of oysters, the Ruge Brothers' plant will not at present operate, as it will take from three to four years for the oyster beds to recuperate sufficiently to supply enough oysters to run the canning factories to full capacity.

THE CULTIVATION OF OYSTERS.

As before stated, planting was tried experimentally on the north side of St. Vincent Sound, and enough was done at the time to show that it could be made a decided success, if the laws of the State regarding planting could be enforced. As it was, no protection whatever was given, and the experiment proved unsuccessful for that reason. The State laws protect the planters, but there appears to be no attempt to enforce the laws, and the moral sentiment among the oystermen is not in favor of such protection. This is due to a misunderstanding of the subject by the oystermen; the law makes a distinction between the cultivated beds and natural beds, and relates wholly to the cultivated beds, but the oystermen have the idea that any protection given the planters is of the nature of a monopoly, and is an encroachment on their rights. Of course such is not the case, as the laws protecting planters do not in any way interfere with oystering as now carried on on the natural beds. All the oyster cultivation would be carried on entirely away from the natural beds, and in some cases in localities quite remote from them. The chart shows exactly where oysters may be cultivated, and any intelligent person by using a compass may locate himself with sufficient accuracy to find the limits of the planting ground; in this connection a sounding pole will be of great assistance, as by it he can judge of the character of the bottom as well as the depth of water. By closely studying the limits of the planting area a person can select certain natural ranges which will help him locate himself.

The whole question of oyster cultivation is of the greatest importance to the people of Apalachicola and vicinity, as undoubtedly, if the law is enforced and the planters protected, it may be made a great industry, and it is only necessary to cite as an example the great success met with by the oyster cultivators of Long Island Sound in order to show what a great business may be developed. But first the oystermen must be brought to a realization of the fact that the protection of oyster cultivation does not in any way infringe upon their rights, and that on the contrary it is directly for their best interests. All have equal rights, and any man having sufficient thrift and energy may, without much doubt, better his condition by undertaking the cultivation of oysters and uniting with others to respect the laws.

The cultivation of oysters would be more easy on account of the number of oyster shells brought into Apalachicola. By simply spreading these shells over the areas of planting ground, the spat would attach itself to the cultch, and only a little care in cleaning and spreading would be required to form, in time, a productive bed. It should always be borne in mind, as has already been mentioned, that oysters grow and thrive much better in a current than in still water, as they have a better food supply. In transplanting the clusters should be broken up and each oyster should be thoroughly cleaned of barnacles and mussels.

It is almost certain that if the question of oyster cultivation were taken up in the proper way by the people of Apalachicola and vicinity, excellent results would be obtained. No better flavored or conditioned oysters can be found anywhere than those at Cat Point Bar and at Silva's Bar, and by using the seed from these bars it can be safely prophesied that oysters of the cultivated bed will excel those of the natural beds. There is little doubt that if the oysters on East Hole Bar, where the vegetable growth renders them unfit for canning purposes, were transplanted to other localities, they would lose the peculiar characteristics so injurious to them, and become, like the Cat Point oysters, excellent in quality.

SPAWNING SEASON AND SPAWNING HABITS.

The spawning season, as near as may be ascertained, extends from April 15 to July 15, but these limits of time vary with the temperature to a considerable degree. However, it is probable that in these waters the oysters spawn, to a greater or less degree, all the year around. This is borne out by the fact that during the season of the survey spat was noticed from the beginning of the work in November to the end of March, and oysters in all stages of growth were observed. It is considered that the oysters reach a spawning age at the end of three or four years, according to the temperature. Depth of water of course affects the temperature, and the current the food supply of the mother oyster. If freshets occur during the spawning season the mud or silt kills the spat.

VALUE OF THE SURVEY HYDROGRAPHICALLY.

As was pointed out in the beginning of the report, the chart may be used with confidence, as the configuration of the bottom is shown with as much accuracy as in the Coast Survey charts. The curves of different depths are all delineated, and the characteristic soundings shown with sufficient frequency. No hydrographic survey of this locality had been made for a number of years, and a good many changes in the bottom had occurred, especially about the mouth of Apalachicola River. Since the time of the original survey two new channels had been dredged, which are shown on the chart, and it was important hydrographically that these channels should be located and their depth of water shown.

The most important development is the discovery of a new channel in the thoroughfare between Apalachicola and Carrabelle. The channel gives more water than the one formerly used, and should be buoyed. This subject has already been alluded to. The chart shows an increased depth and a decided hydrographic change at Indian Pass, and it seems likely that this pass will become of importance when the increased depth is generally known. At present a vessel of the *Fish Hawk's* draft, 8 feet, can enter the pass.

Indian Lagoon, although of not much importance, was surveyed for the first time.

REPORT UPON SPECIMENS COLLECTED FROM THE OYSTER BEDS OF ST. VINCENT SOUND, APALACHICOLA BAY, AND ST. GEORGE SOUND, FLORIDA, DURING THE WINTER OF 1895–96.

By H. F. MOORE, *Assistant, U. S. Fish Commission.*

With very few exceptions, the specimens of oysters submitted for examination are thick-shelled, in crowded clusters, and covered with barnacles and mussels. In some instances the growth of foreign organisms has been so vigorous and rapid as to seriously hamper the development of the oysters, and it was manifest that death had sometimes resulted, or was about to follow, from this cause, as well as from the mutual crowding of the oysters themselves. If the specimens received are fair samples of the character of life upon the beds, there must be considerable mortality from this cause alone. Were the clusters broken up the oysters would be more abundant and better in shape and quality.

Mussels and barnacles grow with great rapidity and wedge themselves between the shells of the clusters in such a manner as to effectually prevent the opening of the valves, and the oyster's death from starvation and suffocation soon follows. The oyster will live, however, if it be permitted to open its shell ever so slightly, but the difficulties of its existence are reflected in its poor and "watery" appearance, a condition which is difficult to recognize in alcoholic specimens.

It is not possible to say much concerning the fleshy portions of the specimens, as not only are the animal parts more or less shrunken by the action of the alcohol, but it is rarely possible to open the oyster without mutilation. In a number of cases the shells are rather deep and capacious, indicating that in their fresh condition the "meats" were plump and fleshy.

A few calcareous worm tubes and several small tufts of hydroids are attached to some of the clusters, but in general the collection is characterized by an absence of such organisms, which, when abundant, sometimes cause harm by collecting sand and débris which smothers the oysters.

The old shells, both living and dead, are usually more or less corroded and partially disintegrated by the attack of a species of boring lamellibranch, not yet identified, but apparently related to, if not identical with, *Martesia smithii* Tryon. This species can not be regarded as parasitic in the sense of feeding upon the oyster, but it causes harm by weakening the shell and harassing the tenant in a manner not unlike that of the boring sponge. This boring clam begins to burrow when it is still quite small, and it makes a depression of corresponding size. Through the external opening food and oxygen are taken, and as the animal grows the size of its domicile is enlarged until there is formed an egg-shaped chamber communicating with the exterior by a short canal of much smaller diameter, the organism thus becoming imprisoned in a cell of its own making.

In the process of excavation the shell of the oyster is often penetrated, but the mantle is thus stimulated to lay down a layer of shelly matter over the inner opening and the leak is promptly repaired. Where there are many such burrows, the drain upon the oyster in making repairs may cause a deterioration in the quality of its flesh, as has been observed where the boring sponge is troublesome.

Another cause tending to produce irregularities is the inclusion of mud and sand between the shell and the mantle. The layer of shell deposited over the foreign material produces blister-like excrescences, which when broken open were found to contain offensive-smelling mud.

The collection contained no organisms which are known to feed upon the oyster.

The specimens from all stations showed evidence that good conditions for spatting must have prevailed during the preceding spawning season. In nearly every lot there were a number of young oysters, varying from ¾ inch to 2½ inches in length. In most cases they were so closely crowded that many of them would have failed to reach maturity and the survivors would surely have been unshapely. In one case the interior of one old shell, the valves of which still held together, contained about 15 oysters ranging in size from 1¼ to 1¾ inches, and in several instances the strong growth of the young had killed the old oyster to which they were attached.

A careful examination was made of the specimens from East Hole. The oysters of this bed are covered by a vegetable growth when taken, and are said to be permeated by hair-like substances when prepared for canning. Neither in the flesh nor in the intestines of these specimens was there any filamentous matter, though the alimentary canal contained considerable sand and gritty material which might be noticed when the oysters were eaten.

So far as could be judged from the alcoholic specimens, the oysters from this bed were "poorer" than those from other places, and in consequence the radial muscles of the mantle stood out in relief. It seems hardly possible that the oystermen could mistake these muscle fibers for filaments of a parasitic organism, but I am assured that the so-called hairs can not be connected with the alga which is found attached to the shells. This plant is not at all parasitic and makes use of the oyster shell merely as a solid place of attachment, as the young spat utilizes the old shell for the same purpose. The filaments of this seaweed may be sometimes carried into the shell by accident, but even then they would not become imbedded in the flesh.

The mantles of these oysters were somewhat darker than those from other beds, but the difference was not very marked and the color does not appear to be developed to an objectionable degree. This dark color is due to causes perfectly natural and harmless, and is not in any measure the result of disease or parasitism. A dark pigment is produced in such parts of the body as are exposed to the light, but is usually confined to the edges of the mantle, the other portions being shaded by the shell.

EXTRACTS FROM THE FLORIDA STATE LAW IN REGARD TO OYSTERS AND THE OYSTER FISHERY.

Appointment of commissioners.—The governor, with the consent of the senate, is hereby authorized to appoint three competent persons, to be known as the commissioners of fisheries, who shall continue in office for the term of two years, and until their successors are appointed.

Supervision of fish and oysters, and laws for their protection.—The commissioners of fisheries shall have general supervision of the fish and oyster interests of this State, and are hereby authorized and instructed to make annual investigation of the oyster waters and oyster beds, both natural and cultivated, of this State, and by conferring with the commissioners of oysters in other States, and personal inspection in this State, make such report to the governor, with recommendations of the best course to pursue to increase the yield and give a revenue to the State. They are also authorized to enforce the existing laws made for the protection of fish and oysters in the coast and inland waters of this State, and to prosecute all violators of such law when coming under their cognizance. And for the better performance of this duty they may appoint fish wardens residing at convenient localities, whose duty it shall be to inform them of such violations.

Commissioners to report to the governor.—The commissioners shall make an annual report to the governor of the work accomplished by them, with such suggestions as to the propagation and protection of fish and oysters as they may deem proper, which report shall be transmitted by the governor to the legislature.

Exclusive right to plant oysters.—Any person desiring to plant oysters in the public waters of this State shall apply to the county commissioners of the county in which the water is situated, setting forth his determination to plant oysters in a certain locality, describing the same as near as possible, and the said commissioners may grant exclusive rights to such person for such locality or any portion thereof, with such boundaries as they may deem proper.

Forfeiture.—Any person obtaining from the county commissioners such grant or exclusive right and failing to utilize the same by planting oysters therein within one year thereafter shall forfeit such grant.

Marks of boundaries.—It shall be the duty of all persons planting oysters as provided above in this chapter, to mark the boundaries and limits of the beds of oysters so planted by them, by stakes or buoys, as may be prescribed by the county commissioners, at intervals of not more than fifty yards apart, clearly defining the limits of their claim, said stakes or buoys not to obstruct or interfere with the navigation of any of the navigable waters of this State, and to keep such stakes or buoys standing and in good order and repair, otherwise no penalty shall be incurred or right protected under the provision of this chapter.

Riparian rights. Transfer of oyster beds.—The provisions of this act shall give no exclusive right or privilege to any persons to plant oysters upon the submerged lands of another without the consent of the owner thereof; but all persons shall have the right to plant oysters in the bays and harbors of this State, but the riparian owner shall not be disturbed thereby in the use of the land a reasonable distance out from medium tide for the purpose of erecting wharves, warehouses, or other permanent improvements thereon; and any owner or lessee of any artificial oyster bed shall have the right to sell, lease, dispose of, or transfer his or her interests therein, which sale, lease, or transfer may be recorded in the same manner as any other transfer or conveyance of property, and all rights and interests therein shall descend according to the rules of descent as prescribed by law.

Limit of bed in front of public lands.—No oyster bed so located in accordance with the provision of this chapter shall extend more than one-eighth of a mile along the bank or shore of any waters, bayous, rivers, or sounds in front of the public or unoccupied lands of this State.

Not to include natural oyster beds.—All the existing natural or maternal oyster beds in the waters of this State are exempt from the provision of this act, and they remain for the free use of the citizens of this State.

Carrying away planted oysters.—Whoever unlawfully, without permission of the owner, takes up and carries away by any means, or in any manner catches, interferes with, or disturbs the oysters of another, lawfully planted upon the beds of the bayous, rivers, bays, sounds, or other waters within the jurisdiction of this State, shall be deemed guilty of larceny, grand or petit as the case may be, and shall be punished accordingly.

Using dredge, etc., for oysters.—Whoever uses a dredge or drag net for the purpose of gathering or catching oysters from any of the natural oyster bars in any of the waters within the jurisdiction of the State shall be punished by imprisonment not exceeding sixty days, or by fine not exceeding one hundred dollars.

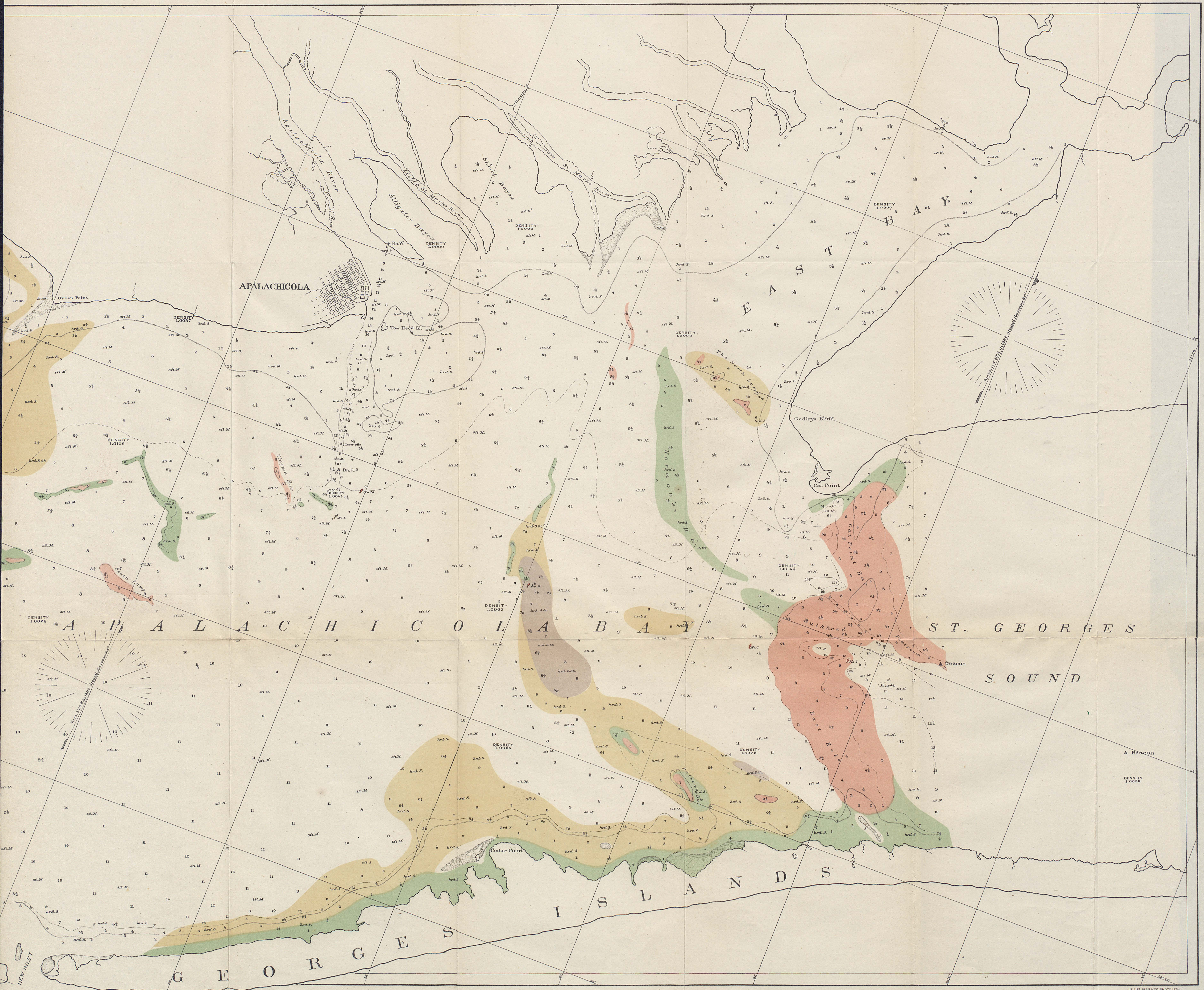
SECTION 1. That from and after the approval of this act, it shall be unlawful for any person or persons to take oysters for any purpose from any beds or reefs in this State except for home consumption from May 1 to October 1 in any year.

SECTION 2. That during the time that it is lawful to take oysters, to wit, from September the first to May the first of the following year, the oysters that are taken from the beds or reefs shall be culled at the places from which they are taken, and the culls and oysters less than two and a half inches in length shall be returned to the beds from which they are taken.

That whoever violates the provisions of sections 1 and 2 of this act shall be punished by fine not exceeding fifty dollars for each offense, or by imprisonment in the county jail not exceeding thirty days, or both such fine and imprisonment, in the discretion of the court.

Approved May 30, 1893.


U.S. COMMISSION OF FISH AND FISHERIES
J. J. BRICE, COMMISSIONER
CHART
OF
APALACHICOLA BAY
ST. VINCENT AND ST. GEORGES SOUNDS
FLORIDA
Showing Location of Oyster Beds
From survey made under direction
of
Lieut. FRANKLIN SWIFT, U.S.N.
Commanding
U.S.F.C. St. FISH HAWK
From Nov. 12th 1895 to March 28th 1896.
Scale
Nautical Miles
Statute Miles
Meters
Yards
NOTES
The Soundings are expressed in feet and show the depth at mean low water.
Mean rise and fall of tide 1.8 ft.
All soundings are original with this survey.
The 3 ft. curve is shown thus .... 6 ft. .... 12 ft. ._._._
Oyster Reefs [dead shells and raccoon oysters] dry
Dense growth of Oysters
Scattered growth of Oysters
Beds of dead Oysters
Ground suitable for planting Oysters
The density shown is the average density of all observations taken at each station reduced to 15° C.
ABBREVIATIONS
M. for Mud, S. for Sand, Sh. for Shells, hrd. for hard, sft. for soft.
Projection by W. F. Hill, Assistant U.S. Fish Commission from data furnished by U.S. Coast and Geodetic Survey. Shore line of North shore of St. Vincent Id. from present survey. Finished sheet by Eugene Veith.
Variations of compasses taken from Coast Survey Chart No. 183.
ST. VINCENT SOUND
ST. VINCENT ISLAND
Indian Peninsula
INDIAN PASS
Green Point
St. Vincent Point
WEST PASS
SAND ISLAND
SAND ID. PASS
Cape St. George
NEW INLET
SAINT
APAL
G



APALACHICOLA
APALACHICOLA BAY
EAST BAY
ST. GEORGES SOUND
ST. GEORGES ISLANDS
Apalachicola River
Little St. Marks River
Alligator Bayou
St. Marks River
Green Point
Tow Head Id.
The North Lumps
Godley's Bluff
Cat Point
Cat Point Bar
Bulkhead
East Hole
Cedar Point
Beacon
NEW INLET
JULIUS BIEN & CO. PHOTO. LITH.

U. S. COMMISSION OF FISH AND FISHERIES,
JOHN J. BRICE, Commissioner

REPORT

ON THE

FISHERIES OF INDIAN RIVER, FLORIDA,

TRANSMITTED TO

THE UNITED STATES SENATE BY THE COMMISSIONER
OF FISH AND FISHERIES, JANUARY 5, 1897.

Extracted from Report of Commissioner for 1896. Appendix 5, Pages 223 to 262, Plates 23 to 59.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1897.

5.—THE FISHERIES OF INDIAN RIVER, FLORIDA.

UNITED STATES COMMISSION OF FISH AND FISHERIES,
Washington, D. C., January 5, 1897.

SIR: I have the honor to transmit herewith a report of an investigation of the condition of the fisheries of Indian River, Florida.

This investigation was made in accordance with a provision of the act of Congress approved March 2, 1895, calling upon the Commissioner of Fish and Fisheries "to make special investigation as to the extermination of migratory fishes of the Indian River, Florida." It was begun January 9 and continued until February 2, 1896, and was designed to cover the following points:

What food-fishes occur in Indian River, continuously or as regular visitants; their present abundance as compared with that of former years; their distribution in different parts of the river; their migrations or other movements; the character of bottom on which they are usually found; their spawning time and place; their food; upon what other fishes the various species prey; the weights of the commercial species; the presence in the river of fish not used as food, and their relation to the food-fishes; and such other facts as would bear upon the abundance of the different fishes in the river; also the commercial aspects of the fisheries, as to the number of persons employed, the capital invested, the value and kind of appliances used, the quantity and value of the fish and other products taken, as well as the development of the industry. The inquiry necessarily included also a study of the physical characteristics of the river.

A great deal of information was gained through interviews with fish-dealers, fishermen, and others, and by an examination of the fish in the fish-houses or as brought in by the boats. The knowledge thus obtained was supplemented by making collections with fine-meshed collecting seines, which proved very important in determining the presence or absence of the young of the various food-fishes.

The natural-history and physical investigations were carried on by Prof. Barton W. Evermann, assisted by Mr. Barton A. Bean, of the United States National Museum, and Mr. A. G. Maddren; and those concerning the commercial aspects of the fisheries by Mr. W. A. Wilcox. Detailed reports, together with illustrations of the more prominent fishes of the region, are appended.

NOTE.—This report of the Commissioner of Fish and Fisheries, with the accompanying reports, was first printed as Senate Document 46, Fifty-fourth Congress, second session.

As a factor in the fish supply in the United States, the Indian River has, within a comparatively short time, attracted much notice. Although only a few years old, the fishing industry of this arm of the Atlantic has already attained considerable prominence, and in 1895 contributed over 2,500,000 pounds of food-fish to the public markets. While the business of taking green turtles antedates the civil war, the fisheries proper did not begin until 1878, when a smack from Connecticut visited one of the inlets with seines and nets, and caught fish for the Savannah market. Up to 1880 this was the only economic fishing carried on in the Indian River, except that for turtles, and it was not until 1886, after the river had been brought into railroad communication with Jacksonville, that the fisheries may be said to have become thoroughly established.

This section of Florida was sparsely settled and practically inaccessible except by water prior to the building of a railroad to Titusville, at the northern end of the river, in 1885, and the abundant fishery resources consequently received but little attention. Mr. George W. Scobie, of Connecticut, may be regarded as the pioneer in Indian River fisheries. In the year named he established an oyster business at Titusville, and in the subsequent year began a regular fishing trade. In 1886 Messrs. A. M. Hambleton & Co. also began operations at Titusville.

From this beginning of the commercial fisheries of the river the business has seen many changes. A second railroad reached Titusville in 1893, and in the two following years extended along the entire length of the river. This resulted in the establishment of new fishing stations farther south and greatly increased the importance of the fisheries, at the same time diminishing the business at the northern end of the river, until in 1895 there were 19 firms with headquarters at 9 points, as follows: Titusville, Cocoa, Eau Gallie, Melbourne, Sebastian, Fort Pierce, Eden, Jensen, and Stuart.

The relative importance of each of these places as a fishing center has varied with the successive completion of the railroad to each, and the regular development of the business. A number of other factors, some of them resulting indirectly from the railroad, have also been potent in influencing the business in particular places, such as the decline in communication along the river by boat, the formation of new settlements, and the success or failure of other vocations. As illustrating this last point, the severe cold of 1894–95 resulted in a relatively large increase in the number of fishermen, as the destruction of the orange and pineapple orchards caused a number of men to engage in the fishing business. This may prove only temporary, and a return of prosperity to the cultivators of the land will call back many who have for a time abandoned their orchards.

Fort Pierce was at the time of the investigation the most important point, partly due to its vicinity to Indian River Inlet, in and near which the commercial fishes occur in greatest numbers. The fishing-grounds were within a few miles of Fort Pierce, and fishing was carried on as near the inlet as the law would permit.

The principal fishing in the extreme lower end of the river was near Santa Lucia Inlet and in the vicinity of Sewall Point.

The Indian River fisheries in 1895 gave employment to 254 persons, representing an investment of $41,512, and yielded 2,659,815 pounds of products, valued at $37,657. The most prominent fishery objects are mullet, pompano, sheepshead, squeteague, and oysters. The catch of mullet was 1,610,869 pounds, worth $12,251. The next valuable fish—and the most highly esteemed of all the species in the river—was the pompano, of which only 149,000 pounds were taken, but which brought the fishermen $9,475.

Besides the fishes mentioned there are other species of some importance, but these are only of secondary value commercially. Some of them, as the gray drum, mutton-fish, and crevallé, are held in low esteem, while many are found in only limited numbers. Some of them, as the gray drum, crevallé, and sergeant-fish, are destroyed in considerable numbers by the commercial fishermen. The gray drum is said to be very destructive to nets, and for that reason is killed when caught. The sergeant-fish and crevallé, and at times others, are allowed to die on the shore when not marketable.

The evidence shows that though possibly in some parts of the river the mullet is less abundant than when fishing first began, it is now sufficiently plentiful to enable the fishermen to secure readily more than are required, and the dealers are frequently under the necessity of putting a limit upon the number which they will accept. So long as this condition of affairs continues the mullet fishery will regulate itself. But an increase in the demand for mullet throughout the country, the rapid development of the salted-mullet industry, cheaper express and freight rates, and cheaper ice are probabilities of the near future, and if the productiveness of the mullet fishery is to be maintained to provide for these greater demands restrictive measures are necessary. One way by which this may be accomplished is to establish a close season during the more important part of the spawning period.

The pompano has decreased greatly, especially since 1894, and the explanation of the fishermen that the decrease is due chiefly to the severe weather in the winter of 1894–95 is not without reason. As this species seems to spawn inside the river, a close season during its spawning period would prove advantageous. Any proposed restrictive legislation should, however, await further investigation of the exact time of spawning, which is not conclusively proved, though probably in April and May.

The sheepshead has apparently been able to hold its own since commercial fishing began in Indian River, and many of the fishermen think there has been an increase.

The sea trout, or spotted squeteague, which, like the sheepshead, is not only a food-fish but one of the important game-fishes of the river, also appears to be as abundant now as formerly, as does the red drum, another of the game-fishes.

The bluefish, which is one of the most important game-fishes, seems to have been able to maintain itself in normal numbers in Indian River. It has, however, never been found in sufficient abundance to constitute any considerable part of the commercial catch, and, being more or less erratic in its movements, it is doubtful if restrictions should be imposed upon its capture.

Other valuable fishery resources of Indian River are green turtles and oysters. The turtles are much less numerous than formerly, owing to excessive fishing, and there has also been a large reduction in the average size of those caught. The oysters are of fair size and good quality, but have received little attention; their more general utilization and the formation of artificial beds, which will doubtless soon be undertaken, will be important factors in the growth of the fishing industry.

Regarding the future of the fisheries of the Indian River region, it may be said that while the resources are great and the supply is still ample, yet owing to the comparatively limited area of the fishing-grounds it would appear that the present tendency to overfishing may result in the ultimate destruction of the business. But with the enforcement of proper restrictive laws and the establishment of close seasons there is no good reason why Indian River should not continue to furnish a reasonable amount of commercial and game fishing. Under the present laws of Florida there is no close season, nor any regulation concerning the character of nets to be used, and the only restriction on fishing in Indian River is an act (chapter 4215, No. 101), approved May 22, 1893, which provides:

> That from and after the passage of this act no seines, gill nets, or other nets, except a common cast net, shall be set or used for the taking of food-fish for sale, within one mile of any pass or inlet, or continuation thereof, from the Atlantic Ocean into any inland waters of this State, or in any of the tributaries of the rivers emptying into the Atlantic Ocean.

This law is undoubtedly a wise one and its rigid enforcement will, in the long run, prove advantageous to the commercial fishermen. So many of the more important species play in and out with the tides that the use of nets near the inlets is analogous to pot-hunting. Without restriction the fishermen would flock to the inlets and in a short time commercial fishing could not be carried on profitably in any other part of the river. The first result would be that all the fishermen not living within easy reach of the inlets would very speedily be driven out of the business, and the final result would be the complete destruction of the fishing industry of Indian River.

The use of nets in the inlets would prove destructive not only to the species desired, but to all other species large enough to be taken in them. The limit at one mile scarcely covers the area of too easy capture, and it should be extended rather than made less.

Every fisherman should interest himself in seeing that this law is not violated, and the wisdom of the law will be fully demonstrated.

Very respectfully,

J. J. BRICE, *Commissioner.*

To the PRESIDENT OF THE SENATE.

INDIAN RIVER AND ITS FISHES.

By BARTON W. EVERMANN AND BARTON A. BEAN.

THE PHYSICAL FEATURES OF INDIAN RIVER.

General description.—Indian River is not a river at all, but a long, narrow, and shallow salt-water lagoon or sound extending along the east coast of Florida, from latitude 28° 47′ on the north to 26° 58′ on the south. Its entire length is about 135 miles. From the sea it is separated by a long and narrow strip of land which rises nowhere more than a few feet above the water. Its width varies from only a few rods at Jupiter Narrows to 5 or 6 miles just below Titusville. The water is usually very shallow, the depth varying from 2 or 3 feet to 17 feet, rarely, however, exceeding 8 to 12 feet.

Just below Titusville is the upper end of Merritt Island, a long, triangular island, separated from the land on the north by Banana Creek and tapering southward in a long, slender point which extends almost to Eau Gallie, a distance of 30 miles. East of this island is Banana River, connecting with Banana Creek on the north and with Indian River opposite Eau Gallie. East of Banana River is the long and narrow outlying sandy island which extends throughout the greater part of the length of the east Florida coast.

Opposite Titusville Indian River is less than a mile in width and the depth ranges from 2 to 12 feet. A few rods above Titusville a depth of 16 feet is found off Sand Point, this being one of the greatest depths given on the Coast Survey charts. Above Titusville the river gradually widens to 1½ miles and then suddenly expands to 3 miles in width. The depth in this portion rarely exceeds 5 or 6 feet and in many places is not over 2 or 3 feet. Below Titusville the river widens rapidly until a width of about 5½ miles is attained opposite the head of Merritt Island proper. The depth also increases somewhat, the average being

7 to 8 feet except near the shores, where it is only about 2 to 4 feet. At Cocoa and Rockledge, about 20 miles south of Titusville, the river is less than three-fourths of a mile in width, the depth being 10 to 15 feet.

For the next 45 miles southward the river continues uniformly narrow, the width nowhere scarcely exceeding a mile, except off the mouth of Sebastian River, where it in some places reaches about 2 miles. From Cocoa to Melbourne the depth runs from 10 to 15 feet. At one place, about 4 miles above Eau Gallie, the Coast Survey chart shows a depth of 17 feet in the channel, which is the greatest depth given for Indian River. Between Melbourne and Sebastian the eastern shore-line is much more irregular, the width variable, and the depth 2 or 3 feet less. A short distance below Sebastian are the "Narrows," where several small islands reduce the width of the river to a few rods. Below this it again widens to 1½ to 2 miles, the depth running from 4 to 9 feet. Opposite St. Lucie the minimum width is less than 1 mile, but immediately below it increases to about 2 miles. From Fort Pierce to below the mouth of St. Lucie River, a distance of about 22 miles, the width varies from 1 to 2 miles and the depth from 3 to 10 feet.

About 2 or 3 miles below the mouth of the St. Lucie are found the North Jupiter Narrows, which for nearly a mile are only 20 to 30 rods wide. Below these is a slight expansion known as Peck Lake. Then the river again contracts, and, under the name of South Jupiter Narrows, extends southward a distance of 3 miles as an extremely narrow and somewhat tortuous waterway, with a depth varying from 3 to 14 feet. Below South Jupiter Narrows is a slight expansion known as Hobe Sound, the greatest width of which is about one-fourth mile, the length about 5 or 6 miles, and the depth 3 to 9 feet. Near latitude 27° is another short narrows separating Hobe Sound on the north from Jupiter Sound on the south. Jupiter Sound is similar to Hobe Sound, and extends from this "narrows" to the mouth of Jupiter River, a little over 3 miles. Opposite the mouth of Jupiter River is Jupiter Inlet, which is regarded as being at the southern end of Indian River.

Inlets.—Indian River at present is connected more or less directly with the ocean at four different places. One of these is near the northern end of the river, and is known as the Haulover Canal. This canal cuts through a very narrow sand isthmus and connects Indian River with Mosquito Lagoon or Hillsboro River, which, in turn, is connected with the ocean by Mosquito Inlet.

Indian River Inlet is in latitude 27° 30′, and almost opposite St. Lucie. This inlet is less than half a mile long and only a few rods wide. Its depth varies from 7 to 12 feet, except at the inner end, where it is normally quite shallow. The Government is doing considerable dredging at this place, and the inlet will doubtless be greatly improved. Besides the inlet proper there are several other shallower channels or cuts, as Fort Pierce Channel, Baker Cut, Garfield Cut, and Blue Hole Cut, all of which connect directly or indirectly with the outer end of the inlet.

Just opposite the mouth of St. Lucie River, in latitude 27° 10′, is Santa Lucia Inlet, which was made some years ago by cutting through the sandstone and coquina rock of Gilbert Bar at a point where it was but a few yards wide. This inlet is said to be quite shallow, but it can be very readily deepened by a little dredging and blasting away a small reef across the outer end.

At the extreme southern end and opposite the mouth of the Jupiter or Lokahatchie River is Jupiter Inlet. This inlet is narrow and usually more shallow than any of the others.

Character of bottom and shores.—Indian River throughout most of its extent has a moderately hard sand bottom. The areas covered by soft mud are few, scattering, and limited in extent. Along the immediate shores and on the shallows about the numerous small islands there is in some places considerable mud, but this is unimportant in comparison with the area having solid bottom, and even on the mud flats the mud is rarely more than 4 or 5 inches deep. In some parts of the river the bottom is of comparatively hard cemented sandstone; in others it is of coquina of various degrees of pureness; most of the coquina found along Indian River has considerable sand mixed with the shell fragments.

The river is well supplied with various species of algæ and other species of aquatic plants suited to shallow salt or brackish waters. So generally is the vegetation distributed and so firm is the bottom that no considerable shifting of the bottom by storms seems to have taken place recently. The stability of bottom is of great importance to the fishery interests of the river, as will be shown farther on in this report.

The shores of Indian River are generally low and composed of sand, with considerable coquina in some places. In the southern part of the river mangrove bushes are abundant on the mud flats and on the shores, while northward the cabbage palmetto is the principal tree.

Streams tributary to Indian River.—The streams carrying fresh water into Indian River are few and usually small. Beginning at the north the only ones worthy of mention are Eau Gallie Creek, and Sebastian, St. Lucie, and Jupiter rivers.

Eau Gallie Creek flows into Indian River between Eau Gallie and Sarno. At its mouth it has considerable width, but only a mile or so above it narrows to only a few feet. It has a very slight current and probably at no time carries any considerable amount of fresh water into Indian River.

Sebastian River, near the station of that name, is a stream of some importance, but it is only a few miles long.

St. Lucie River is the most important tributary, and carries more fresh water into Indian River than all others combined. Its mouth, opposite Santa Lucia Inlet, is from one-fourth to one-half mile wide and has a depth of 7 to 21 feet. It is 30 miles long or more, and is fresh down to near its mouth.

Jupiter River is somewhat smaller than the St. Lucie and empties near the lower end of Indian River opposite Jupiter Inlet.

Salinity and temperature.—Tests were made at different places to determine the temperature and density of the water of Indian River. These are recorded in the following tabular statement:

Table of observed temperatures and densities.

Date.	Hour.	Place.	Temperature of water in Fahrenheit degrees.	Density corrected to 15° C.
Jan. 14	9 a. m.....	Scobie's fish-house, at Titusville......................	59	1.01800
14	11 a. m....	.....do	60	1.01919
17	....	Cocoa..	62	1.01636
20	8 a. m	Sarno wharf, Eau Gallie Creek	55	1.01116
20	10 a. m....	Eau Gallie Creek, 1 mile from mouth	55	1.00022
22	8.30 a. m ..	Hotel wharf at Fort Pierce.............................	63	1.01978
22	8.43 a. m ..	Between Fort Pierce and St. Lucie......................	....	1.01962
22	9.20 a. m ..	Senator Quay's wharf at St. Lucie......................	64	1.01952
23	....	Indian River Inlet.....................................	65	1.02205
25	1 p. m.....	Outer end of wharf at Jensen	69	1.01075
29	....	Wharf at Stuart..	64	1.00894
30	7.40 a. m ..	St. Lucie River at mouth	65	1.02506

THE COMMERCIAL FISHES OF INDIAN RIVER.

The commercial fishes of Indian River number about 24 species. Of these, only about 16 species are found in sufficient abundance to be of importance. The 24 species, named approximately in the order of their value as food-fishes, are as follows:

1. Common mullet (*Mugil cephalus*).
2. Pompano (*Trachinotus carolinus*).
3. Sheepshead (*Archosargus probatocephalus*).
4. Trout or spotted squeteague (*Cynoscion nebulosus*.
5. Channel bass or red drum (*Sciænops ocellatus*).
6. Mangrove snapper (*Neomænis griseus*).
7. Bluefish (*Pomatomus saltatrix*).
8. Whiting (*Menticirrhus americanus*).
9. Crevallé (*Caranx hippos*).
10. Sailor's choice (*Lagodon rhomboides*).
11. Black drum (*Pogonias cromis*).
12. Southern flounder (*Paralichthys lethostigma*).
13. Spanish mackerel (*Scomberomorus maculatus*).
14. Croaker (*Micropogon undulatus*).
15. Permit (*Trachinotus falcatus*).
16. Key West permit (*Trachinotus goodei*).
17. Silver mullet (*Mugil curema*).
18. Triple-tail (*Lobotes surinamensis*).
19. Pigfish (*Orthopristis chrysopterus*).
20. Spot (*Leiostomus xanthurus*).
21. Yellow-tail (*Bairdiella chrysura*).
22. Mutton-fish (*Gerres olisthostoma*).
23. Pinfish (*Diplodus holbrookii*).
24. Sergeant-fish (*Centropomus undecimalis*).

Only the first 15 or 16 species of this list are caught in sufficient quantities to figure separately in the records of shipments.

In the following pages each of the 24 species is considered in detail, chiefly with reference to its present and former abundance, its migrations and other movements, its spawning habits, its food, and its size and importance as a food-fish. The conclusions have been reached from a consideration of all the evidence obtained from dealers, fishermen, and others, supplemented by the original observations of the party.

MULLET (*Mugil cephalus*).

This fish, which is here known only by the names mullet or common mullet, is the most abundant and generally distributed food-fish in the Indian River. The opinions obtained from the fishermen upon the habits, abundance, and spawning of the mullet appear, at first sight, quite diverse and contradictory in character. Most of these differences, however, are susceptible of a reasonable explanation, and the various views, when fully and properly understood, are not inconsistent. The apparent differences are mainly due to the fact that the opinions of most of the fishermen are based solely upon their observations in one limited portion of the river; and it is probable that what is true of the mullet in one section of the river may not be true throughout the entire river.

A careful examination of the various opinions given by the fishermen, in the light of the original observations, leads to the following statements regarding the habits and abundance of the common mullet in Indian River.

Ever since commercial fishing began in Indian River the mullet has been the most abundant food-fish there. In the north end of the river, as far south as Fort Pierce, it constitutes 60 to 70 per cent of the entire catch. In the south end it is apparently rather less abundant, though it is likely that this is because it is not fished for to any extent south of Fort Pierce. There has probably been some decrease during the last ten years, but dealers still obtain all the mullet they want to fill their orders, and some dealers limit their fishermen in the number of mullet which they will accept, thus showing that, in a night's fishing, more mullet can be taken than can be disposed of. So long as this condition exists it would seem that the mullet fishery will regulate itself.

The mullet is doubtless found throughout the year in Indian River in considerable numbers. The periods of least abundance seem to be in July and August, and again in early winter. It is most abundant in the fall, from September to December. Its movements are not well understood. That it runs in and out through the inlets with the tides seems well established, and it is apparently greatly influenced by changes in the weather, the shallowness of the river causing it to respond very promptly to temperature changes in the air. A norther blowing for more than a day will cause a marked change in the temperature of the water. The mullet, being a warm-water fish, is affected by the cold and driven out to warmer water. As to whether they run with or against the winds depends upon the direction they must go to get outside or to reach warmer water.

The spawning time for the species seems to extend over a considerable period, probably from September to the last of January. Mullet examined the last week in January, that had been caught at Fort Pierce, were in full roe. These were the only ones, however, which were in roe. Many others were examined at Titusville, Cocoa, Eau Gallie, and Sebastian, but none contained developed eggs. The theory that different schools spawn at different times seems reasonable. While the spawning of different schools may extend over several months, any particular school occupies but a very short time in spawning. The period may not exceed two or three days. The majority of the schools probably spawn from October to December.

The fishermen are agreed that the mullet go outside to spawn, but just where no one seems to know. If they run in and out while spawning, as many believe, the spawning-grounds can not be far from the inlets.

Some of the fishermen speak of a large mullet which they call the "mangrove mullet." It is doubtless simply a large common mullet. They think it remains in the river all the time, not going outside even to spawn. They reach a weight of 5 pounds.

POMPANO (*Trachinotus carolinus*).

Of all the fishes of Indian River the pompano is most valued and brings the best price to the fishermen and the dealer. In the light of the inquiries and of the testimony obtained we believe that the following is an approximately correct statement of the present status of this fish in Indian River:

The pompano is present in Indian River throughout the year, and is probably most abundant during the winter. The best fishing seems to be from late in January to April. They are probably common in the summer months, but are not fished for then. They are most abundant about the inlets, and play in and out with the tides. They run in bunches or schools, and are easily influenced by changes in temperature. They seem to be a warm-water fish, and continued cold weather causes them to leave the river temporarily. The unusual cold of December, 1894, and February, 1895, appears to have had a serious effect upon them, not only in driving them away but in actually killing many.

So far as Indian River is concerned, the pompano is not properly a migratory fish, and it is probable that when it goes outside it does not wander far from the inlets and soon comes inside again. Very little can be said definitely as to its spawning habits. The evidence indicates that they spawn inside the river, chiefly during April and May. The spawning period may be even more prolonged and extend from March to early summer.

It could not be learned where young pompano may be found, nor whether they remain in the river. Though considerable collecting was done with fine-meshed seines, no young were taken, and no information was obtained as to the capture of the young at any time in Indian River.

The fishermen are well agreed as to the food of the pompano. It consists chiefly of small bivalve mollusks and small crustaceans. The fish feed extensively about the inlets, and in the surf outside are often seen feeding near the shore. The habit of digging in the mud and sand, referred to by some fishermen, is probably a searching for food.

The average weight of the pompano now handled by the Indian River dealers is about 2 pounds. The smallest observed weighed about half a pound each. The largest one, seen on January 24, weighed 4½ pounds and measured 21½ inches to the tips of the caudal lobes, or 16 inches to the base of the caudal fin.

Examples of a fish which the fishermen agree in calling pompano are taken occasionally, weighing 20 to 27 pounds, but none was seen during the investigation. The largest reported weighed 27 pounds. They are probably the same species of *Trachinotus* known about Key West as the "permit," recently decided to be a distinct species and named *Trachinotus goodei* by Jordan & Evermann. They are, of course, not the permit of Indian River, which is a small fish. The true pompano of Indian River does not exceed 7 or 8 pounds in weight.

SHEEPSHEAD (*Archosargus probatocephalus*).

Next to the mullet, the sheepshead is the most abundant food-fish in Indian River, and is one of the most important to the commercial fishermen. It is constantly present in considerable numbers. Though at times it runs in and out with the tide and moves about from place to place in the river, it is not properly a migratory fish. It does not school as does the mullet, but is often found in bunches made up of individuals brought together on account of food. Feeding almost wholly, as it does, upon mollusks, crustaceans, and plants, it frequents the oyster beds and similar places, particularly in the vicinity of the inlets. Stomach contents examined at different places consisted of fragments of small crustaceans and mollusks, together with a large amount of vegetable matter. In some instances the stomachs contained scarcely anything but large masses of green plants.

The spawning time seems to be in February, extending perhaps into April. Specimens examined at Eden, Sebastian, and Eau Gallie contained well-developed roe, which indicated a spawning time in February. Other specimens contained roe not so well developed, and it is probable that they would not have spawned until March or April. It is an interesting fact that males seemed much scarcer than females. Some fishermen state they have rarely, if ever, seen examples with milt; but several were examined at Eden which contained milt. A large majority of those examined were females. But little information could be obtained as to where sheepshead spawn. Their principal spawning-beds are probably in the vicinity of the inlets and inside the river.

In all the collecting with fine-meshed seines only a few small sheepshead were obtained. The smallest were secured at Indian River Inlet, and were 2¾ to 4 inches in total length.

The average weight of sheepshead handled by the fishermen is probably from 3 to 4 pounds, and the maximum as much as 12 to 15 pounds. A female seen at Eden weighed 7 pounds.

The fishing for sheepshead is practically all done with gill nets. They are run in different places, but the best grounds are evidently in the vicinity of the inlets. The general opinion among the fishermen is that the sheepshead has not suffered any decrease in recent years.

SPOTTED SQUETEAGUE OR SEA TROUT (*Cynoscion nebulosus*).

This species ranks fourth among the commercial fishes of Indian River. In 1880 the spotted squeteague was not known to extend south of St. Augustine, on the east Florida coast. The present investigation has shown its presence in abundance in Indian River. It is also common in Lake Worth, and has long been known as an important food-fish on the west coast of Florida and on the coast of Texas. The evidence points to its continuous presence in Indian River in considerable numbers, though the largest catches are during the latter part of winter and early spring. It is more of a wanderer than any of the others yet mentioned, and is found in schools, which pass in and out with the tides in pursuit of the various smaller fishes.

This fish has apparently held its own in Indian River. The fishermen all claim that there has been little or no decrease, some even maintaining that it has increased in numbers. No definite statements regarding its spawning habits can be made. Only two or three of the dealers ventured any opinion upon the matter, and they do not agree, one giving May and another November and December. Young fish caught at various places in Indian River were 4½ to 8 inches long, which would indicate that they were probably spawned in the river.

The average weight of those handled by the commercial fishermen is 2 to 4 pounds, though the maximum size is very much greater. The largest example seen was at Fort Pierce and weighed 13½ pounds.

REDFISH OR RED DRUM (*Sciænops ocellatus*).

This fish is known locally on the east coast of Florida as bass, redfish, and channel bass; the most appropriate names are redfish and red drum. The Spanish name is *verbena*. It ranks fifth among the commercial fishes of the river and is one of the best game-fishes.

There is lack of agreement among the fishermen as to its habits. That it is a constant resident of Indian River seems certain. It is most abundant during winter and early spring. The larger ones, such as are usually called channel bass, appear to leave the river for a brief period during the coldest season; they also probably go outside for a short time during the warmest season.

Specimens of various sizes were collected, the smallest being less than half an inch in length and the others varying from that size up to a foot or more. This would indicate that the spawning season extends over a considerable period, probably from spring until fall. The abundance of very young fish in the river makes it quite certain that the species spawns inside.

The fishermen are pretty well agreed as to the food and size of this species. Small free-swimming fish, such as young mullet, together with crustaceans and mollusks, seem to constitute the chief part of the food supply. About 40 pounds is the greatest weight attained by the red drum in Indian River. There is little or no demand, however, for those of such large size, and those weighing more than 12 or 15 pounds are not usually handled by the dealers. The average weight of those shipped by the dealers is from 4 to 6 pounds.

The red drum seems to be as abundant now in Indian River as at any time. Commercial fishing has not resulted in any apparent decrease in recent years, and there seems to be no reason for apprehension as to the result of the continuance of present fishing methods.

PERMIT (*Trachinotus falcatus*).

The permit is not a common or important species in Indian River, and nothing was learned as to its habits. The fishermen seem to know very little about it. It is scarce in the upper part of the river, and was not seen at any of the fishing centers north of Eau Gallie. During the inquiries at that place, four examples were brought in by fishermen, who had no name for the fish and said it was rare in that part of the river. It was also noticed at Sebastian, Eden, and Stuart, but only a few specimens were seen at each place and they were all small, none weighing over a pound, which seems to be the average. The maximum weight is about 3 pounds.

MANGROVE SNAPPER (*Neomænis griseus*).

This species is of considerable commercial importance in Indian River and is regarded as a very good fish. It is rarely or never seen in the northern portion of the river, but from Indian River Inlet southward it is present in some numbers throughout the year. It is said to be equally plentiful at all seasons. Its favorite feeding-grounds seem to be among the little mangrove islets and about the narrows and inlets, especially where it is somewhat rocky. Extreme cold is said to have killed a good many fish of this species. The average weight is about 2 pounds, the maximum 6 or 7 pounds. Nothing could be learned regarding its spawning habits.

BLUEFISH (*Pomatomus saltatrix*).

The bluefish is one of the most important game-fishes. It is also eagerly sought by commercial fishermen, but the annual catch has never been large. It is the most truly migratory species found in Indian River. It appears in the fall, usually about October, according to the fishermen, and remains until April or May, when most of them disappear. A few are said to remain throughout the year. During the winter it is most common about the inlets, frequently running in and out with the tides and preying upon other fishes. It is voracious in the extreme and causes great havoc among the schools of mullet, menhaden, and other species.

As long since pointed out by Professor Baird, the bluefish is very erratic in its movements. During certain years, which can not be predicted, it is present on our Atlantic coast in enormous numbers; then it suddenly disappears and may not be seen again except in moderate numbers for many years. The cause of these apparent irregularities has not yet received an adequate explanation.

The bluefish entering Indian River in the fall evidently come from the coast of the Carolinas and farther north, and when they leave in the spring it is to return northward. So far as can be learned, there has never been any remarkable fluctuation in their abundance in Indian River. They have never been especially numerous, and appear not to have suffered any serious diminution in numbers.

The average size of those taken in Indian River is 3 to 5 pounds, the range being from about 2 to 14 pounds. One weighing 14 pounds was seen at Stuart, and four others were seen there whose combined weight was 47 pounds. Several which were caught by trolling at Fort Pierce weighed 2 to 3 pounds each.

With a fine-meshed seine very young examples, less than 2 inches long, were secured at Fort Pierce. This would indicate that the bluefish spawn in the river to some extent at least, and probably in the summer or fall; but as the fishermen have not seen them in roe it is probable that they usually spawn elsewhere.

WHITING (*Menticirrhus americanus*).

The whiting is of some importance in Indian River. Though not abundant, it is considered a very good fish and always finds a ready sale. It is caught in largest numbers from December to March, in mullet gill nets. On January 16 one net at Cocoa took 20 pounds, and that was regarded as a very good catch. It is believed to remain in the river all the time and probably spawns in the early spring. The average size is about 1 to 1½ pounds. The fishermen believe that it is as common now as it has been at any time since commercial fishing began in Indian River. One dealer thinks it is increasing to some extent.

CREVALLÉ (*Caranx hippos*).

The crevallé is probably common in Indian River at all times, but is not highly esteemed by commercial fishermen. A good many are caught, but are thrown away. It is most abundant in the lower end of the river and in Lake Worth, and is said to be common outside. It bites voraciously, and affords much sport to the angler, who takes it by trolling. It is very ravenous, swimming with great swiftness and preying upon smaller fishes, particularly mullet, menhaden, and young red drum. It is said to attain a weight of 20 pounds; but the average probably does not exceed 3 pounds. Several examples taken and others seen at Eden, Stuart, and Lake Worth averaged about 3 pounds. It probably spawns in salt-water lagoons and bays during the summer, as schools of young have been seen going out in the fall.

SAILOR'S CHOICE (*Lagodon rhomboides*).

This species is said by fishermen not to be very common in Indian River. Its small size, however, allows it to pass through the meshes of the nets used for other species, and its scarcity may be only apparent. It is highly prized as a pan-fish, and is permanently resident in Indian River. The average weight is one-half pound or less. and the maximum probably not over a pound.

GRAY DRUM (*Pogonias cromis*).

This is also sometimes called the black drum. It is a constant resident of the river in considerable numbers, but is not valued as a food-fish. Large numbers are caught, but they are usually killed and thrown away, as they do great damage to the nets and are known to be destructive to the oyster beds. They reach a large size, specimens weighing 40 to 75 pounds often being taken. The large individuals are said to be infested with worms. Several large specimens examined at Santa Lucia Inlet the last of January contained well-developed roe, which indicates late winter or early spring as the spawning season.

SOUTHERN FLOUNDER (*Paralichthys lethostigma*).

This is the most common flounder found in Indian River and is apparently the only species handled by fishermen. It is well regarded, but the catch is small. There is no special fishery for it and its abundance is probably greater than indicated by the present catch. Nothing important was learned of its habits.

SPANISH MACKEREL (*Scomberomorus maculatus*).

This species is very scarce in Indian River. One dealer at Titusville received four early in January and regarded that as an unusually large number—generally only one or two are secured per day by his entire fishing force. The weight of the four was 15 pounds. They are rarely or never caught as far up the river as Cocoa, but are occasionally taken about the inlets.

CROAKER (*Micropogon undulatus*).

Not abundant in Indian River. It is said to be present throughout the year and to spawn early in spring. It was seen only at Fort Pierce and points below. One fine example, a female, 18½ inches long and weighing 3 pounds, was seen at Eden. It was quite full of well-matured roe and would doubtless have spawned early in March.

SILVER MULLET (*Mugil curema*).

Besides the common mullet of Indian River, there is a second species which is usually known as the "silver mullet," or "white mullet." It may be readily told from the common mullet by its more silvery color, the absence of dark longitudinal streaks, the narrower and more pointed snout, and the presence of small scales on the dorsal and anal fins. It is considerably smaller than the common mullet and much less abundant. According to some dealers, it averages only about half the size of the common mullet, and not more than one out of every hundred mullet taken is a silver mullet. Very little could be learned of its habits as distinct from the common species, except that it is more of a sea fish than the other.

TRIPLE-TAIL (*Lobotes surinamensis*).

This species does not appear to be very well known to the fishermen of Indian River. None was observed north of Fort Pierce, but from that place southward a few were found at each fish-house. Very few fishermen were certain as to its right name; it is known locally as "rockfish," "grouper," "black grouper," or "black drum." The greatest numbers were seen at Stuart. At Eden one of 8 pounds and one of 10 pounds were noticed. It is said to run as high as 50 pounds. The average of those taken is probably 8 or 10 pounds. It is regarded as a very good fish. It is said to come into the river in December and go out in the spring. Nothing is known of its spawning habits in this region.

PIGFISH, SPOT, AND OTHER MINOR SPECIES.

The pigfish (*Orthopristis chrysopterus*) is a small fish which enters only sparingly into the commercial catch. Only a few could be found at any of the fishing centers during the investigation.

The spot (*Leiostomus xanthurus*) is probably abundant, but the catch is small, as the mesh of the nets used is not suited to its capture. It attains a length of a foot or less and a weight of half a pound. Little is known of its habits in Indian River, but it probably spawns in shallow water about the inlets. Local names for this fish on Indian River are "mazuca" and "jimmy."

The yellow-tail (*Bairdiella chrysura*) is a small species that is not abundant and not taken in noteworthy quantities for food. It is very different from the yellow-tail of Key West.

Gerres olisthostoma, known as the mutton-fish in Indian River, was not observed north of Fort Pierce, and only a few were seen there, but a good many were noticed at Eden and a few at Stuart. It is not highly valued and is thrown away by most fishermen. The specimens seen averaged less than one-half pound in weight.

The pinfish (*Diplodus holbrookii*) is found occasionally in the catch, but it is not sufficiently abundant to be of much commercial importance.

The sergeant-fish or snook (*Centropomus undecimalis*) is not uncommon in the river, especially in the southern part. It is a food-fish of some value, but is frequently not utilized when caught, unless better fishes are scarce.

ANNOTATED LIST OF THE FISHES KNOWN FROM INDIAN RIVER.

In the following list are included all the species of fishes which are known to occur in Indian River. A few of these are fresh-water fishes which were not obtained by us, but which have been reported from streams tributary to Indian River by Dr. Goode, Dr. Jordan, Dr. Henshall, and others. Common names more or less local in their use by Indian River fishermen are inclosed in quotation marks. The total number admitted to the list is 106. In nomenclature and sequence of species Jordan & Evermann's Fishes of North and Middle America, recently issued as Bulletin 47, U. S. National Museum, is followed.

1. **Carcharhinus milberti** (Müller & Henle). *Blue Shark.* Probably common, but not seen during this investigation. Reported from Indian River in 1879 by Dr. Goode.

2. **Scoliodon terræ-novæ** (Richardson). *Sharp-nosed Shark.* Probably common. One example, 2½ feet long, seen at Indian River Inlet.

3. **Sphyrna tiburo** (Linnæus). *Shovel-nosed Shark.* Mr. Scobie says this shark is not uncommon about the inlets. A dead one was seen near Titusville.

4. **Sphyrna zygæna** (Linnæus). *Hammer-headed Shark.* Not seen during this investigation, but reported from Indian River by Dr. Goode in 1879. Probably not uncommon.

5. **Squalus acanthias** Linnæus. *Dogfish; Dog Shark; "Puppy Shark"; "Herring Shark."* This little shark is probably the most abundant shark in Indian River. Said to be a permanent resident.

6. **Pristis pectinatus** Latham. *Common Sawfish.* The sawfish is an abundant species, permanently resident in Indian River, where it does considerable damage to the fishermen by becoming entangled in their nets. The larger ones tear or cut the nets, while the smaller ones become entangled and are difficult to remove. The examples observed were usually less than 3 feet in total length, saw included, but it is known to reach a very large size in this river. Several very large "saws" were seen at Eden, Stuart, and elsewhere, the largest being 6 feet long, thus indicating a fish of 12 or 15 feet. One fisherman has seen them 16 or 17 feet long. Another reports that a sawfish 12½ feet long and weighing 425 pounds was caught near Eau Gallie in October, 1895. He thinks fully 300 sawfish were taken in his nets last season.

   Some very interesting information concerning the young sawfish was obtained from Mr. F. B. Everett and Mr. Stypmann. Mr. Everett says that from a large sawfish which he caught a few years ago he took a number of young, which swam away when placed in the water. The "saws" were enveloped by a membrane, which disappeared in specimens left to dry in the sun, and the teeth became visible. Mr. Stypmann says he has taken eighteen or twenty young from a sawfish about the first of July. The "saws" were well developed, but they, including the teeth, were soft like leather. He says he has found the young in a sawfish 16 or 17 feet long.

   There is some variation in the number of teeth, and there is usually one more tooth on one side than on the other. The numbers most frequently found were 25 and 26.

7. **Dasyatis sabina** (LeSueur). *Sting Ray.* Said to be quite common. Three young examples from Cocoa and Stuart.

8. **Dasyatis say** (LeSueur). *Southern Sting Ray.* Probably more common than the preceding species, though the collection contains but a single specimen, taken at Stuart. This species may be distinguished from *Dasyatis sabina* by its smoother skin and the absence of a median series of prickles on the back.

9. **Pteroplatea maclura** (LeSueur). *Butterfly Ray.* Reported from Indian River by Dr. G. Brown Goode in 1879.

10. **Acipenser brevirostris** LeSueur. *Short-nosed Sturgeon.* Sturgeon are occasionally taken in Indian River. One was taken in 1894 and one in 1895. Two others were obtained several years ago; they weighed 15 or 16 and 20 pounds, respectively. Two others were caught near Indian River Inlet about eight years ago; the larger weighed 40 pounds, dressed, the other 20 pounds.

11. **Lepisosteus tristœchus** (Bloch & Schneider). *Alligator Gar.* Mr. Scobie states that this species is found in the creeks emptying into Indian River. One large specimen was seen at Cocoa that had been obtained at Lake Poinsett, a few miles west of Cocoa.

12. **Felichthys marinus** (Mitchill). *Gaff-topsail.* Not so abundant as *G. felis*, but not at all uncommon.

13. **Galeichthys felis** (Linnæus). *Sea Catfish.* The common catfish of Indian River and one of the most abundant fishes found there. The young are extremely abundant everywhere; large schools can be seen at almost any time about the wharves and landings. Large numbers were taken wherever the seine was used. It was particularly numerous at Stuart. The freeze of 1894–95 is said to have killed vast numbers of this species, but it is still very abundant.

Mr. Stypmann assures us that eggs are never found in this catfish, but that the young are brought forth alive. He says during March the adult females are found filled with well-developed young, each rolled up in a ball, and the various balls connected in a long string. He thinks they hatch out very much like the sawfish. Others give the same information, and it seems certain that this species is ovoviparous.

14. **Ameiurus erebennus** Jordan. *Catfish.* This species of fresh-water catfish, originally described from St. Johns River in 1877, was recorded by Dr. Jordan from Sebastian River in 1880. Not seen during this investigation.

15. **Erimyzon sucetta** (Lacépède). *Chub Sucker.* Reported by Dr. Jordan (as *Erimyzon goodei*) in 1880 from Sebastian River. Not seen during this investigation.

16. **Anguilla chrysypa** Rafinesque. *Common Eel.* Not uncommon, but apparently of no commercial importance. Young individuals were obtained at Cocoa and Eau Gallie; others seen at Titusville.

17. **Tarpon atlanticus** (Cuvier & Valenciennes). *Tarpon.* The tarpon is the prize most sought by the angler who goes to Indian River, and it is doubtful if any other portion of our coast furnishes more and better tarpon fishing than the East Florida coast from Titusville on the north to below Biscayne Bay on the south. Many phenomenal catches are reported from Indian River, Lake Worth, and Biscayne Bay.

18. **Elops saurus** Linnæus. *Big-eyed Herring; Tenpounder; "Bony-fish."* Observed at Fort Pierce and at mouth of St. Lucie River. Known to some of the fishermen as "Lady-fish." Frequently taken in the seines. Examples from Fort Pierce preserved.

19. **Alosa sapidissima** [illegible]on). *Shad.* On May 5, 1892, the United States Fish Commission made [illegible]nt of 800,000 shad fry in Halifax River, north of Titusville, with the assist[illegible]ce of Capt. M. Moseley, then State fish commissioner of Florida. Since then shad have been taken occasionally in Indian River. Mr. Ricon reports one taken in the St. Lucie River and another at Eden. Captain Saunders caught a roe shad weighing 5 pounds in January, 1895, and another without roe a year before. Mr. Collins has heard of shad being taken, but has not seen any himself. It is said that since the opening of Gilbert Bar several have been seen in the St. Lucie. Mr. Church reports two or three shad taken near the mouth of the St. Lucie; they weighed about 4 pounds each. Mr. Stypmann says that four or five fine shad were caught near the St. Lucie a year ago.

Whether or not Indian River and its connecting streams furnish favorable conditions for the establishment of a large run of shad is not known. No examination has been made of Sebastian and St. Lucie rivers for the purpose of determining the presence or absence of suitable spawning-grounds. The Sebastian is probably too short a stream to promise much in this respect, but the St. Lucie is much larger, and is said to be very much like the St. Johns in general character. The St. Johns has long been known as one of the most important shad streams. The opening of Gilbert Bar, thus making a good inlet from the sea opposite the mouth of the St. Lucie, will probably prove very helpful to shad in making it easier for them to reach the St. Lucie for spawning purposes. The possibility of establishing a run of this valuable fish in St. Lucie River warrants an experimental plant of shad fry in that stream, and this has recently been made.

20. **Opisthonema oglinum** (LeSueur). *Thread Herring.* Doubtless common, but the only examples seen during this investigation were two found in the nest of a brown pelican (*Pelecanus fuscus*) at Pelican Island. They measured 6¾ and 7⅝ inches, respectively. D. 19; A. 22; scales 50–12; scutes 17 + 12.

21. **Brevoortia tyrannus** (Latrobe). *Menhaden; Bunker; Stink Shad.* The menhaden is abundant in Indian River and along the entire eastern coast of Florida, and is considered a great nuisance. It is seldom utilized in any way by Indian River fishermen. Among the names heard for this fish on Indian River are menhaden, bunker, stink shad, bony fish, yellow-tailed shad, jack shad, hickory shad, yellow-fin shad, pogy, and bonefish.

22. **Stolephorus mitchilli** (Cuvier & Valenciennes). *Anchovy.* Found in considerable numbers in small coves and around a sand spit at Cocoa. Many seined along shore of St. Lucie River 5 miles from its mouth. D. 13; A. 25.

23. **Fundulus similis** (Baird & Girard). Seven examples, 1 to 1¼ inches long, are in the collection from Pelican Island. Not obtained at any other place.

24. **Fundulus heteroclitus** (Linnæus). *Common Killifish; Mummichog.* This species, which was more or less common in January and undoubtedly abundant in summer, was taken in the seines at Titusville January 14, at Indian River Inlet January 22, Cocoa January 17, and Pelican Island January 21, 1896. The specimens measured from 3 to 4½ inches in length, and the species is doubtless valuable as food for larger fishes.

25. **Fundulus chrysotus** Holbrook. Indian River (Jordan, 1884).

26. **Fundulus henshalli** (Jordan). This cyprinodont was originally described from Sebastian River in 1879 by Dr. Jordan. The types were collected by Dr. J. A. Henshall.

27. **Fundulus rubrifrons** (Jordan). The types of this species were also obtained in Sebastian River by Dr. Henshall, and were described in 1879.

28. **Fundulus nottii** (Agassiz). *Star-headed Minnow.* The specimens collected in Elbow Creek, near Eau Gallie, by Dr. Henshall, and described in 1881 by Goode & Bean as *Zygonectes craticula*, seem to belong to this species.

29. **Lucania ommata** (Jordan). The types of this species were obtained near Titusville by Mr. R. Edward Earll and described by Dr. Jordan in 1884.

30. **Lucania venusta** (Girard.) This small killifish is one of the most abundant species of Indian River, being seined along the grassy shores in considerable numbers. Examples were obtained at Titusville, Cocoa, Indian River Inlet, Pelican Island, and other points. D. 12; A. 11; scales 28–7.

31. **Cyprinodon variegatus** Lacépède. *Sheepshead Killifish.* This species was abundant at Titusville, Indian River Inlet, Cocoa, Pelican Island, and Stuart. The individuals vary in length from 1 to 2 inches.

32. **Jordanella floridæ** Goode & Bean. This species, originally described from Lake Monroe, Florida, has been recorded from Sebastian River (Jordan, 1880) and from Indian River (Jordan, 1884).

33. **Gambusia affinis** (Baird & Girard). *Top-minnow.* Recorded from Sebastian River by Dr. Jordan in 1880.

34. **Mollienisia latipinna** LeSueur. Numerous fine specimens were obtained at Titusville, and a few at Indian River Inlet.

35. **Tylosurus notatus** (Poey). *Silver Gar.* One specimen was taken in seine at Titusville. D. 14; A. 14. Head $2\frac{3}{5}$; eye 9.

36. **Tylosurus marinus** (Walbaum). *Silver Gar.* One small example, $3\frac{1}{4}$ inches long, taken at Pelican Island. Quite a number taken at Indian River Inlet, 17 of which are very small, measuring from 4 to $6\frac{1}{2}$ inches. D. 15; A. 18. Eye $2\frac{1}{2}$, in posterior part of head.

37. **Hyporhamphus unifasciatus** (Ranzani). *Halfbeak.* Not seen during this investigation, but recorded by Dr. Jordan from Indian River.

38. **Siphostoma scovelli** Evermann & Kendall. *Pipefish; "Needle-fish."* The common pipefish of the Indian River. Many examples were seined at Titusville and Cocoa; one specimen at Pelican Island. One Titusville lot contained 69 females and 10 males. Six of the small males, $2\frac{1}{2}$ to $2\frac{4}{5}$ inches long, have eggs in pouch. The two largest examples, 4 and $4\frac{1}{2}$ inches, have a few eggs in their pouches. D. 30 or 31, very high in the females, low in males. One example has D. 34.

39. **Siphostoma louisianæ** (Günther). *Pipefish.* One secured at Titusville and two at Cocoa.

40. **Menidia peninsulæ** (Goode & Bean). *Silverside.* Abundant throughout Indian River. Specimens obtained from Titusville, Cocoa, Pelican Island, and Indian River Inlet. D. usually V–I, 8 or 9; A. I, 16 or 17. The dorsal varies from IV to VII–I, 8 to 10. Scales 3–38 to 40–5.

41. **Labidesthes sicculus** (Cope). *Brook Silverside.* One specimen of this interesting little fish, $1\frac{3}{4}$ inches long, was obtained at Pelican Island, January 21, 1896. D. IV, 10; A. about 20; scales 70. Color: Pale green; top of head black; a black stripe composed of black dots along dorsal line from head to tail; a similar stripe along ventral line from throat to tail; lateral band dark silvery, edged with dark dots; all the scales bordered with spots of black pigment.

42. **Mugil cephalus** Linnæus. *Common Mullet.* By far the most abundant and most important food-fish of Indian River. From the silver mullet, which is much less abundant, it may be distinguished by its less silvery color, the presence of dark longitudinal streaks, the broader and more rounded snout, and the absence of scales on the dorsal and anal fins. The mangrove mullet spoken of by some of the fishermen is apparently a large example of the common mullet. The name *galan botie* (variously spelled *gallan botie, gallan bota*, and *gallam bote*) is a term used chiefly by the Minorcans to designate spent mullet, and is probably applied to large spent mullet of either species when in poor condition.

43. **Mugil curema** Cuvier & Valenciennes. *Silver Mullet; White Mullet.* Will probably not average more than half as large as the common mullet and is much less abundant. Examples obtained at only a few of the places visited.

44. **Scomberomorus maculatus** (Mitchill). *Spanish Mackerel.* Taken in Indian River only occasionally; more common outside. One 15 inches long taken at Santa Lucia Inlet January 30.

45. **Oligoplites saurus** (Bloch & Schneider). *Leather Jack.* Indian River (Jordan, 1880).

46. **Caranx hippos** (Linnæus). *"Cavally;" Crevallé.* Common, particularly in the lower half of the river. Life colors: Opercle with an inky black spot; pectoral with rather plain black blotch near tips of lower rays; anterior parts of anal bright lemon yellow; under part of caudal peduncle, caudal, and top of head, orange yellow; lower lobe of caudal yellowish; pectoral long, falciform, longer than the head; axil of pectoral dark; eye golden.

47. **Caranx crysos** (Mitchill). *Hard-tail; Yellow Mackerel.* Not seen during this investigation, but doubtless not rare here. Recorded from Indian River by Dr. Jordan.

48. **Vomer setipinnis** (Mitchill). *Moonfish; Horsefish.* Recorded from Indian River in 1881 by Dr. Goode.

49. **Selene vomer** (Linnæus). *Moonfish; Look-down; "Old Man-of-the-Sea."* Common, particularly in lower portion of Indian River.

50. **Chloroscombrus chrysurus** (Linnæus). *Casaba; Bumper.* Recorded from Indian River in 1880 by Dr. Jordan. Probably not uncommon.

51. **Trachinotus falcatus** (Linnæus). *"Permit"; Round Pompano.* This species should be called round pompano, a name by which it has long been known, to distinguish it from the larger species, *Trachinotus goodei*, which also probably occurs in Indian River. The round pompano appears to be rare in the north end of the river, and was not seen north of Eau Gallie, but examples were seen at Eau Gallie, Eden, and Stuart. Its usual weight is about a pound.

52. **Trachinotus goodei** Jordan & Evermann. *Key West Pompano,* or *"Permit" of Key West.* All of the very large pompano reported from Indian River probably belong to this species. Mr. Scobie has seen examples weighing 20 to 25 pounds; Mr. Collins, 20 pounds; Mr. Church, 27 pounds; Mr. O'Brien, 26 pounds, and Mr. Keller 22 pounds.

53. **Trachinotus carolinus** Linnæus. *Common Pompano.* The most highly prized fish of Indian River.

54. **Pomatomus saltatrix** (Linnæus). *Bluefish.* Not abundant, but highly prized both by commercial fishermen and anglers. Young less than 2 inches long were obtained near Indian River Inlet.

55. **Elassoma evergladei** Jordan. This interesting fish was described in 1884 from specimens obtained in Lake Jessup and Indian River, near Titusville, by Mr. R. Edward Earll.

56. **Chænobryttus gulosus** (Cuvier & Valenciennes). *Warmouth.* Recorded from Sebastian River in 1880 by Dr. Jordan.

57. **Enneacanthus obesus** (Baird). Recorded in 1880 by Dr. Jordan from Sebastian River.

58. **Apomotis punctatus** (Cuvier & Valenciennes). *Spotted Sunfish.* Recorded by Dr. Jordan from Sebastian River in 1880.

59. **Lepomis pallidus** (Mitchill). *Blue Bream; "Brim."* The most common sunfish in the fresh-water streams tributary to Indian River. Two specimens were obtained from Eau Gallie Creek and numerous examples from South Lake, near Titusville. One of the Eau Gallie specimens, 4½ inches long, has the following characters: Head 3; depth 2½; eye large, 3 in head, and slightly greater than the snout. D. x, 12; A. III, 11; scales 6–42–14. Fins rather high and long; pectorals slightly longer than head; opercular flap short; body with faint dark-greenish vertical bars; black blotch at base of posterior dorsal and anal rays very distinct.

60. **Eupomotis holbrooki** (Cuvier & Valenciennes). *"Bream"; "Brim."* Doubtless found in all the streams flowing into Indian River. Two specimens, 5½ and 9 inches long, respectively, were taken in South Lake, near Titusville. Head 3; depth 2⅖; eye 4. D. x, 12; A. III, 11; scales 7–45–15.

61. **Micropterus salmoides** (Lacépède). *Large-mouthed Black Bass; "Trout."* Obtained in Eau Gallie Creek and South Lake. Said to be common in all the fresh waters near Indian River. Dr. Henshall obtained specimens from Sebastian River.

62. **Boleichthys fusiformis** (Girard). The only darter ever reported from waters tributary to Indian River. Dr. Jordan (1884) records it (as *Pœcilichthys barratti*) among the species collected by Mr. Earll near Titusville.

63. **Centropomus undecimalis** (Bloch). *Sergeant-fish; "Snook."* Rather common in Indian River, particularly in the southern part. It is a food-fish of some importance, but is sometimes not utilized if better fish are caught in sufficient abundance. Dark silvery; dark-greenish above, becoming silvery along the lateral line, with many black punctulations below; head pale-greenish

above, silvery on sides, white below; black stripes along lateral line, very plain; dorsals, anal, and pectorals olivaceous; ventrals pale lemon; caudal olivaceous; lower lobe darker.

64. **Promicrops guttatus** (Linnæus). *"Grouper"; Guaza; Spotted Jewfish.* Probably not uncommon. Four young examples obtained from Indian River Inlet. They measure 1⅝, 2⅜, 2, and 3 inches respectively. D. XI, 15; A. III, 8. A fresh example showed the following life colors: Dark olivaceous, with somewhat regular darker vertical bars; first bar most indefinite and just back of the gill-opening; the second under last four dorsal spines and connected with first above pectorals; third extends from third to seventh soft dorsal ray and divided to inclose a paler spot; fourth bar under the last seven dorsal rays and continued on to the anal fin; fifth bar on caudal peduncle and inclosing a pale spot below. Anterior part of body, opercles, cheeks, upper jaw, and top of head, with some round black spots varying from one-sixteenth to one-eighth of an inch in diameter. Somewhat similar, paler spots on the pectorals, arranged in five or six more or less definite vertical rows. Under parts pale, dirty olivaceous; dorsal membrane dirty olivaceous, black margined with a row of black spots; soft dorsal with two or three irregular rows of dark spots; caudal similar. Anal dark olivaceous; ventrals similar. Inside of mouth flesh-colored. Eye greenish.

65. **Lobotes surinamensis** (Bloch). *Flasher; Triple-tail.* Not common in Indian River and not well known by any of the fishermen; apparently most frequent in the southern portion of the river. It attains a length of 3 feet and a weight of 25 or 30 pounds, but those taken in Indian River are usually much smaller.

66. **Neomænis griseus** (Linnæus). *Mangrove Snapper.* A common and important species from Fort Pierce southward. The following life colors were exhibited by fresh examples examined at Fort Pierce: Back, down to lateral line, dark-greenish, with lighter on margin of scales; scales with coppery centers, very faint on anterior part, brightest under the soft dorsal and on side of caudal peduncle; scales of middle side rich iridescent copper on anterior half, then a narrower paler streak; next a greenish-white margin, this margin plainer posteriorly.

Another specimen had the belly pale rosy; top of head dark-greenish; cheeks and opercles iridescent greenish, becoming coppery below and on lower mandible; preopercular flap iridescent greenish; spinous dorsal dark-greenish, with wine-colored margin fringed with black; soft dorsal rays whitish, membranes black; anal rosy purple; the fine scales on membrane greenish; caudal very dark purplish; pectorals uniform pale; ventrals white, tinged with purplish; white in the axils; pectorals dusky in the axils; eye coppery; mouth white inside.

67. **Neomænis synagris** (Linnæus). *Lane Snapper.* Two young examples, 2½ and 3¼ inches long, respectively, obtained at Indian River Inlet. Not known to the fishermen.

68. **Neomænis apoda** (Walbaum). *Schoolmaster.* Eight young examples, 1½ to 2¼ inches long, from Indian River Inlet. D. X, 13 or 14; A. III, 7; scales 6–44–12. The fishermen do not know this species.

69. **Hæmulon macrostoma** Gunther. Indian River Inlet, January 23, 1896, five specimens, 1½ to 2 inches long. D. XII, 17; A. III, 8; scales 50.

70. **Anisotremus surinamensis** (Bloch). *Pompon.* A fine example, 15 inches in total length, obtained from Capt. Joseph Smith at Fort Pierce.

Head 3⅓; depth 2⅛; eye 4½; snout 2⅜; maxillary 3. D. XII, 16; A. III, 8 or 9; scales 5–50–13. Body deep, back elevated, greatly compressed, profile steep, nearly straight from snout to above eye, a slight depression in front of nostril and another in interorbital space; from interorbital space to dorsal strongly arched in a broad curve. Head moderate; cheek deep; mouth rather small; jaws subequal, maxillary barely reaching front of orbit; ventral line of body nearly straight; caudal peduncle moderately long, its least depth equal to snout; teeth in several bands, the outer enlarged and canine-like. Fourth dorsal spine strongest and longest, its length $2\frac{1}{3}$ in head; soft dorsal as well as anal, pectoral, ventrals, and caudal densely covered with minute scales; height of longest soft dorsal ray 3 in head; second anal spine very stout, its length equal to that of fourth dorsal spine; third anal spine broad at base, but shorter; free edge of soft anal straight; dorsal and anal fins depressible in a scaly sheath. Pectoral long and falcate, nearly reaching tip of ventrals, $1\frac{1}{3}$ in head; ventral shorter, $1\frac{1}{3}$ in pectoral. Caudal well forked, the lobes about equal to ventral. Preopercle strongly but irregularly serrate. Scales of cheek in about 7 rows; those on opercle in about 8 rows; those on interorbital and nape small and crowded; scales of back and sides arranged in oblique rows not parallel with the lateral line. Lateral line arched, following approximately the contour of the back. Gillrakers rather short, stiff, 13 + 19.

Color grayish, darkest on anterior half of body, where each scale is dark brown on its basal half, then with a white ellipse, the narrow border darker, the contrast between the dark base and the white ellipse very marked; owing to the irregular arrangement of the scales the dark bases in some cases appear as spots; upper side of caudal peduncle brown, sides nearly plain white; snout and under parts of head lilac-brown; under parts of body rusty brown; fins all dark brown, especially the soft parts of dorsal and anal.

This is the first time this fish has been recorded in our waters, it hitherto being known only from Cuba and south to Brazil.

71. **Orthopristis chrysopterus** (Linnæus). *Pigfish.* One example obtained at Eden, from Capt. Nathan Saunders, January 24, 1896. D. XII, 16; A. III, 13.

72. **Lagodon rhomboides** (Linnæus). *Sailor's Choice.* Common, though not abundant in Indian River at the time of this investigation. Small examples were seined at Titusville and Indian River Inlet.

Pale; side with about nine pale-bluish streaks, the upper five plainest; two above lateral line, the third running just below the lateral line and connecting with the fourth under origin of soft dorsal; the first five streaks alternate with four or five brassy lines of about equal width, the one on the lateral line the plainest; under parts white, with silvery and rosy iridescence; cheeks silvery, with brassy and rosy iridescence; belly white; dorsal pale, with irregular, longitudinal, brassy lines, margined with brassy; anal pale whitish, with a bright orange or brassy line through the middle; pectoral plain; ventrals with some orange; caudal pale, with orange spots, margin dark; a dark spot near beginning of lateral lines.

73. **Archosargus probatocephalus** (Walbaum). *Sheepshead.* Young sheepshead were seined at Titusville, Cocoa, and Indian River Inlet. Very abundant in Indian River.

74. **Diplodus holbrookii** (Bean). *Sailor's Choice; "Spot."* Observed at different points. Examples preserved from Eden. D. XII, 14; A. III, 13; scales 7-61-13. Sides dusky silvery, with rich sheen of olivaceous, steely, purplish, etc., darkest above, plain white on belly; about 18 faint longitudinal stripes through center of scales; black blotch on anterior upper part of caudal peduncle, absent underneath; axil of pectoral purplish black, the color showing slightly on outside above; inside of ventrals washed with purple; anal faint purplish; dorsal dark; base of spines lighter; cheeks purplish, iridescent.

75. **Eucinostomus gula** (Cuvier & Valenciennes). A number taken at Pelican Island, Indian River Inlet, and from St. Lucie River at Stuart.

76. **Gerres olisthostoma** Goode & Bean. *"Mutton-fish"; Irish Pompano.* Quite common in Indian River, where it is known as mutton-fish. Examples preserved from Fort Pierce. Head 3; depth $2\frac{1}{4}$; D. IX, 11; A. III, 9; scales 6-40-9.

The following notes are from specimens examined at Eden: Premaxillary space narrow, slightly curved; height of longest dorsal spine 1¼ in head; longest anal spine 1⅝ in head; second anal spine strongest, but third slightly longer; pectoral as long as head; eye about 4 in head. Color plain silvery, with purplish iridescence on anal sheath and on part of sides and opercles; top of head and body above lateral line somewhat olivaceous, with steely iridescence; sides with fine dark punctulations.

Another example had anal spine 2 in head.

77. **Cynoscion nebulosus** (Cuvier & Valenciennes). *"Trout"; Spotted Squeteague.* Abundant throughout Indian River; young examples taken at Titusville, Cocoa, and Indian River Inlet.

78. **Sciænops ocellatus** (Linnæus). *Red Drum; "Bass"; "Channel Bass."* Very abundant in Indian River. Young examples, from 1 to 4 inches long, obtained at Pelican Island January 21, and at Indian River Inlet January 23.

79. **Leiostomus xanthurus** Lacépède. *"Spot,"* confused with *Croaker.* Examples 5½, 6, and 6½ inches long were seined at Titusville. One specimen was taken at Indian River Inlet. A large example, 13½ inches long, was obtained at West Palm Beach, Lake Worth, from Mr. G. W. Jennings, who says it is called "Jimmy" by the fishermen. D. x, 1, 30; A. II, 12; scales 60.

80. **Micropogon undulatus** (Linnæus). *Croaker,* confused with *"Spot."* Abundant.

81. **Menticirrhus americanus** (Linnæus). *"Whiting."* Common; examples obtained at Cocoa January 17, 1896, from Mr. Fred. Church.

82. **Pogonias cromis** (Linnæus). *Gray Drum; "Drumfish"; Black Drum.* Common in Indian River. Reaches a large size and said to be destructive to the oyster beds and fishing nets. Not esteemed as food. Examples from Cocoa and Fort Pierce were preserved. Other very large examples were seen at Santa Lucia Inlet.

83. **Cryptotomus ustus** (Cuvier & Valenciennes). A single specimen, 2½ inches long, from Indian River Inlet. Head 3½; depth 3½; eye 3⅞; snout 3½. D. IX, 10; A. II, 9; scales 2–23–6.

84. **Chætodipterus faber** (Broussonet). *Angel-fish.* Not uncommon, especially in lower part of river. Said to reach a weight of 20 pounds. Examples seen at Fort Pierce and Eden.

85. **Spheroides spengleri** (Bloch). *Southern Puffer; Swell-toad.* Probably common. Four specimens obtained from mouth of St. Lucie River and 3 from Cocoa.

86. **Spheroides maculatus** (Bloch & Schneider). *Globe-fish; Puffer; Blower.* Five small specimens, ⅝ to 1⅝ inches long, from Cocoa; no large ones seen. These specimens can be readily inflated by applying a blowpipe at the mouth. The specimen 1⅝ inches long, when inflated, measured 1 inch wide and ⅞ of an inch deep, while the width of the head is ½ inch. Eye 3⅔ in head; interorbital width 2 in snout, or 6 in head.

Possessing young individuals, of approximately the same size, of these three species of *Spheroides* (*S. spengleri*, *S. testudineus*, and *S. maculatus*), their relative inflating abilities have been compared. The one possessing this power in the greatest degree is *S. maculatus.* When fully inflated the young of this species are nearly globular and look like marbles. The surface is evenly rounded. *S. spengleri* can not be inflated so greatly, and *S. testudineus* is inflatable in a still less degree. Moreover, these two species when inflated differ very materially in shape from *S. maculatus,* in that the nose projects noticeably and the inflated belly is not continuously and regularly rounded where it joins the back, but a considerable angle is formed on a line parallel with the lower edge of the pectoral fin. The young of *S. maculatus* is most uniformly covered with prickles, differing but slightly from *S. spengleri* in this respect, while *S. testudineus* has considerable areas without prickles. Of the three species *S. maculatus* is best entitled to the name globe-fish.

87. **Spheroides testudineus** (Linnæus). One specimen 1½ inches long from St. Lucie River at Stuart. Head 2½; depth, when not inflated, 3½; snout 3; eye 3½. Back dark, with whitish curved lines; lower part of side with a series of large black spots; belly white; fins all pale except caudal, which has a subterminal black bar. Back and sides from nape nearly to front of dorsal closely covered with small prickles; belly, with similar prickles from throat to vent; anterior half of head and posterior third of body nearly smooth. This specimen is inflatable to only a relatively slight degree, differing in this respect very markedly from *Spheroides maculatus*, but in a less degree from *Spheroides spengleri*.

Another specimen, 7 inches long, was taken at Cocoa. It differs from the smaller specimen in having fewer prickles on the throat and belly and the less distinct color pattern on the back.

88. **Diodon hystrix** Linnæus. *Porcupine-fish.* Probably not common; seen only at Cocoa.

89. **Chilomycterus schœpfi** (Walbaum). *Burfish; Spiny Swellfish.* Two examples seined at Cocoa.

90. **Scorpæna brasiliensis*** Cuvier & Valenciennes. *Rascascio.* A fine example was presented at Fort Pierce by Mr. Harry Munson, of New York City. D. XI–I, 9; A. III, 5; P. 18; scales in about 33 rows. A young example, 2 inches long, was seined at Indian River Inlet.

91. **Gobius soporator** Cuvier & Valenciennes. Four specimens from Indian River Inlet, each about 2½ inches long. D. VI–I, 10; A. I, 8; scales 38.

92. **Gobius boleosoma** Jordan & Gilbert. Four examples were seined at Indian River Inlet. The length of each is about 1½ inches.

93. **Gobius stigmaticus** (Poey). An example 2½ inches long, apparently of this species, was seined at Indian River Inlet. Head 4; depth 4½; D. VI, 11; A. 12; scales 28.

94. **Gobius lyricus** Girard. A single specimen from Indian River Inlet. D. VI, 10; A. 11; scales 32.

95. **Microgobius gulosus** (Girard). *Goby.* Very abundant. Taken at Titusville, Cocoa, Pelican Island, and Indian River Inlet. The collection from South Lake, which is fresh water, contains 8 specimens of this species. They are all very much darker than any of those from Indian River. Length about 2 inches. D. VI or VII, 16; A. 16; third, fourth, and fifth spines of dorsal ending in filaments.

96. **Gobiosoma bosci** (Lacépède). Common in Indian River. Specimens from Titusville, Cocoa, Pelican Island, and Indian River Inlet; the largest scarcely more than an inch in total length.

97. **Hypsoblennius punctatus** (Wood). A single specimen of this little blenny, 2 inches long, was taken at Indian River Inlet.

98. **Chasmodes saburræ** Jordan & Gilbert. This interesting blenny seems to be abundant in all suitable places in Indian River. The collection contains 76 fine specimens from Titusville and 3 from Cocoa. The largest are about 4 inches in total length. Head 3⅘; depth 3⅘; eye 4⅘; snout 3⅘; maxillary reaching posterior border of eye. D. XI, 18; A. III, 17.

A specimen 2 inches long, probably a male, has the following colors: Side with six broad, dark vertical bars, the anterior four extending on the dorsal fin; these bars separated by irregular narrow pale spaces; entire side profusely covered with small white spots; a small black spot at base of caudal; head mottled with light and dark; two small dark spots on under side of lower jaw; just behind these and extending downward from the angles of the mouth are two other larger, blacker spots, while behind these, extending downward and backward from middle of cheek, is an irregular black line;

* Equals *Scorpæna stearnsi* Goode & Bean.

whole head with numerous fine dark punctulations; dorsal and anal variously spotted or barred with light and dark; spinous dorsal with a large dark area at top of anterior spines; caudal faintly barred; pectorals and ventrals more plainly barred.

99. **Prionotus evolans** Linnæus. *Striped Gurnard.* An example, 12¾ inches in length, was examined at Collins's fish-house at Cocoa. It was caught in the Indian River. D. x, 11; A. 9; pectoral half length of body.

100. **Prionotus tribulus** Cuvier & Valenciennes. *Sea Robin.* An example 4 inches long was seined at Indian River Inlet. D. x, 12; A. 12; scales 57; head 2½; depth 3⅝; cranial spines strong. General color dark above, with small whitish markings; white underneath; black blotch on side of head from eye to end of mandible; black blotch covering almost entire membrane between fourth and sixth spines of dorsal, this blotch extending on body to pectoral base; a narrow bar from membrane of fourth and fifth dorsal rays downward on body to below lateral line, another from tenth ray, and still another from upper caudal base on peduncle; pectorals dark, with four darker cross-bands; ventrals and caudal whitish.

101. **Remora remora** (Linnæus). *Remora; "Sucker."* Specimens seen at Cocoa; they were obtained in Indian River.

102. **Gobiesox strumosus** Cope. Four specimens obtained at Titusville, each 1 to 2½ inches long. Head 2½; eye 5½; D. 11; A. 8. The type of this interesting species came from Hiltonhead, S. C. Titusville is the second locality from which the species has been collected.

103. **Paralichthys lethostigma** Jordan & Gilbert. *Southern Flounder.* The common flounder of Indian River. Examples in the collection from Fort Pierce and Stuart.

104. **Citharichthys spilopterus** Günther. One example, 1¼ inches long, obtained in St. Lucie River opposite Stuart.

105. **Achirus lineatus** (Linnæus). *Sole; Hog-choker.* A single example, 1 inch long, seined in St. Lucie River opposite Stuart.

106. **Symphurus plagiusa** (Linnæus). *Tongue-fish.* Two examples seined at Indian River Inlet.

COMMERCIAL FISHERIES OF INDIAN RIVER, FLORIDA.

By WILLIAM A. WILCOX.

THE FISHING CENTERS AND GROUNDS.

The points on the Indian River which serve as the headquarters of the fishermen and the centers for receiving and shipping fish are Titusville, Cocoa, Eau Gallie, Melbourne, Sebastian, Fort Pierce, Eden, Jensen, and Stuart. These places are all in Brevard County, on the line of the Jacksonville, St. Augustine and Indian River Railroad, and they are all on the western side of the river.

Titusville, the principal place on the river, is the county seat, with a resident population of 900. It was the birthplace of the Indian River fishing business, and has the advantage of two railroads for shipping products. Two firms were at this place during the first four years; in 1889 another engaged in the industry; in 1890, 1891, and 1892, when the fishing at this point was at its height, there were four firms; in the two following years the number was three, and at the end of 1895 and the beginning of 1896 only one remained.

The following table shows the monthly shipments of fresh fish from Titusville during each of the six years ending 1895:

Month.	1890.	1891.	1892.	1893.	1894.	1895.
	Lbs.	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*
January	80,855	205,015	98,705	105,205	79,280	25,335
February	73,685	74,340	75,755	91,845	67,185	41,960
March	37,215	64,105	51,685	50,415	43,125	40,495
April	10,330	33,625	47,400	27,005	32,455	11,705
May	15,660	60,050	70,190	57,565	42,130	34,385
June	24,840	105,515	64,150	53,870	34,960	42,960
July	40,535	93,775	70,965	106,565	29,010	51,870
August	68,985	75,005	118,975	104,820	42,890	60,875
September	130,680	97,800	117,945	86,920	23,585	39,995
October	237,285	123,070	91,260	85,585	13,315	25,995
November	222,895	160,452	138,450	110,415	124,215	10,120
December	129,390	124,485	98,000	99,420	24,940	24,015
Total	1,072,355	1,217,237	1,046,480	979,630	557,090	409,710

At the beginning of the fishing industry at Titusville the catch was taken within a few miles of that place, but as business increased new grounds were continually sought farther down the river until the operations of the Titusville fishermen were finally extended beyond Sewall Point, 125 miles to the south. Between these points camps were located at the most desirable places, chief of which were Eden, Indian River Inlet, and Sewall Point. The fish taken in the vicinity of the camps were carried to the camps and there packed in fish-cars holding from 800 to 1,500 pounds of well-iced fish, which were sent to Titusville by the steamers plying regularly on the river. Before being shipped by rail to the northern markets the fish were repacked with ice in barrels. The empty cars were filled with ice and sent back to the camps on the return trips of the steamers. The construction of a railroad along the western bank of the Indian River naturally led to a diversion of trade from Titusville, and reduced the necessity for maintaining fully equipped camps in isolated localities.

Cocoa, situated 19 miles south of Titusville, is one of the principal fishing centers on the river. Of the 300 inhabitants in 1895, 40 were engaged in the fisheries. The railroad reached this point in February, 1893, and the fishing business was established the next year. The shipments of fresh fish in 1895 amounted to nearly 500,000 pounds, most of which went to Georgia.

Commercial fishing at Eau Gallie dates from 1893, in June of which year it was brought into railroad communication with Jacksonville. In 1895 the business was represented by four firms; two of these, however, moved farther down the river and one suspended, leaving only a single firm in operation at the close of the year. The shipments from this place in 1895 were over 250,000 pounds of fresh fish. In 1893, when this was for some time the railroad terminus, it received by steamer the catch from points lower down the river and shipped by rail 255,105 pounds of fresh fish. Eau Gallie has a small oyster fishery, the product of which is used locally. The fishermen of this place fish from 3 miles above to 10 miles below the settlement, and at times also resort to Banana River from its mouth to a distance of 10 miles upstream.

Melbourne is a small settlement whose fisheries are now less extensive than those of any other place on the river. In the first part of 1896 there was only one fisherman at this place, although in 1895 there were six crews. The fish shipments in 1895, as shown by the express company's records, amounted to 27,600 pounds.

Fishing at Sebastian began in September, 1895, the first shipment of fish by rail being on September 11. Up to the close of the year 103,890 pounds of fish had been shipped. The year 1896 will doubtless witness a noticeable increase in the fishing centering at this point. Four firms were engaged in the business in the winter of 1895-96; these shipped mostly to New York, Richmond, and New Orleans. The grounds visited by the Sebastian fishermen extend for 15 or 20 miles north and south of that place. A small turtle fishery is there carried on.

Fort Pierce is now the principal fishing center on the river. From its nearness to Indian River Inlet, this part of the river is regarded by the fishermen as a very important section. Fishing camps were located in this vicinity soon after the arrival of the railroad at the northern end of the river, and for several years the catch was shipped from the camps by steamer to the nearest station. On February 1, 1894, the railroad reached this place; soon after the camps were deserted and the business of receiving and shipping fish was transferred to Fort Pierce. The quantity of fresh fish sent from this place in 1894 was 555,915 pounds. New firms entered the business in 1895, when the shipments reached nearly a million pounds. The principal points to which the products were consigned are Jacksonville, Palatka, Sanford, and St. Augustine, in Florida; Mason, Atlanta, Altona, Savannah, and Marietta, in Georgia; Eufaula, Ala.; Charlotte, N. C.; Louisville, Ky.; Norfolk, Va.; Washington, D. C., and New York City. Three-fourths of the shipments from this place in 1895 were mullet, which were sent chiefly to cities in Georgia. Fort Pierce is the principal headquarters of the alligator hunters of the eastern part of Florida. A very large trade in alligator hides was formerly carried on there, but the business has greatly declined.

Fishing at Eden dates from December, 1894, the railroad having reached the place in February of that year. One firm was here in 1894, and during 1895 there were two firms, who shipped 210,300 pounds of fresh fish. A few turtles are taken here. The fishing-grounds extend north to Fort Pierce, a distance of 13 miles, and south to Sewall Point, a distance of 10 miles.

Jensen has never been important as a fishing center; between November, 1894, and March, 1895, one firm was engaged in the business, since which time the fisheries have been unrepresented. The aggregate shipments were 28,230 pounds in 1894 and 40,485 pounds in 1895.

Stuart is the most southern fishing station on the Indian River. One firm established headquarters here in January, 1895, and shipped 89,658 pounds of fresh fish during that year. From its favorable position with reference to Santa Lucia Inlet, Stuart may be expected to show considerable development of its fisheries within a short time. The Stuart fishermen set their nets as far north as Jensen (4 miles distant) and south to the inlet (3 miles away); they also go from 3 to 6 miles up each arm of the Santa Lucie River.

FISHERY RESOURCES OF THE REGION.

The commercial water products of Indian River comprise fishes, oysters, and turtles. Considering the nearness of this region to the West Indies, with their remarkably rich fauna, the fishing resources are not especially varied, although a number of aquatic animals now regarded as unmarketable have economic value and will doubtless be utilized as the fisheries become further developed.

Only about 16 species of food-fish are taken in noteworthy quantities and comprise the regular catch of the Indian River fishermen; 8 or 10 others are obtained in relatively small numbers. A number of other fish, with recognized food value in other localities, occur in the river, which are either not caught at all, owing to the nonadaptability of the apparatus used, or, if taken, are not considered of sufficient importance to justify shipment to distant markets.

More than half the fish taken for market consists of mullet, which is more abundant and caught in larger quantities in Florida than in any other State. Its maximum weight is 5 pounds, although the average of the fish caught is only 2 pounds. The mullet is plentiful throughout the river, but the principal part of the catch is taken in the upper part; the low price received has deterred the fishermen of the lower river from taking as many fish as the conditions warrant, owing to the express charges. Some mullet are in the river at all seasons, but they are most abundant from September to January.

Bluefish and Spanish mackerel are ordinarily scarce at all times. Occasionally, in recent years, these fish have entered the river in considerable numbers. On January 13, 1894, a party of seine fishermen caught between Sewall Point and Eden 2,162 pounds of bluefish, which is said to have been the finest lot of bluefish ever taken in the river; none of the fish was under 8 pounds in weight, some weighed 18 pounds, and the average was 12 or 15 pounds. The average weight of the bluefish regularly taken is about 5 pounds.

The pompano is the most highly esteemed fish of Indian River. Its average weight is 2 or 2½ pounds, although some weighing 6 or 8 pounds are taken. A maximum weight of 25 pounds is assigned by the fishermen, but there is little doubt that all supposed pompano weighing more than 10 pounds belong to a different species from the true pompano. The latter is taken at all times during the year, but up to the past two years has been most plentiful in the northern part from September to November, the run continuing until spring, when the bulk of them leave the river. In the southern part of the river pompano are reported to be most abundant from December to March in recent years. After the excessively cold weather of 1894–95, they became very scarce, and up to the end of January, 1896, had not appeared in anything like the former abundance. In illustration of the recent decrease in this species, the following catch of a firm that made a specialty of pompano fishing may be given:

	Pounds.
1892	61,014
1893	122,614
1894	93,579
1895	31,353

In the opinion of some fishermen, the best days for pompano fishing on Indian River have past, owing to overfishing; others regard the recent scarcity as largely the result of natural causes.

Such fishes as sheepshead, trout, channel bass, snappers, sailor's choice, sergeant-fish, crevallé, and black drum, which are locally known as "bottom fish," are generally plentiful in all parts of the river and do not appear to have undergone any noticeable changes in abundance in recent years.

The sheepshead is perhaps the most esteemed of the "bottom fish." In the quantity of the catch it ranks next to mullet, and in value it is surpassed only by mullet and pompano. The maximum weight is about 10 pounds and the average 3 pounds. It is taken at all fishing centers on the river, but the largest catch is at Eden. At Jensen a seine took 2,300 pounds of sheepshead at one haul in 1895.

The sea trout or spotted squeteague is a prominent factor in the catch; it ranks after the sheepshead in the amount and value of the yield. Some weighing 14 pounds are caught, but the average weight is only 2 pounds. The fishermen of Cocoa and Fort Pierce take the largest quantities.

The channel bass or red drum (locally called bass) is taken in considerable numbers and shipped to market. The range in weight is 1 to 40 pounds, the average being about 5 pounds. The principal part of the catch is obtained at Fort Pierce.

In some localities the red and the black drums, the crevallé, the sergeant-fish, and other species are either always discarded from the shipments or utilized only when it is not possible to fill out the packing barrels with the higher grades of fish. Other fish which are usually not utilized when caught are catfish, menhaden, moonfish, angel-fish, hogfish, and mutton-fish.

Sea catfish weighing 1 to 2 pounds are among the most abundant fishes of the river, but are seldom utilized; shipments aggregating 10,000 pounds of dressed fish were sent from Jensen to St. Louis in 1894, but the fish were not received with sufficient favor to warrant a continuance of the business.

The green turtle (*Chelonia mydas*) is the only product of the Indian River fisheries belonging to the turtle class. It is far from being abundant or even common, and in the past few years has undergone a noticeable decrease in numbers.

Turtles are occasionally taken in Indian River weighing nearly 200 pounds, but they now seldom attain a weight of 100 pounds, and the average weight is little more than one-third of that figure. In 1891, when this region was visited in the interest of the Fish Commission, the average weight of the turtles caught was reported to be 50 pounds. In 1895 the aggregate catch of 18,909 pounds represented 519 turtles, whose average weight was, therefore, 36 pounds. This decrease in weight of more than 25 per cent in five years is suggestive of the decrease in quantity which the available statistics and observation show to have occurred.

Turtles remain in the river more or less plentifully at all seasons, but the principal season is between November and March.

Prior to the advent of the railroad in the Indian River region alligators were comparatively numerous and their capture constituted an important business, but at present, as the result of active hunting operations during the past ten years, they are very scarce, not enough alligators being left to support an industry. The few skins which now reach the hands of the dealers on Indian River come from the interior.

Oysters of large size and good flavor exist in various parts of Indian River, and they constitute one of the principal fishery resources, but up to the present time they have received comparatively little attention. The fuller utilization of oysters is doubtless one of the chief lines along which the further development of the fisheries of this region will take place.

The oysters are found in small scattered beds, but their real abundance is not known. Some of the beds are located as follows: On the east side of the river nearly opposite Titusville; immediately south of Rockledge; one-half mile north of Fort Pierce on the east shore and at Indian River Inlet; on the west shore off St. Lucie and for a number of miles north of that point.

The oyster shells are large, thick, and of irregular shape. They usually occur in clusters, and have mussels and barnacles attached.

Crabs are abundant throughout Indian River, but are not utilized at present. Probably these and other crustaceans, such as shrimp, will receive the attention of commercial fishermen as the fishing industry becomes further developed.

FISHING APPARATUS AND METHODS.

The economic fisheries of Indian River are for mullet, pompano, turtles, and oysters. A large variety of other fish are taken, but they are obtained incidentally in fishing for mullet and pompano. The apparatus employed comprises gill nets and seines for fish, nets for turtles, and tongs for oysters. Of the gill nets, which are the principal means of capture, there are two kinds, according as they are adapted for mullet or for pompano and other species.

THE MULLET FISHERY.

In 1895 mullet fishing was carried on at every fishing center on the river except Jensen. The business is most extensive at Titusville, Cocoa, and Fort Pierce. Practically the entire catch of mullet was taken with gill nets, only a few thousand pounds additional being incidentally secured in a haul seine.

Mullet gill nets are 250 yards long and 12 to 14 feet (or 40 to 50 meshes) deep, with a 4-inch-stretch mesh. They are made of linen thread, and when new are valued at $50 each. The web lasts only two or three months, and has to be replaced by new twine. The usefulness of the nets is prolonged by washing them in lime water to remove the adhering animal matter, which promotes decay. The nets are rigged with cork floats and lead weights.

The mullet fishermen usually go in crews of four, in two boats. When the fish are seen swimming or jumping freely at the surface, a net from one boat is united to one from the other boat, and the two boats are rowed in opposite directions around the school as the nets are thrown out. When the boats come together the nets are again united, with the boats in the inclosed space. By beating on the water with oars, etc., the mullet, and the other fish incidentally encircled, are frightened into the meshes of the nets, from which they are then removed, the catch being equally divided between the two boats. The nets may be cast several times during a night if a sufficient supply is not obtained in the first haul.

THE POMPANO FISHERY.

Fishing for pompano is carried on throughout the length of the river, but is most important at Titusville, Fort Pierce, and Eden.

Nets used for pompano and other species besides mullet have a wide range in length. They are primarily about 200 or 250 yards long, but sections of netting are often connected until, as used, they extend from 600 to 2,000 yards, many pieces 1,000 or 2,000 yards long being employed. They have a stretch mesh of $5\frac{1}{8}$ to 6 inches, and are from 15 to 35 meshes deep. They are constructed of linen twine and are worth, when rigged, about $12.50 per 100 yards.

Fishing for pompano is done only at night, the darker the night the more favorable the conditions. In the daytime or by moonlight few pompano could be caught, as the fish see the netting and avoid it. The nets are set and left to drift for one or two hours before being visited, the fishermen, in the meantime, being on the adjacent shores, where fires are kindled for warmth or to keep the mosquitos away. The catch is removed from the nets several times during a night's fishing. Besides pompano, the principal fish taken are bluefish, sheepshead, sea trout, channel bass, mangrove snapper, and crevallé.

Owing to the peculiar shape of the pompano and the relatively large mesh in the pompano gill nets, the fish are not caught by being actually gilled. The fish push their heads through the mesh far beyond the gill-openings and are made fast by the twine getting behind the pectoral and ventral fins. Frequently, also, the mesh is caught on one of the stiff rudimentary spines in front of the dorsal fin.

THE SEINE FISHERY.

Seine fishing is unimportant, and only two seines were used in 1895. One of these, at Jensen, was 400 yards long; the other, at Stuart, was 825 yards long, 12 feet deep in the center and 6 feet in the wings, with a 4-inch mesh. The seine at Jensen was fished for only a short time in 1895, the catch consisting chiefly of pompano and sheepshead. In operating the larger seine, which was not regularly used in 1895, a small steamer (of 3.56 tons) was used to assist in drawing the seine ashore. Pompano, sheepshead, channel bass, and whiting made up the bulk of the catch.

THE TURTLE FISHERY.

The turtle fishery is comparatively unimportant. It is followed only from Sebastian, Fort Pierce, and Eden, although turtles are incidentally caught at a number of other points on the river.

The nets used in the turtle fishery are constructed on the principle of ordinary gill nets; they are made of 12-cord thread, with a 28-inch-stretch mesh, and are 85 to 115 yards long and 10 meshes deep. They are worth about $10 each. Two fishermen usually go in one boat, and 10 nets are the complement of a crew, although only 4 to 6 are in active use at one time.

The turtles are caught by being entangled in the meshes. Some of the nets are fastened to stakes that are driven on the turtle feeding-grounds, others are left to drift freely. The staked nets are visited twice a day. When the fishermen use a loose net, they take a position near by, and on seeing the net struck by a turtle pull up in their boat and secure it.

Turtle fishing begins about November 1 and continues until March 1, after which it is impracticable on account of the arrival of large sawfish, sharks, and other fish that destroy the nets.

The total number of turtles taken for market on the Indian River in 1895 was 519, having a weight of 18,909 pounds; 51 of these, weighing 1,694 pounds, were taken in gill nets set for fish. The value of the catch was $1,320, or about 7 cents a pound. The regular fishery was carried on by 12 men in 7 boats, using 66 nets.

In 1890, according to the report of Mr. W. deC. Ravenel, of the United States Fish Commission, the turtle catch of the Indian River was 738 turtles, weighing 36,900 pounds, valued at $2,722; this yield, however, was obtained by 24 men, using 168 nets.

There is no doubt that turtle fishing on the Indian River is much less productive than formerly. Mr. Charles Pearke, of Sebastian, who has followed the turtle business during the past ten years, reports a great decrease of turtles as compared with earlier years. About 1886 he took 2,500 turtles with eight nets; in 1895 he secured only 60 turtles with six nets. The principal reason assigned for the decrease by Mr. Pearke is that the turtles have been frightened off by the steamboats and launches. The unusual cold of the winter of 1894–95 is also known to have seriously affected the abundance of turtles. Several hundred turtles were then found floating on the surface in a numbed or frozen condition. On being warmed most of them survived and were soon on their way to the northern markets. Since the cold spell turtles have been much scarcer than ever.

When it is desirable to retain the turtles any length of time prior to shipment, they are confined in pens and fed on vegetable matter, the articles principally used being a marine plant known as turtle grass, sweet-potato vines, and sometimes morning-glory vines and mangrove leaves.

THE OYSTER INDUSTRY.

The taking of oysters is a more extensive business than any other fishery on the river with the exception of the gill-net fishery. It is carried on by fishermen of Titusville, Cocoa, Eau Gallie, and Fort Pierce, the first-named place having the principal interests. The entire supply is taken by means of tongs from natural beds in the vicinity of the places named.

The 29 persons who in 1895 gave special attention to the oyster fishery took 6,084 bushels, which yielded $2,115, or about 35 cents a bushel. The oysters are handled by dealers, who ship them in the shell or opened, as desired by purchasers. When shucked the oysters seldom produce over 3 quarts of meats to a bushel. The market is limited to the near-by cities and towns of Florida and Georgia.

There seems no doubt that the conditions are very favorable for the expansion of the oyster industry. By the adoption of such measures as are now followed with great benefit in other States—the allotment of land for oyster cultivation, the spreading of oysters on prepared grounds, the planting of seed and cultch, etc.—a valuable permanent industry may here be established, while under present conditions it is only a question of time when the natural supply will become exhausted.

FISHERMEN, PRICES, SHIPMENTS, MARKETS, ETC.

The Indian River fishermen are from many parts of the country, and, with few exceptions, are white and American-born. Some had followed the fisheries of the Great Lakes, Long Island Sound, and Mississippi River before going to Florida. A number, however, were entirely without previous experience and began fishing from force of circumstances. The decline of the steamboat business on the river after the building of the railroad threw many persons out of employment, and some of these are now connected with the leading fish firms. The great damage to the fruit crop by frosts forced men of small means temporarily at least into other branches, the fisheries receiving a fair proportion, owing to the limited capital required to begin the business.

The fishermen, as a rule, contract with some fish-dealer as to prices to be paid for fish during a particular season. Sometimes the dealer furnishes a part of the fishermen's outfit, and takes his pay in fish. During 1895 the ruling prices received by the fishermen from the dealers were 1½ cents each for mullet, 2 cents a pound for bluefish, and 6 cents a pound for pompano and Spanish mackerel. All other fish, which are collectively known as "bottom fish," bring 1½ cents a pound. These prices seem very low, but it is doubtful if the dealers could pay much more and realize any profit, after meeting the heavy expenses for ice and the express charges on fish sent to the distant northern markets. Shipments often result in actual loss, owing to an overstocked market or the spoiled condition of the fish on arrival.

The average income of the fishermen on the river in 1895 was about $200; many of them worked at the fisheries only one-third or one-half the time, being engaged in other business during the remainder of the year.

Practically the entire product of the Indian River fisheries is sold fresh. From time to time small lots of fish have been salted, but the demand is limited. In 1895, 25,000 pounds of salt mullet were prepared at Titusville, Fort Pierce, and Eden. The fish were put up in barrels holding 200 pounds each, and sold for $5 per barrel, mostly in Charleston, S. C. The fish when thus prepared are split down the back like mackerel, and, if properly treated, are an excellent article of food.

It seems probable that before long a profitable market will be found for the surplus mullet by salting them.

While the fish trade of the river is carried on throughout the year, it is most active between October and April, when the northern markets are largely dependent on southern waters for their fish supply.

The catch is landed from the fishing-grounds early in the morning and at once packed in barrels with ice for shipment on the early express train going north. The more select fish go as far as New York, Louisville, and St. Louis, but the mullet are chiefly consigned to points in Florida and Georgia. The express rates being from $2 to $8 per barrel, the shipments to the northern cities usually have to be limited to the highest-priced fishes.

Ice is an important and expensive item in the fisheries of this region. Owing to the long distances to which most of the catch is shipped, it is necessary to use relatively large quantities of ice for its preservation. Ice is procured in small lots from factories at Titusville, Cocoa, and West Palmbeach at prices ranging from $4.50 to $6 per ton; the freight charges sometimes bring the price up to more than $7 per ton. The total quantity of ice consumed in the fishing business of the river in 1895 was 1,226 tons, or 2,452,000 pounds, an amount nearly equal in weight to that of the fish shipped. The cost of the ice was $8,187, an average of $6.67 per ton.

STATISTICS OF THE FISHERIES.

In the appended tables detailed figures are given showing the extent of the commercial fisheries of the Indian River in 1895. The statistical information is based on personal interviews with fishermen and dealers and careful examination of available records. The investigation showed that the industry gave employment to 254 persons, represented an investment of $41,512, and yielded 2,659,815 pounds of fish and other products, having a value to the fishermen of $37,657.

Of the total number of persons directly connected with the fisheries in 1895, 172 were engaged in taking fish, 29 in oystering, 8 in catching turtles, and 41 in caring for the products pending shipment or in preparing them for market. The number of each class in each locality is shown in the following table:

Table showing the number of persons employed in the commercial fisheries of Indian River, Florida, in 1895.

Fishing centers.	General fisheries.	Oyster fishery.	Turtle fishery.	Preparing products.	Total.
Titusville	40	8	....	6	54
Cocoa	22	9	....	9	40
Eau Gallie	22	2	....	6	30
Melbourne	12	....	....	2	14
Sebastian	6	....	2	2	10
Fort Pierce	26	10	8	6	50
Eden	26	....	2	6	34
Jensen	8	....	....	2	10
Stuart	10	....	....	2	12
Total	172	29	12	41	254

The following table shows the amount invested in vessels, boats, apparatus, shore property, and cash capital at the various fishing centers. The details of the investment are given in subsequent tables. The largest investments are at Titusville and Fort Pierce, where the most men are employed and the principal business done.

Table showing the capital invested in the commercial fisheries of Indian River, Florida, in 1895.

Fishing centers.	Amount.
Titusville	$10,921
Cocoa	5,103
Eau Gallie	4,047
Melbourne	1,140
Sebastian	3,530
Fort Pierce	8,786
Eden	4,390
Jensen	1,100
Stuart	2,495
Total	41,512

The number and value of the vessels and boats employed in the Indian River fisheries are stated in the next tabulation. Only one vessel of over 5 tons' burden is used in the fisheries of the river; this is a sloop of 8.09 net tons, having headquarters at Eden. A steamer of 3.56 tons is connected with the fisheries at Stuart. Of the 106 boats employed, 84 were in the general fisheries, 15 in the oyster fishery, and 7 in the turtle fishery. The total value of the vessels and boats was $6,790.

Table showing the number and value of the vessels and boats employed in the commercial fisheries of Indian River, Florida, in 1895.

Fishing centers.	Vessels.		Boats.								Total value of vessels and boats.
			Fishing.		Oystering.		Turtling.		Total.		
	No.	Value.	No.	Value.	No.	Value.	No.	Value.	No.	Value.	
Titusville			20	$980	4	$140			24	$1,120	$1,120
Cocoa			11	550	5	200			16	750	750
Eau Gallie			11	715	1	40			12	755	755
Melbourne			6	300					6	300	300
Sebastian			3	90			1	$50	4	140	140
Fort Pierce			13	650	5	350	4	200	22	1,200	1,200
Eden	1	$400	12	600			2	100	14	700	1,100
Jensen			4	200					4	200	200
Stuart	1	1,000	4	225					4	225	1,225
Total	2	1,400	84	4,310	15	730	7	350	106	5,390	6,790

The value of the apparatus of capture employed in the Indian River fisheries was $8,507; the shore and accessory property and the cash capital were valued at $26,215. The mullet and pompano gill nets used, numbering 221, had an approximate combined length of 162,300 feet (or over 30 miles), and were valued at $7,400. The 66 turtle nets were valued at $660, and were 19,800 feet in length.

The following table gives detailed figures on these items for the various fishing centers:

Table showing the quantity and value of the apparatus employed in the commercial fisheries of Indian River, Florida, in 1895.

Fishing centers.	Mullet gill nets.			Pompano gill nets.			Turtle nets.		
	No.	Length (feet).	Value.	No.	Length (feet).	Value.	No.	Length (feet).	Value.
Titusville	12	9,000	$600	74	44,400	$2,280			
Cocoa	11	8,250	550	6	3,600	240			
Eau Gallie	11	8,250	385						
Melbourne	6	5,400	300	1	1,500	40			
Sebastian	3	2,700	150	2	3,000	80	6	1,800	$60
Fort Pierce	13	11,700	650	8	10,800	380	40	12,000	400
Eden	1	750	30	48	36,000	960	20	6,000	200
Jensen				12	7,200	300			
Stuart	1	750	35	12	9,000	420			
Total	58	46,800	2,700	163	115,500	4,700	66	19,800	660

Fishing centers.	Haul seines.			Oyster tongs.		Value of shore and accessory property.	Cash capital.
	No.	Length (feet).	Value.	No.	Value.		
Titusville				8	$56	$4,365	$2,500
Cocoa				9	63	2,000	1,500
Eau Gallie				1	7	1,400	1,500
Melbourne						200	300
Sebastian						2,600	500
Fort Pierce				8	56	3,700	2,400
Eden						1,300	800
Jensen	1	1,350	$100			200	300
Stuart	1	2,475	165			350	300
Total	2	3,825	265	26	182	16,115	10,100

The quantity and value of the principal products of the Indian River fisheries in 1895 are shown in condensed form in the following table. The fish comprised 2,598,318 pounds, valued at $34,222; the weight of the 519 turtles was 18,909 pounds, valued at $1,320; the 6,084 bushels of oysters yielded 42,588 pounds of meats, and had a market value of $2,115:

Table showing the quantity and valueof the fish and other products taken in the commercial fisheries of Indian River, Florida, in 1895.

Species.	Pounds.	Value.	Species.	Pounds.	Value.
Black drum	10,900	$140	Sheepshead	301,141	$4,445
Bluefish	33,086	703	Spanish mackerel	1,100	66
Channel bass or red drum	142,400	2,115	Trout	200,735	2,872
Crevalle	14,700	184	Whiting	25,300	375
Flounders	9,000	136	Other fish	11,516	166
Mangrove snapper	76,900	1,137	Turtles	a 18,909	1,320
Mullet, fresh	1,585,869	11,501	Oysters (meats)	b 42,588	2,115
Mullet, salted	25,000	750			
Pompano	149,111	9,475	Total	2,659,815	37,657
Sailor's choice	11,560	157			

a 519 in number. b 6,084 bushels.

More detailed figures relating to the output of the fisheries are given in the next table, which shows by fishing centers and apparatus the quantity and value of each principal species. The fishing centering at Fort Pierce is seen to have yielded over $11,700 in 1895, a sum considerably larger than is credited to any other place. Titusville follows with $6,900, after which come Eden with $6,000 and Cocoa with $4,800.

Table showing by fishing centers and apparatus with which taken the products of the commercial fisheries of Indian River, Florida, in 1895.

Apparatus and species.	Titusville.		Cocoa.		Eau Gallie.		Melbourne.		Sebastian.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Gill nets:										
Black drum	....	......	9,500	$119	....	......	....	......	....	......
Bluefish	2,256	$45	525	11	280	$6	400	$8	1,200	$24
Channel bass or red drum	12,100	181	8,200	102	30,000	459	3,500	52	8,300	125
Crevalle	....	......	14,700	184	....	......	....	......	....	......
Flounders	....	......	....	......	....	......	....	......	200	3
Mangrove snapper	....	......	7,300	91	1,500	23	1,300	20	2,800	42
Mullet, fresh	285,119	2,138	330,400	2,065	157,160	1,164	4,800	72	66,090	495
Mullet, salted	10,000	300	....	......	....	......	....	......	....	......
Pompano	38,553	2,313	9,800	490	600	30	6,100	366	1,100	66
Sailor's choice	3,300	50	2,600	23	600	9	400	6	1,200	18
Sheepshead	39,531	593	28,100	351	5,200	78	8,400	126	9,600	144
Trout	22,835	342	54,600	683	36,400	543	1,500	23	12,100	181
Whiting	3,000	45	2,400	30	2,500	38	....	......	900	14
Other fish	3,016	45	2,600	32	....	......	1,200	18	400	6
Turtles	500	35	100	7	....	......	....	......	4,500	315
Total	420,210	6,087	470,825	4,188	234,840	2,350	27,600	691	108,390	1,433
Tongs:										
Oysters	17,227	861	11,235	669	5,600	280	....	......	....	......
Grand total	437,437	6,948	482,060	4,857	240,440	2,630	27,600	691	108,390	1,433

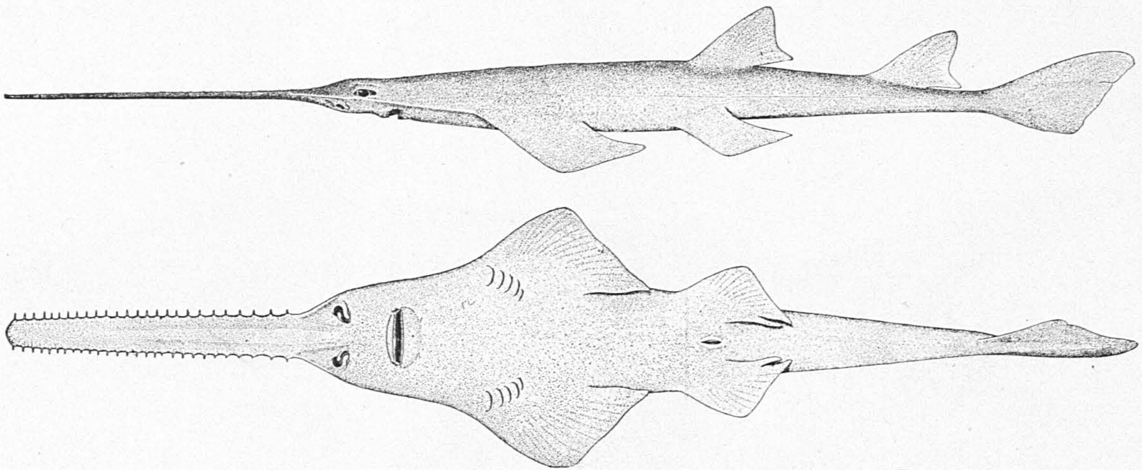
Apparatus and species.	Fort Pierce.		Eden.		Jensen.		Stuart.		Total.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Gill nets:										
Black drum	....	......	800	$12	....	......	....	......	10,300	$131
Bluefish	18,000	$360	8,000	200	....	......	1,200	$24	31,861	678
Channel bass or red drum	58,000	870	8,100	121	1,300	$20	4,366	66	134,466	1,996
Crevalle	....	......	....	......	....	......	....	......	14,700	184
Flounders	8,000	120	300	5	....	......	....	......	8,500	128
Mangrove snapper	57,000	855	3,200	48	800	12	500	8	74,400	1,099
Mullet, fresh	730,000	5,475	....	......	....	......	6,800	51	1,580,869	11,460
Mullet, salted	5,000	150	10,000	300	....	......	....	......	25,000	750
Pompano	27,000	1,890	36,300	2,541	5,800	348	13,106	780	138,359	8,830
Sailor's choice	....	......	1,100	16	600	9	....	......	9,800	131
Sheepshead	29,110	436	136,100	2,041	11,300	169	8,300	125	275,641	4,063
Spanish mackerel	....	......	600	42	....	......	150	9	750	51
Trout	50,000	750	14,100	211	2,200	33	3,100	47	196,835	2,813
Whiting	9,000	135	....	......	....	......	....	......	17,800	262
Other fish	....	......	1,700	26	....	......	1,800	27	10,716	154
Turtles	6,107	428	6,608	463	594	42	500	30	18,909	1,320
Total	997,217	11,469	226,908	6,026	22,594	633	39,822	1,173	2,548,406	34,050
Haul seines:										
Black drum	....	......	....	......	....	......	600	9	600	9
Bluefish	....	......	....	......	1,225	25	....	......	1,225	25
Channel bass or red drum	....	......	....	......	1,200	18	6,734	101	7,934	119
Flounders	....	......	....	......	....	......	500	8	500	8
Mangrove snapper	....	......	....	......	700	11	1,800	27	2,500	38
Mullet	....	......	....	......	....	......	5,500	41	5,500	41
Pompano	....	......	....	......	4,200	252	6,552	393	10,752	645
Sailor's choice	....	......	....	......	560	8	1,200	18	1,760	26
Sheepshead	....	......	....	......	8,700	130	16,800	252	25,500	382
Spanish mackerel	....	......	....	......	....	......	850	15	350	15
Trout	....	......	....	......	1,900	20	2,000	30	3,900	59
Whiting	....	......	....	......	....	......	7,500	113	7,500	118
Other fish	....	......	....	......	....	......	800	12	800	12
Total	....	......	....	......	18,485	473	50,336	1,019	68,821	1,492
Tongs:										
Oysters	8,526	305	....	......	....	......	....	......	42,588	2,115
Grand total	1,005,743	11,774	226,908	6,026	41,079	1,106	90,158	2,192	2,659,815	37,657

The shipments of fresh fish from the Indian River fisheries in 1895 aggregated 2,573,318 pounds. The quantity of fish sent from Fort Pierce, namely, 986,110 pounds, was larger than the combined shipments from the two next important centers, Titusville and Cócoa, which contributed 409,710 pounds and 470,725 pounds, respectively. From Eau Gallie and Eden over 200,000 pounds were sent, and from Sebastian over 100,000 pounds. The difference between these figures and those given as the catch of the fishermen at the fishing centers represents the local consumption, although large quantities of fish caught by sportsmen and others are used at the hotels and private houses, of which no account is taken in these statistics. From the following table, showing the monthly fish shipments from the various points in 1895, it appears that the smallest shipments were in June, from which month to December there was a steady increase in the trade. The shrinkage in the business in February and March, which are ordinarily very good months, was due to the effects of the memorable cold snap. The fish sent from Indian River during the warmer months are chiefly from the northern part of the river, while in the colder months the largest consignments are from that section below Indian River Inlet.

Table showing the monthly shipments of fresh fish from points on Indian River, Florida, in 1895.

Fishing centers.	Jan.	Feb.	March.	April.	May.	June.	July.
	Pounds.	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*
Titusville	25,335	41,960	40,495	11,705	34,385	42,960	51,860
Cocoa	21,900	32,120	18,835	30,855	55,015	39,725	57,590
Eau Gallie	7,590	12,050	17,710	29,900	15,335	11,355	15,485
Melbourne	....	....	....	2,990	12,420	4,140	8,050
Sebastian	....	....	....	....	....	....	....
Fort Pierce	93,160	60,795	59,710	67,395	64,335	41,565	48,070
Eden	21,325	14,840	34,960	11,040	....	....	....
Jensen	28,520	3,685	8,280	....	....	....	....
Stuart	9,478	10,240	9,215	6,220	14,265	350	....
Total	207,308	176,290	189,205	160,105	195,755	140,095	181,055

Fishing centers.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
	Pounds.	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*
Titusville	60,875	39,995	25,995	10,120	24,025	409,710
Cocoa	56,315	60,770	60,545	19,005	12,050	470,725
Eau Gallie	48,470	38,330	22,260	8,720	7,035	234,840
Melbourne	....	....	....	....	....	27,600
Sebastian	....	10,455	14,320	37,020	42,095	103,890
Fort Pierce	38,180	54,510	132,250	152,800	173,340	986,110
Eden	....	5,495	28,850	28,840	64,950	210,300
Jensen	....	....	....	....	....	40,485
Stuart	....	....	1,840	10,580	27,470	89,658
Total	203,840	209,555	292,060	267,085	350,965	2,573,318



PRISTIS PECTINATUS Latham. *Sawfish.* Side and ventral views.

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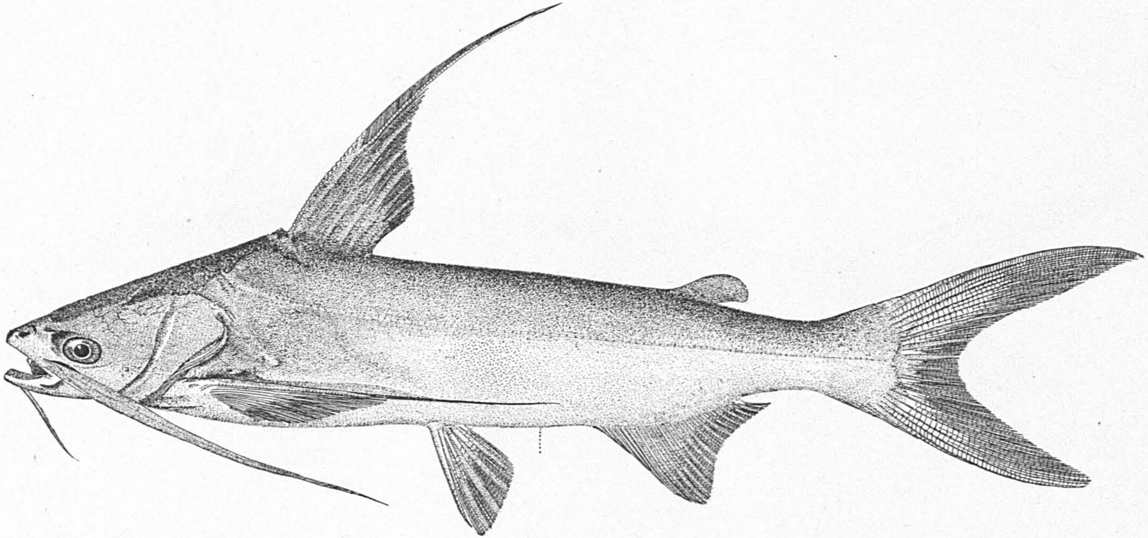
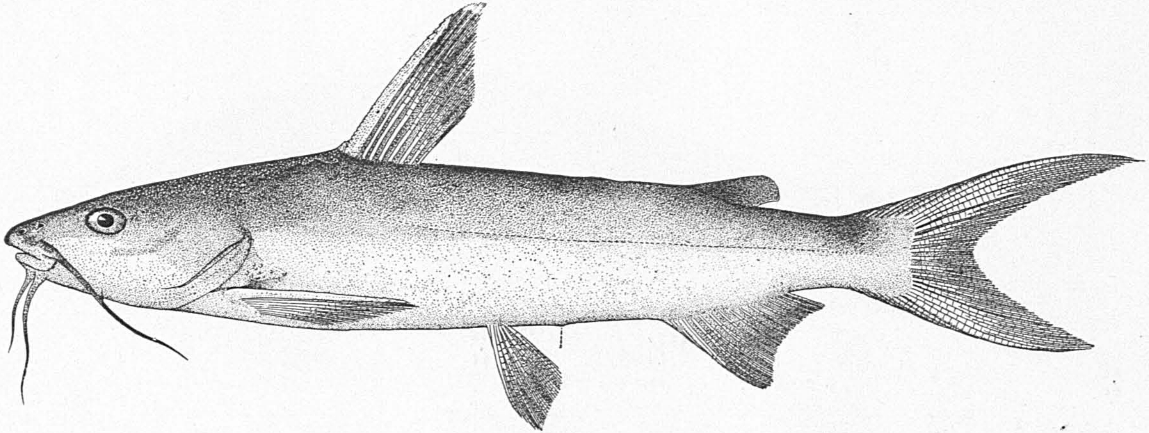
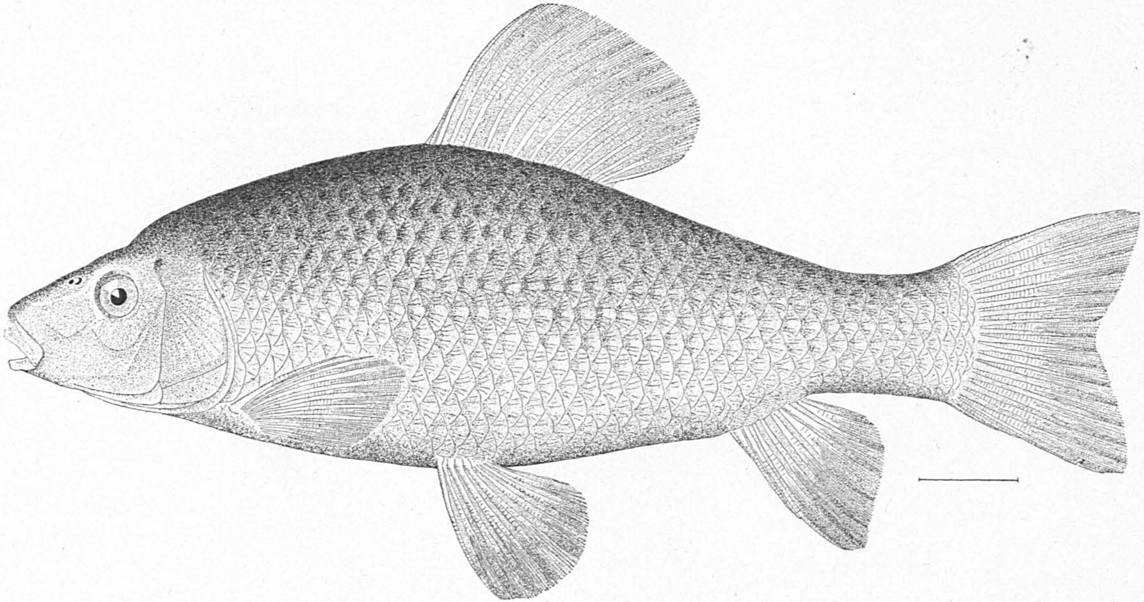


FELICHTHYS MARINUS (Mitchill). *Gaff-topsail; "Catfish."*



GALEICHTHYS FELIS (Linnæus). *Sea Catfish; "Catfish."*

 (To face page 262.)



ERIMYZON SUCETTA (Lacépède). *Chub Sucker; Creek Sucker.*

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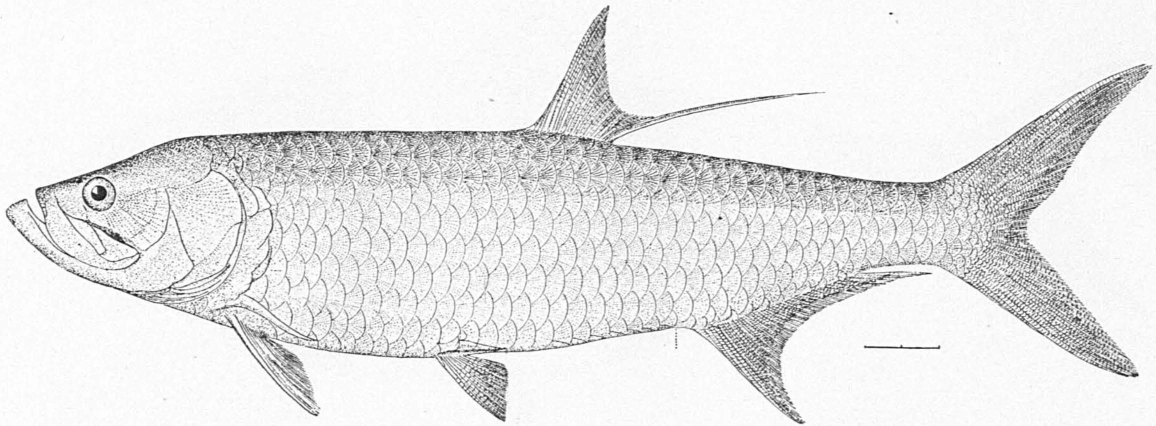
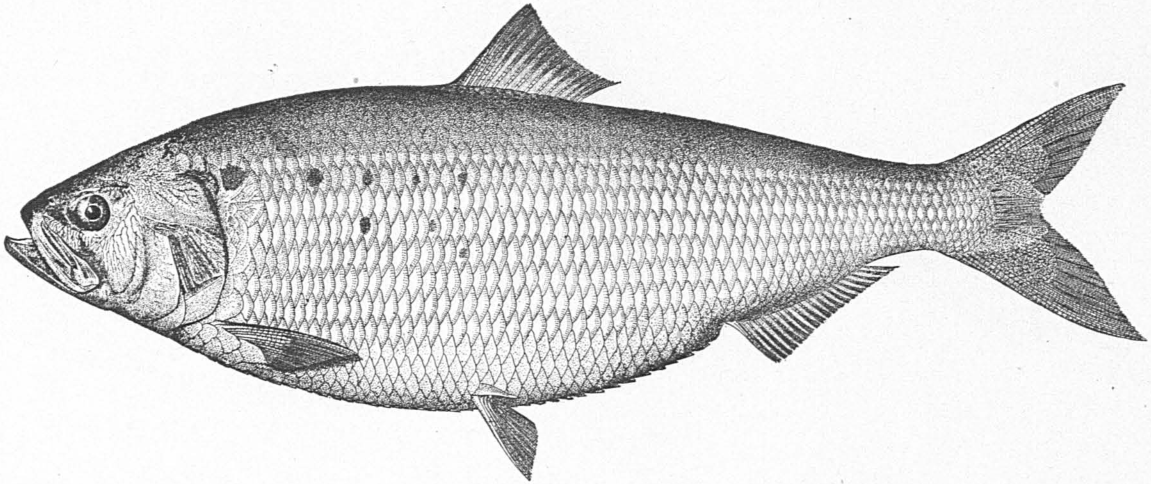
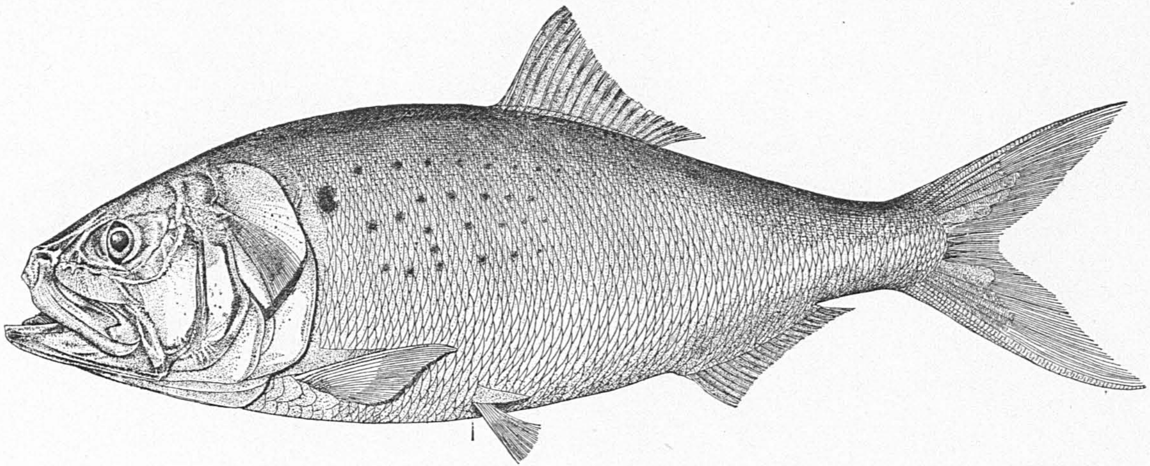


TARPON ATLANTICUS (Cuvier & Valenciennes). *Tarpon; Tarpum.*



ALOSA SAPIDISSIMA (Wilson). *Shad.*



BREVOORTIA TYRANNUS (Latrobe). *Menhaden.*

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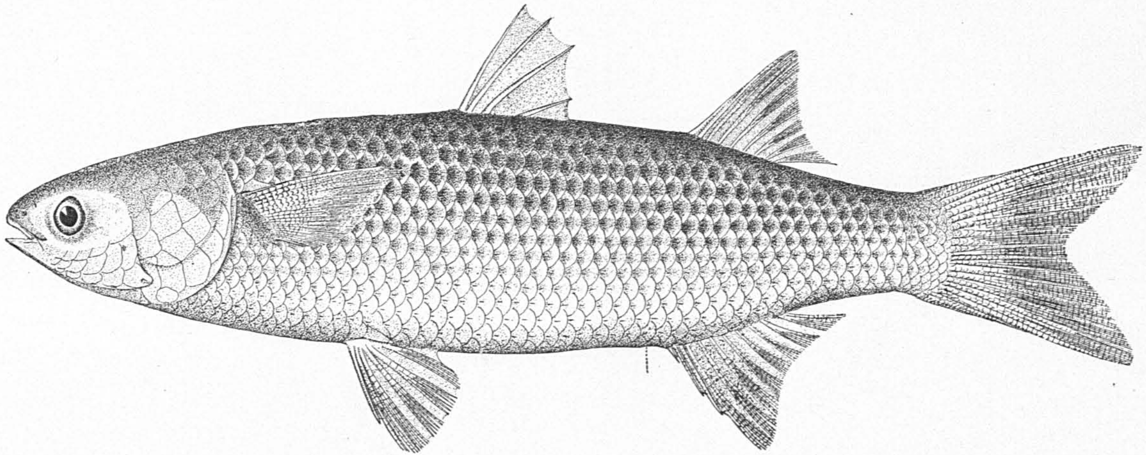
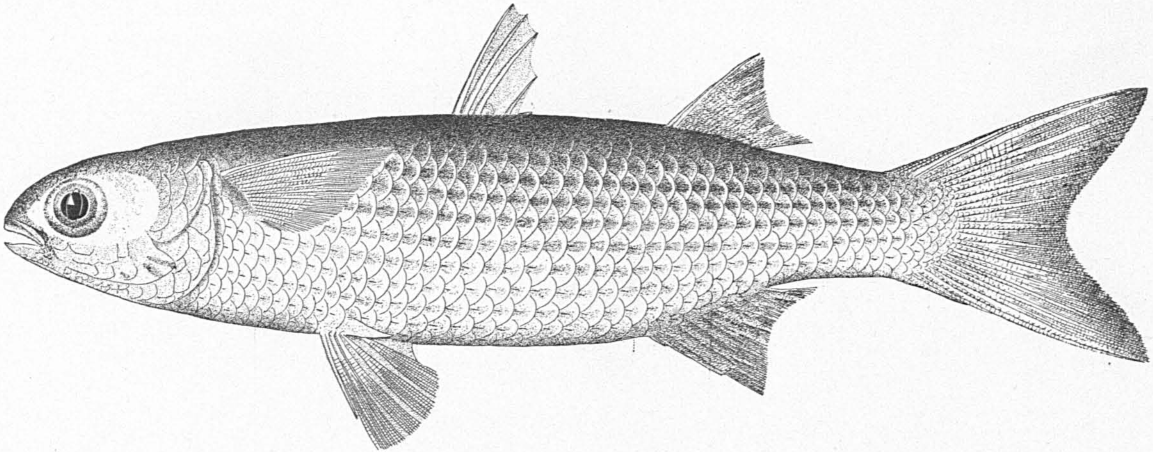
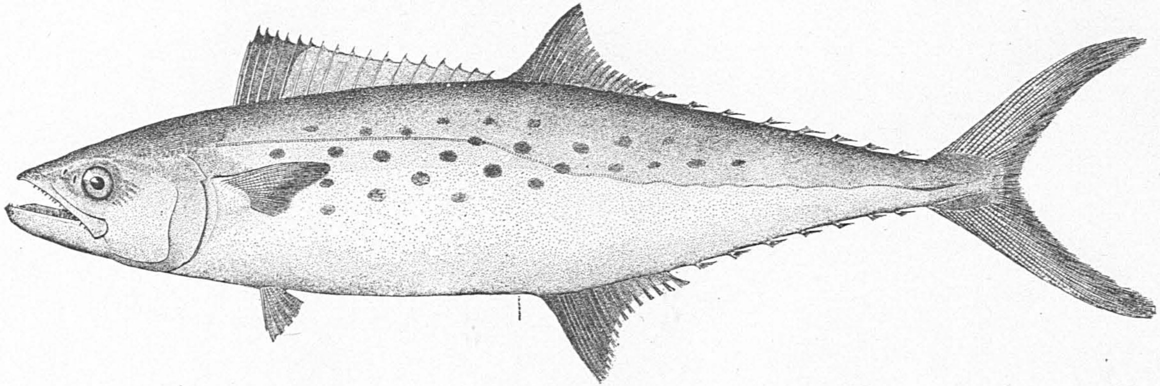


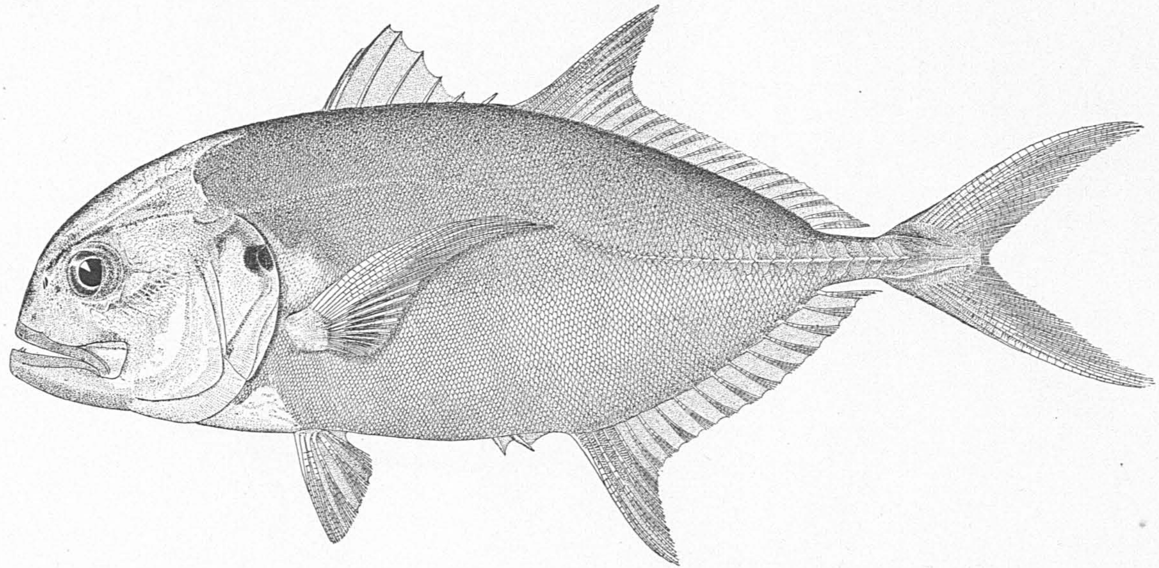
MUGIL CEPHALUS Linnæus. *Common Mullet; Striped Mullet.*



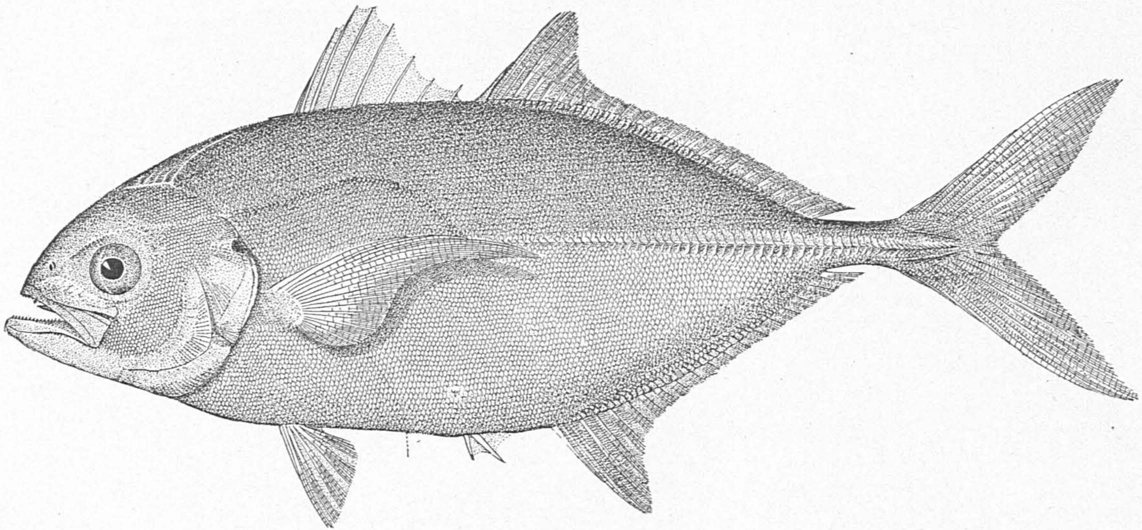
MUGIL CUREMA Cuvier & Valenciennes. *White Mullet; "Silver Mullet."*



SCOMBEROMORUS MACULATUS (Mitchill). *Spanish Mackerel.*



CARANX HIPPOS (Linnæus). *Crevallé; "Cavally"; "Jack."*



CARANX CRYSOS (Mitchill). *Hard-tail; "Runner."*

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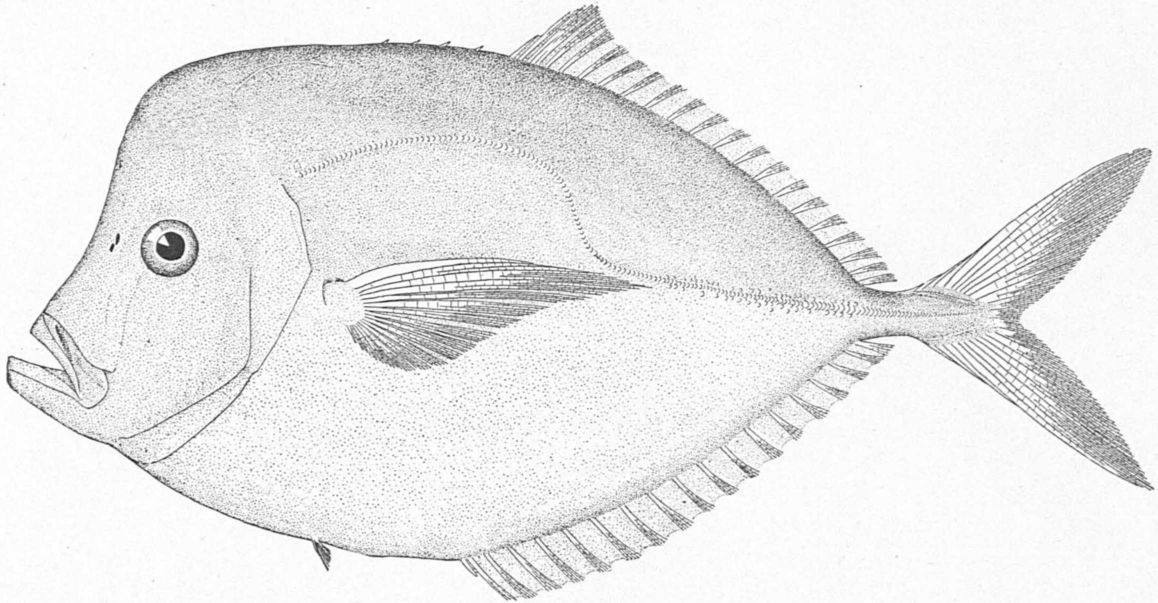
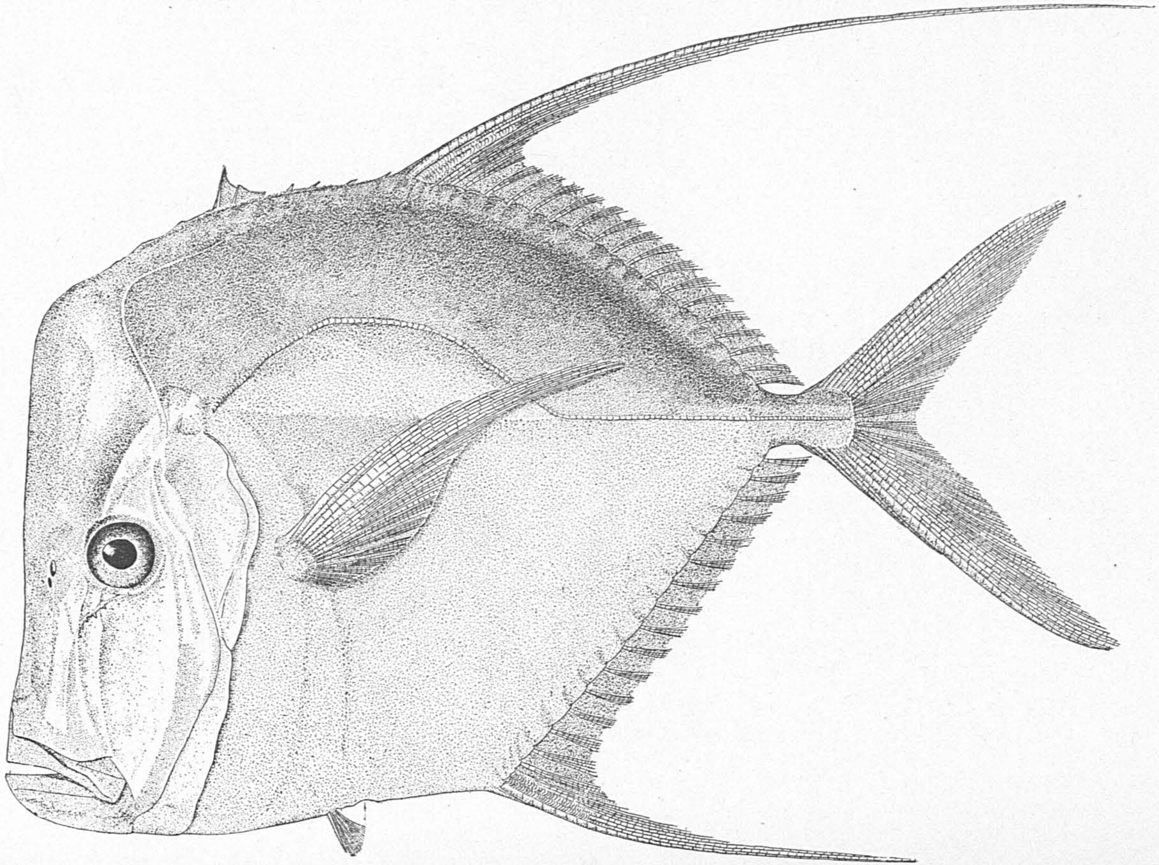


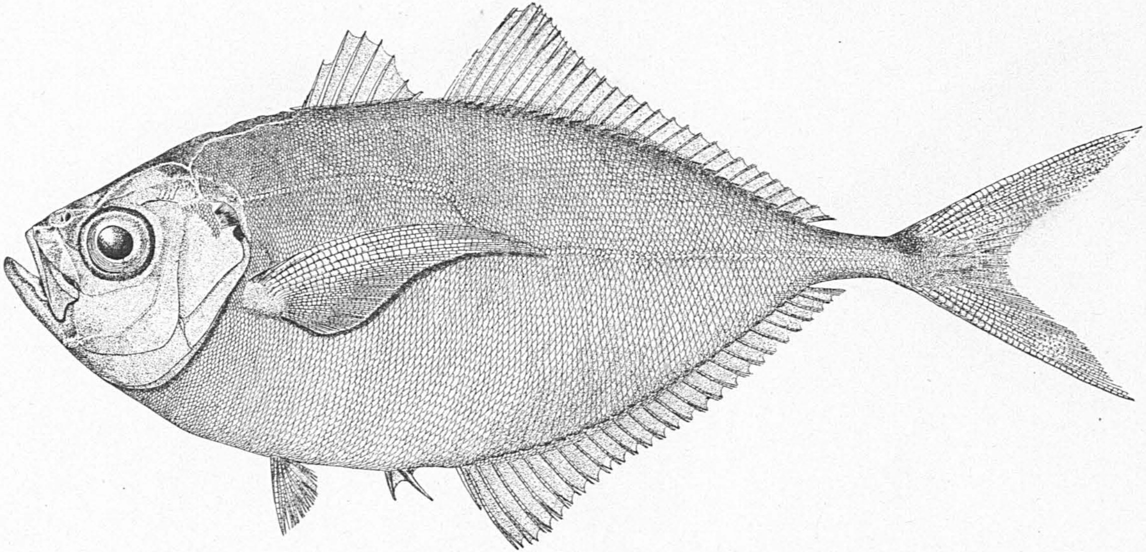
VOMER SETIPINNIS (Mitchill). *Moonfish.*

PLATE 36.

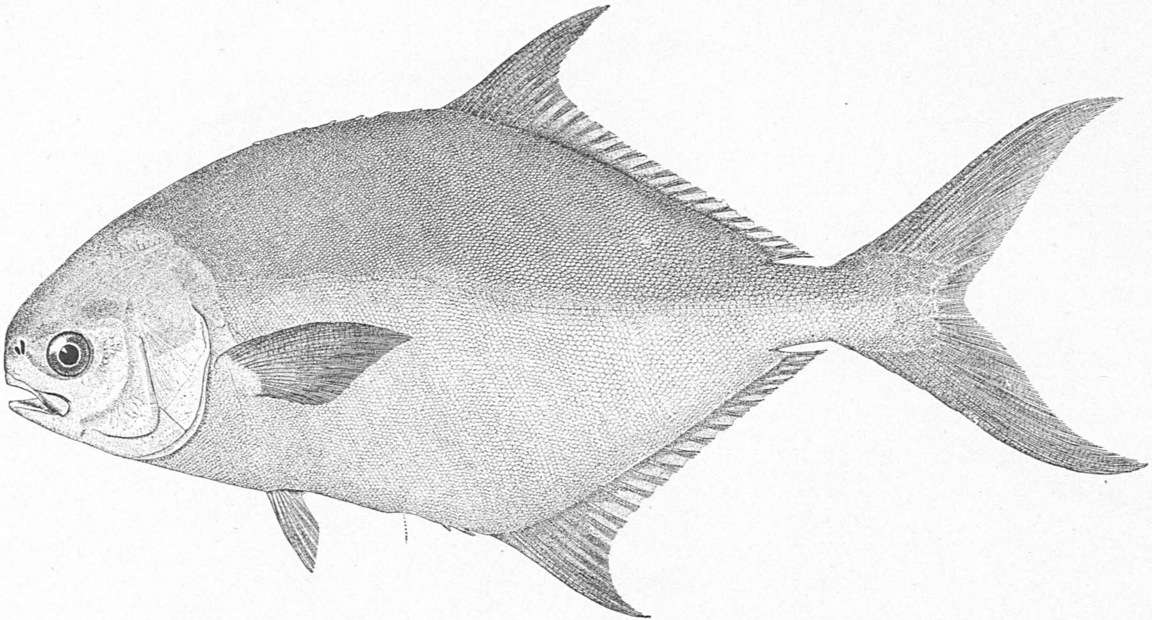


SELENE VOMER (Linnæus). *Silver Moonfish; Look-down.*

Report U. S. F. C. 1896. (To face page 262.)



CHLOROSCOMBRUS CHRYSURUS (Linnæus). *Bumper.*



TRACHINOTUS CAROLINUS (Linnæus). *Common Pompano.*

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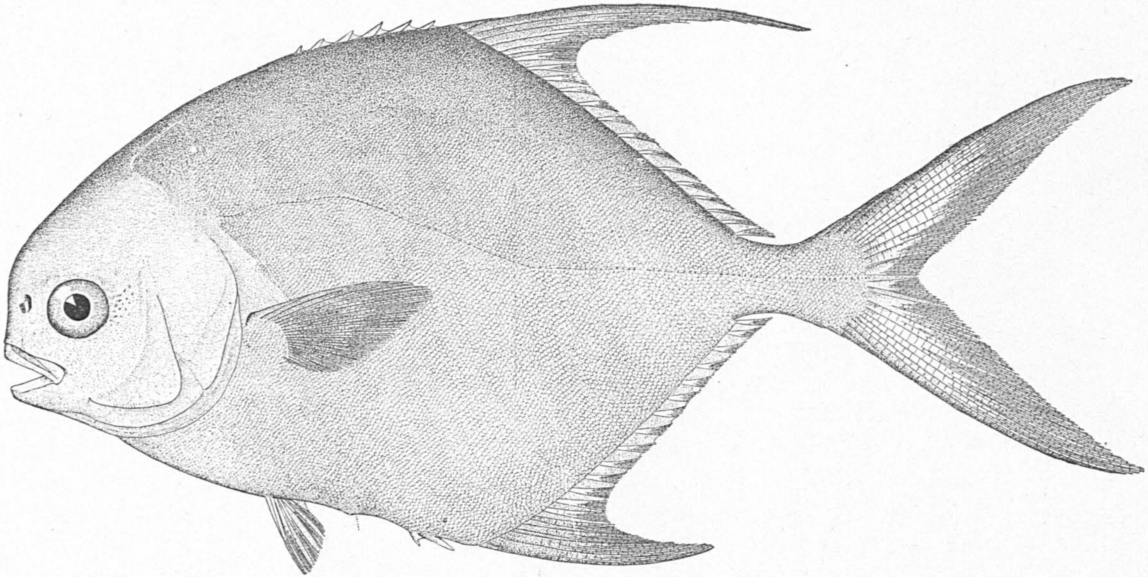
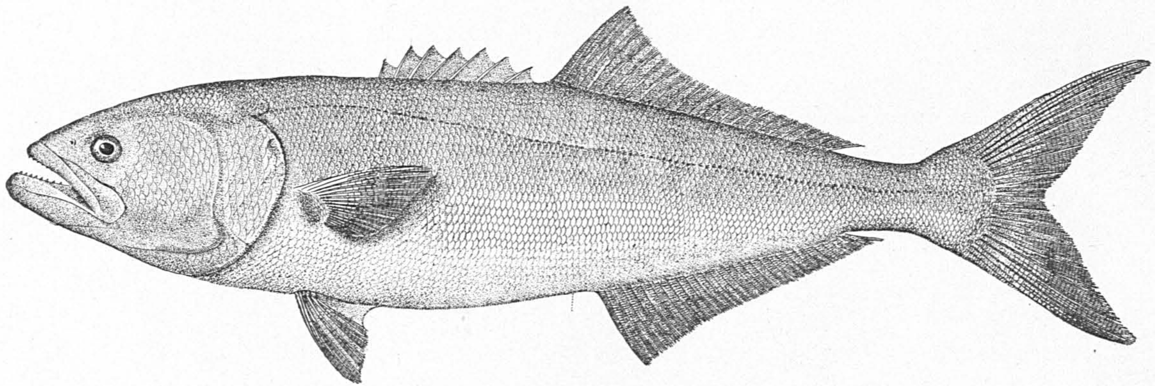
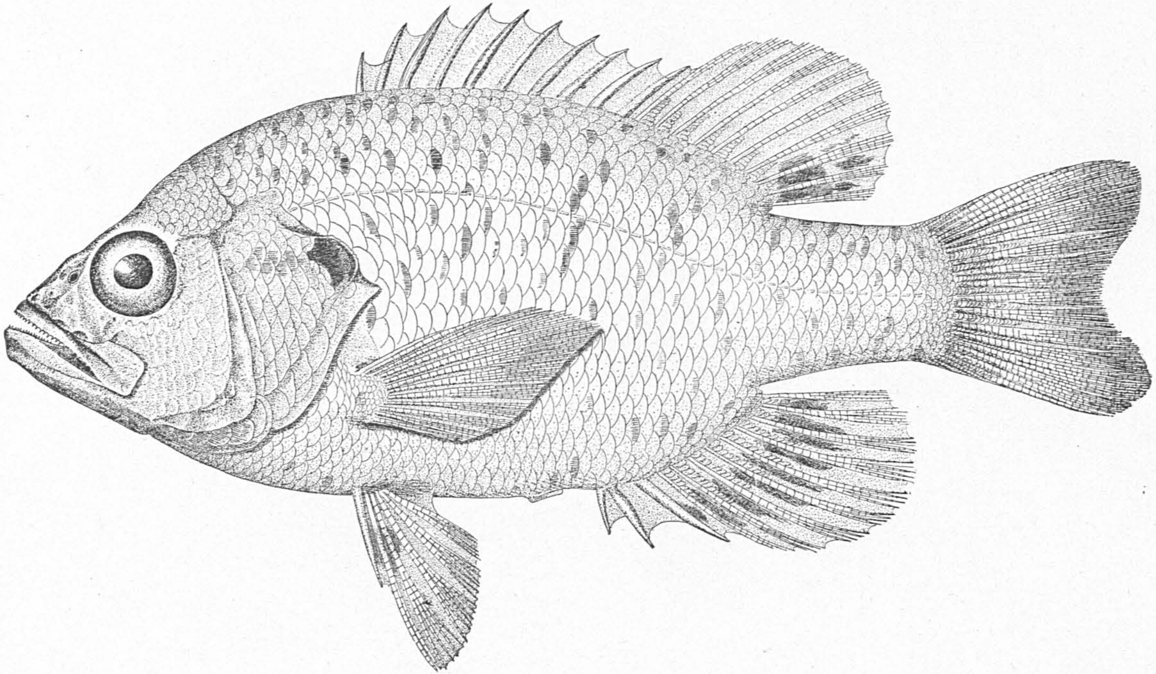


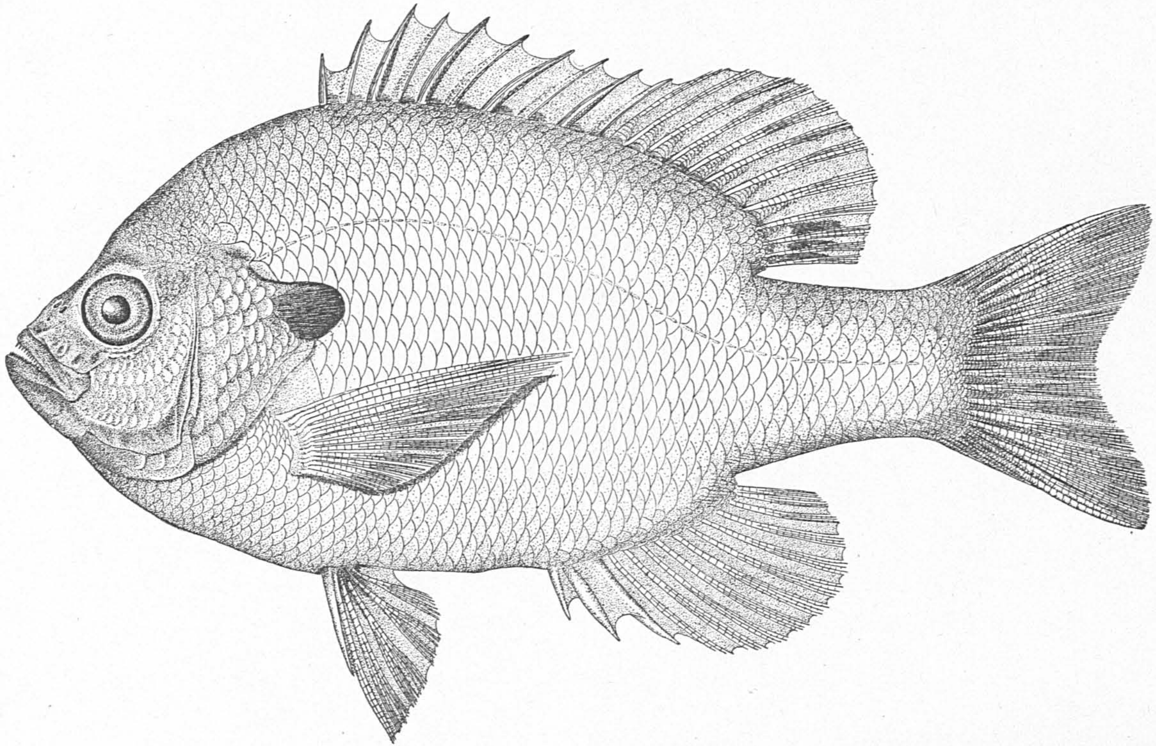
TRACHINOTUS FALCATUS (Linnæus). *Round Pompano.*



POMATOMUS SALTATRIX (Linnæus). *Bluefish.*



CHÆNOBRYTTUS GULOSUS (Cuvier & Valenciennes). *Warmouth.*



LEPOMIS PALLIDUS (Mitchill). *Blue Sunfish; Blue-gill; Bream.*

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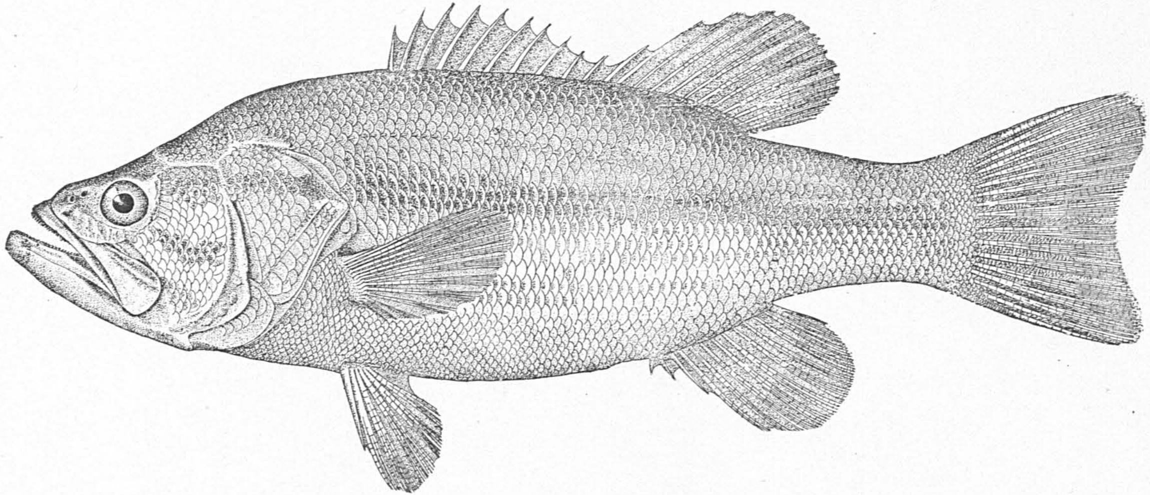

MICROPTERUS SALMOIDES (Lacépède). *Large-mouthed Black Bass; "Trout."*

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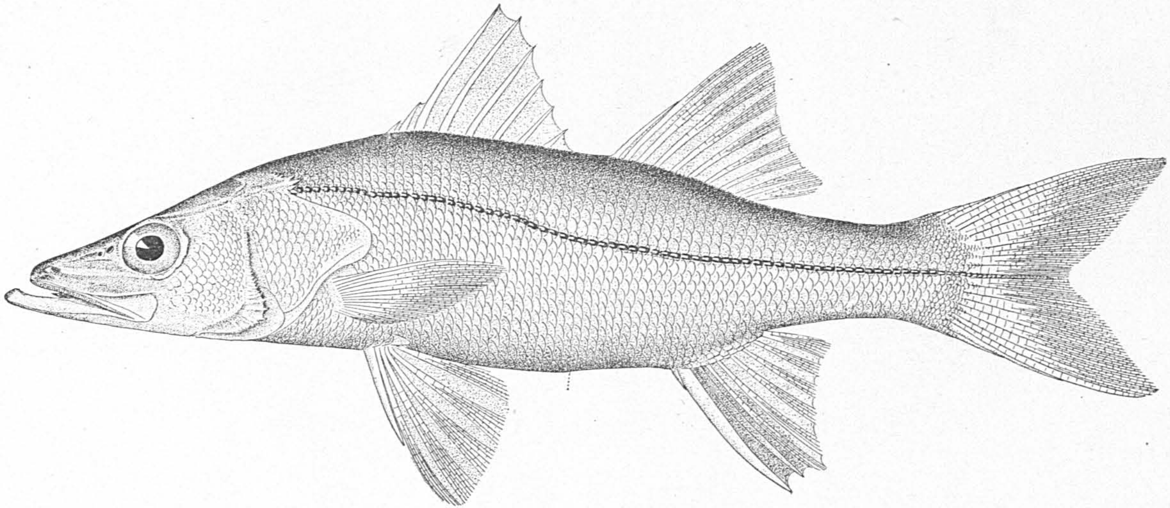

CENTROPOMUS UNDECIMALIS (Bloch). *Snook; Sergeant-fish.*

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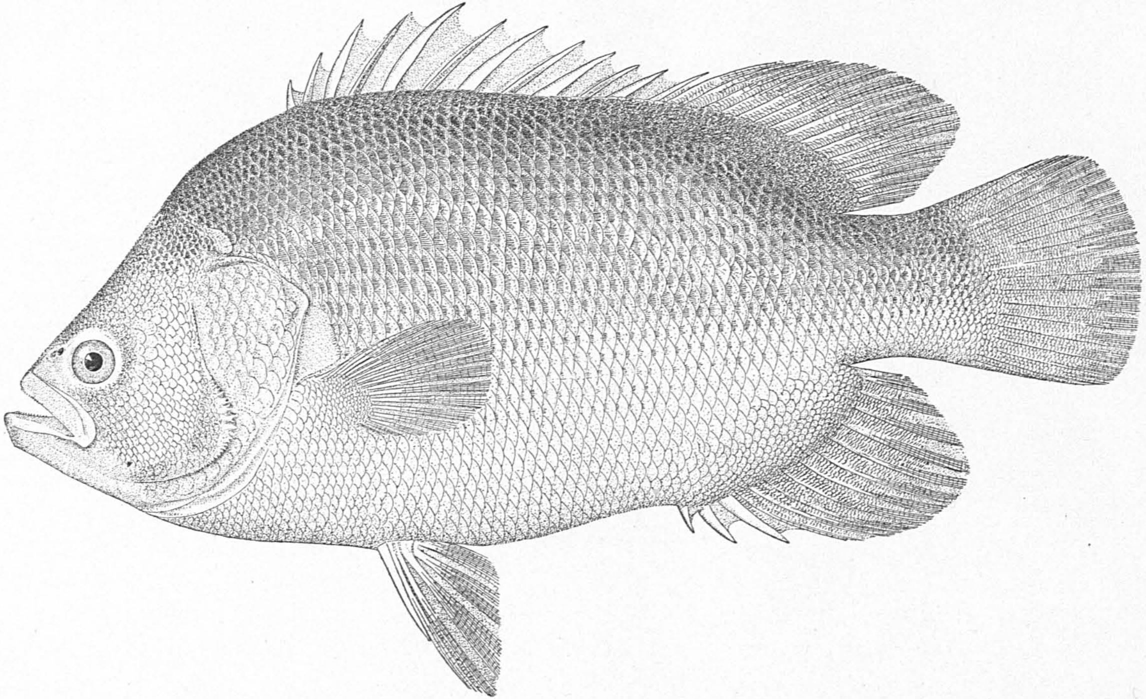
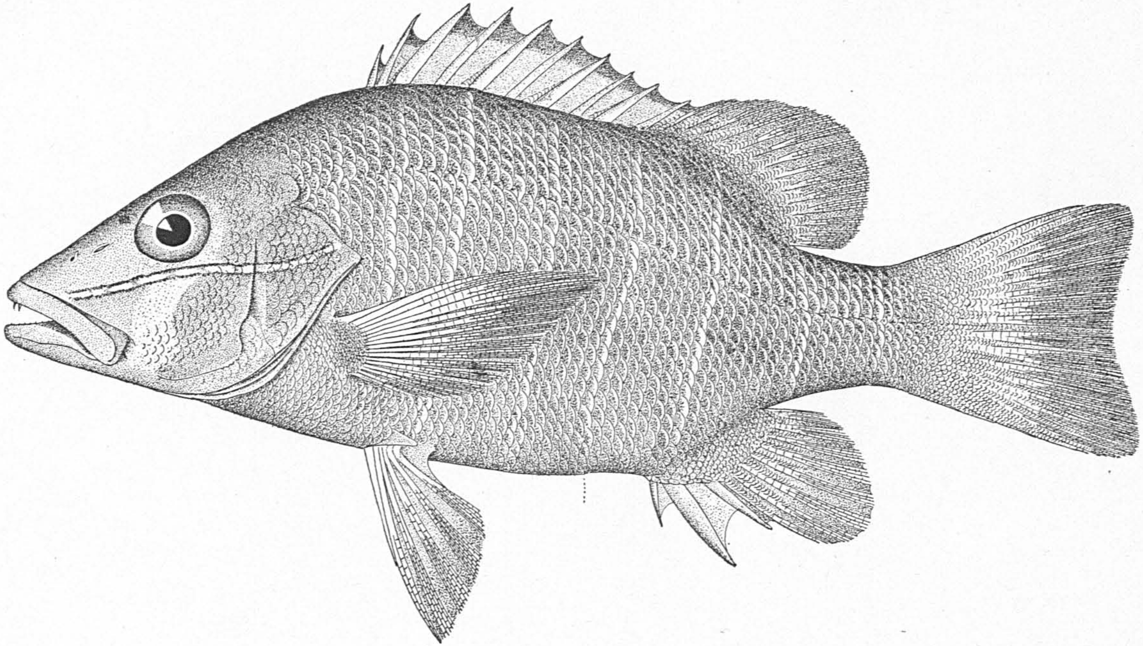


LOBOTES SURINAMENSIS (Bloch). *Triple-tail; Flasher.*



NEOMÆNIS APODA (Walbaum). *Schoolmaster.*

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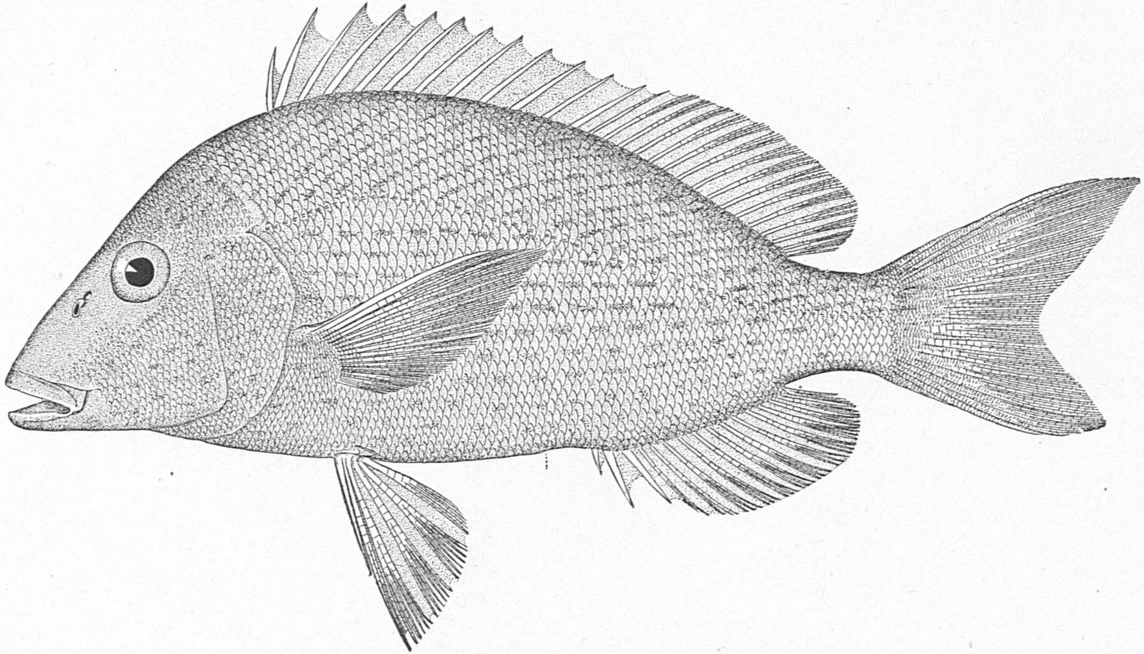
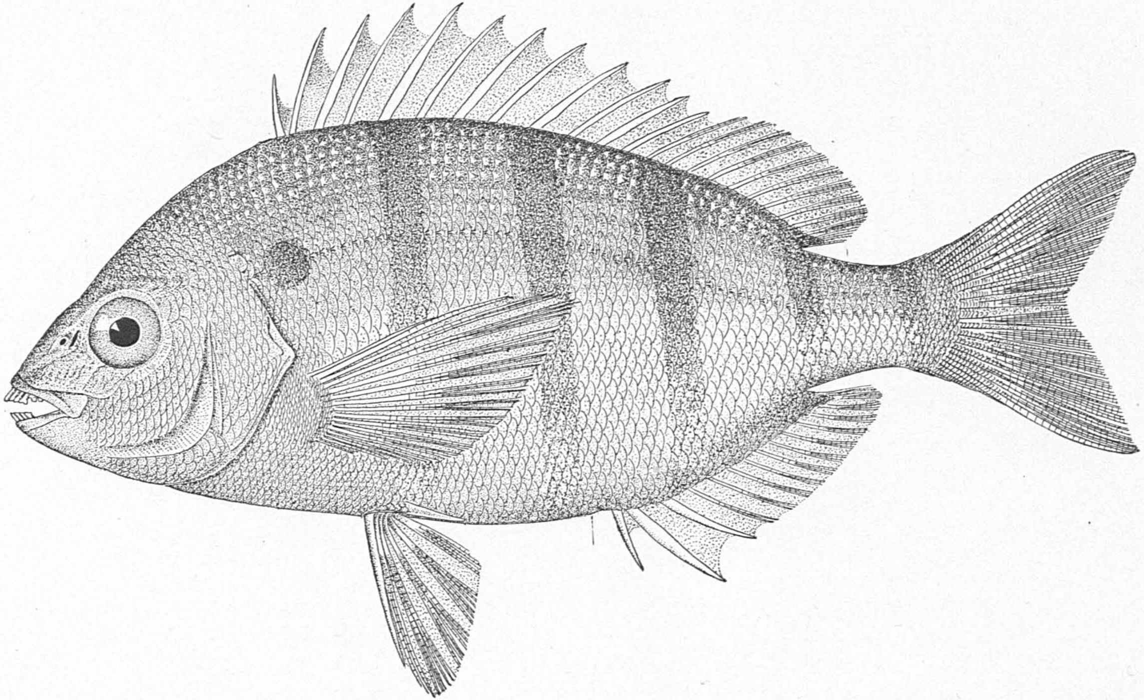
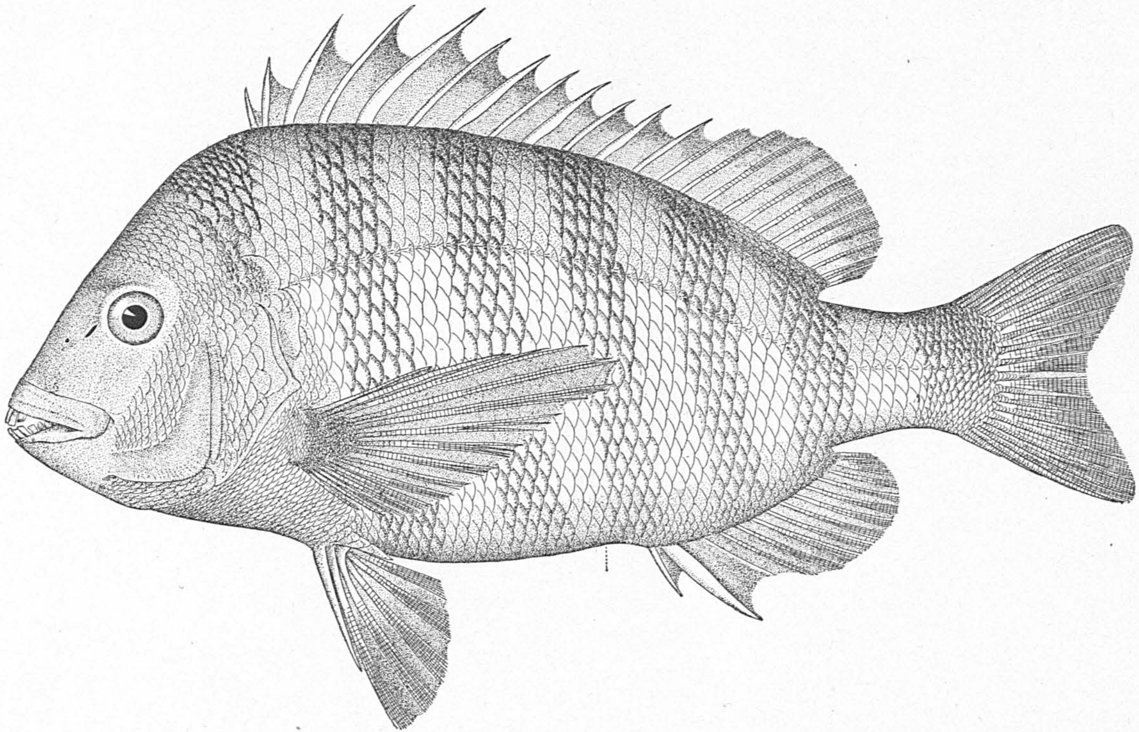


ORTHOPRISTIS CHRYSOPTERUS (Linnæus). *Hogfish; Grunt; Pigfish.*

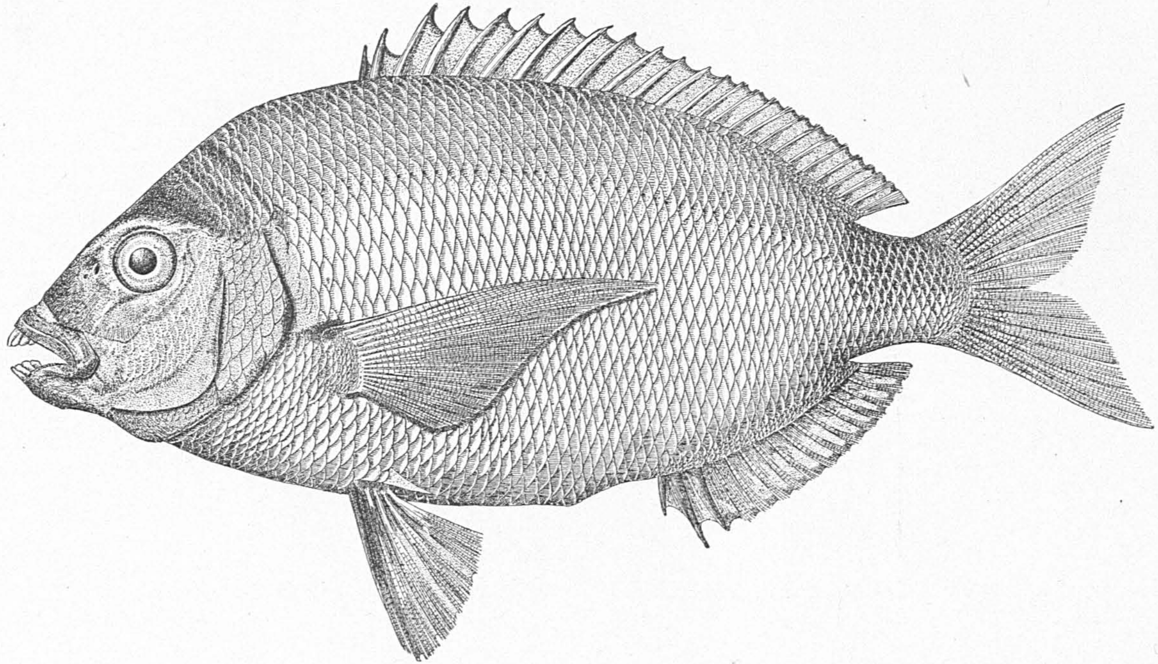
PLATE 48.



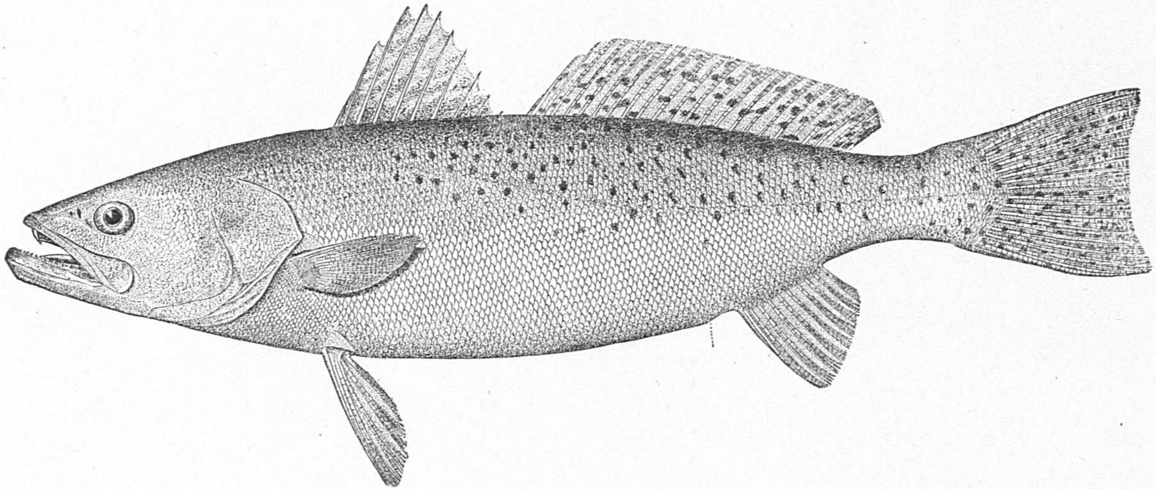
LAGODON RHOMBOIDES (Linnæus). *Sailor's Choice; Bream; Pinfish.*



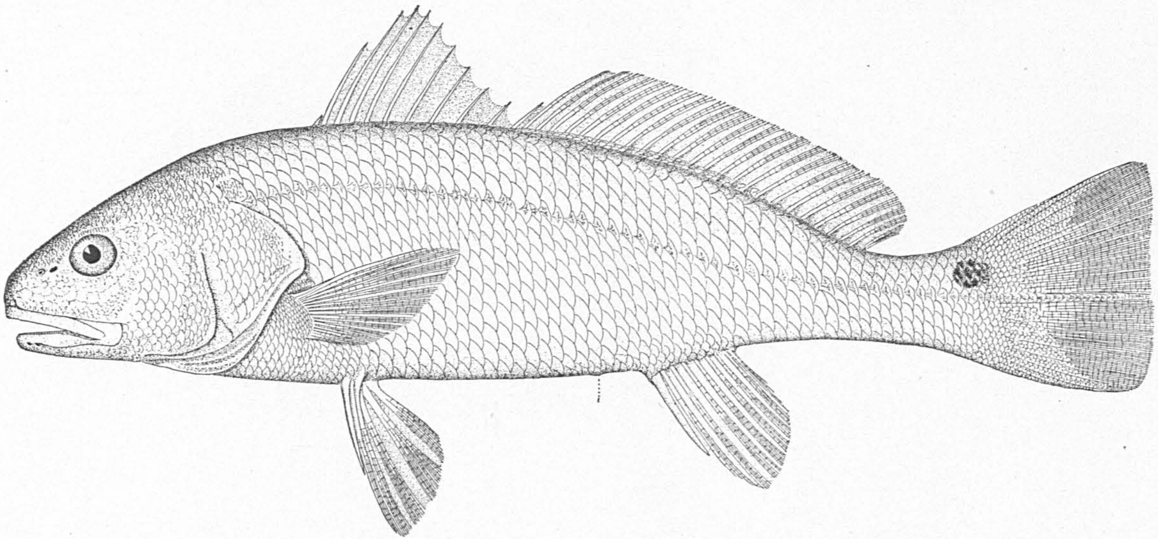
ARCHOSARGUS PROBATOCEPHALUS (Walbaum). *Sheepshead.*



DIPLODUS HOLBROOKII (Bean). *Pinfish; Bream; "Spot."*

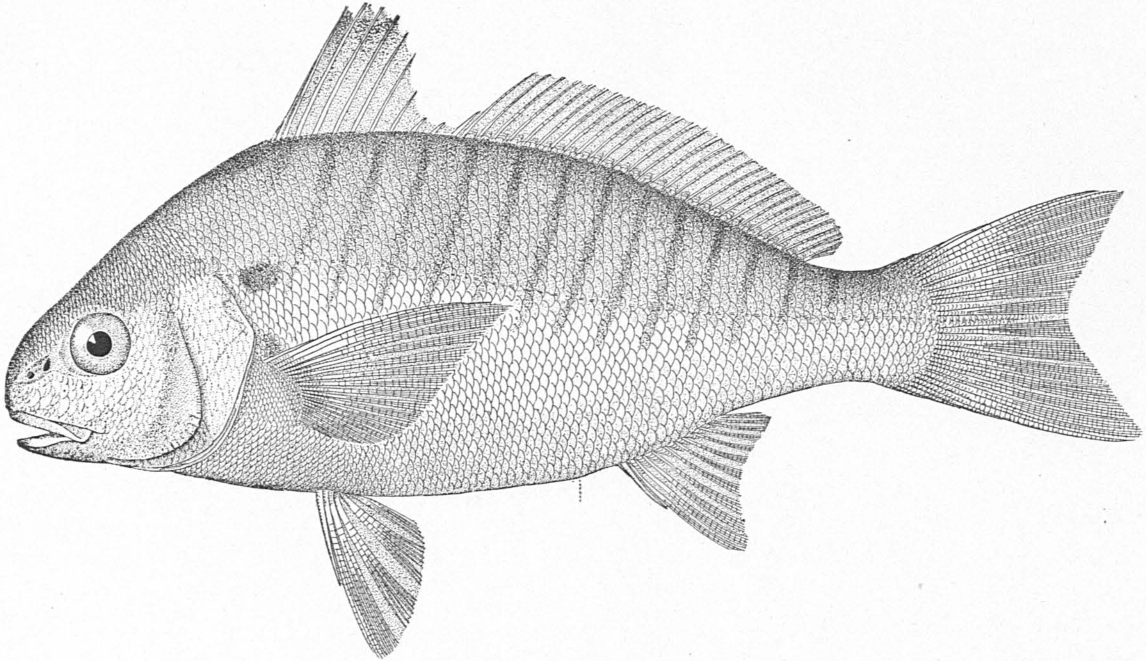


CYNOSCION NEBULOSUS (Cuvier & Valenciennes). *Spotted Squeteague; Spotted Sea Trout; "Trout."*

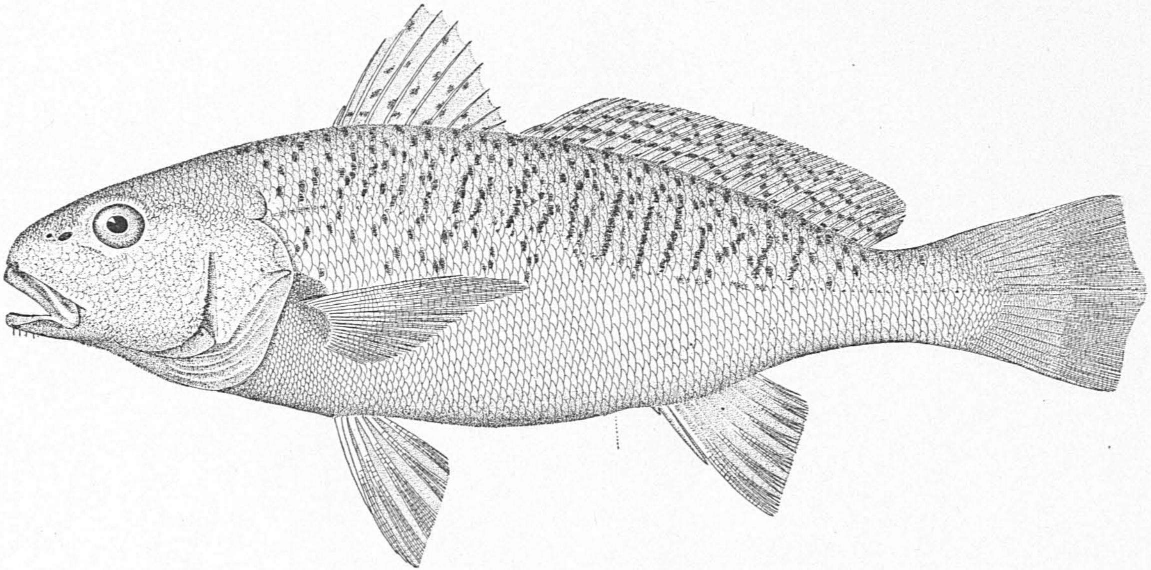


SCIÆNOPS OCELLATUS (Linnæus). *Red Drum; Redfish; "Channel Bass"; "Bass."*

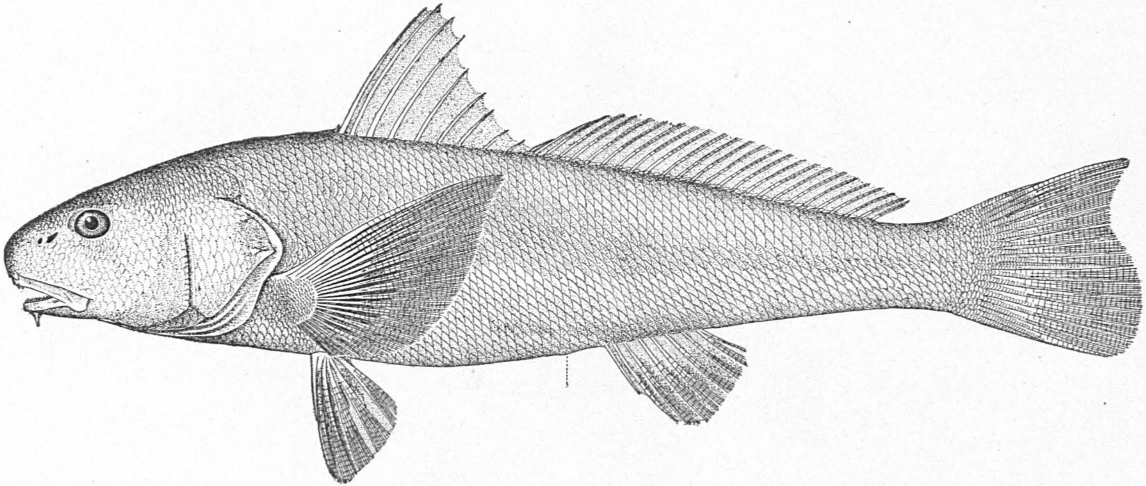
Report U. S. F. C. 1896. (To face page 262.)



LEIOSTOMUS XANTHURUS Lacépède. *Spot; "Jimmy."*

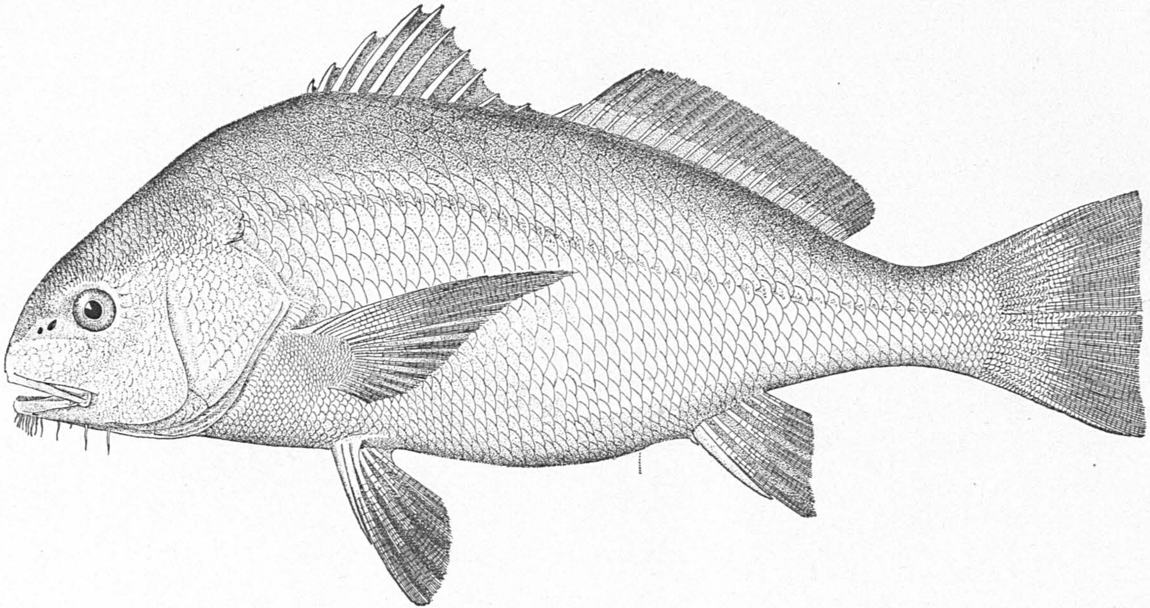


MICROPOGON UNDULATUS (Linnæus). *Croaker.*



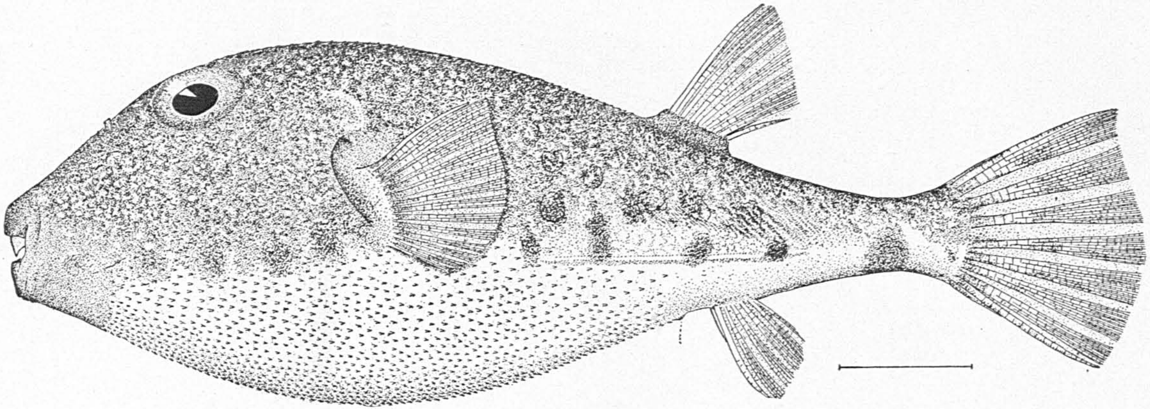
MENTICIRRHUS AMERICANUS (Linnæus). *Whiting.*

 (To face page 262.)



POGONIAS CROMIS (Linnæus). *Drum; Gray Drum.*

 (To face page 262.)



SPHEROIDES SPENGLERI (Bloch). *Swellfish; Puffer.*

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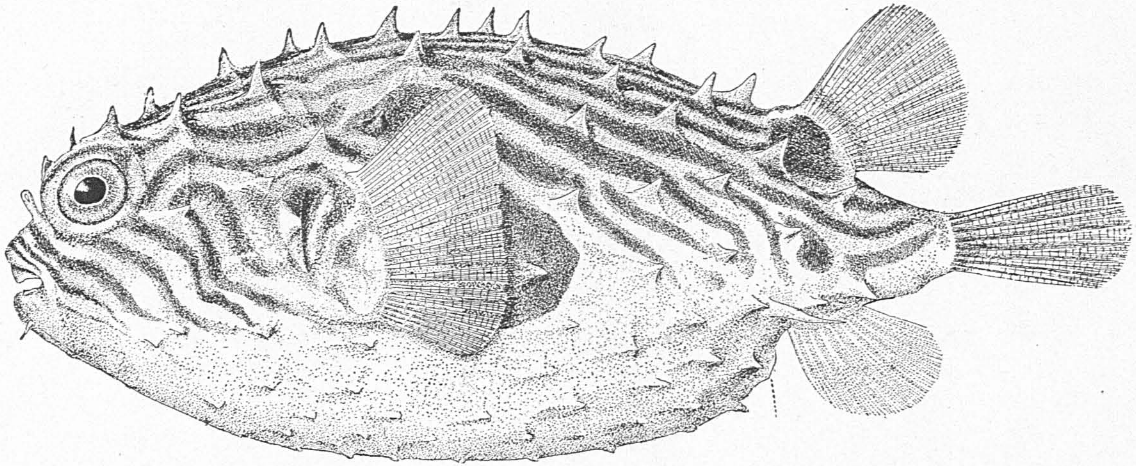
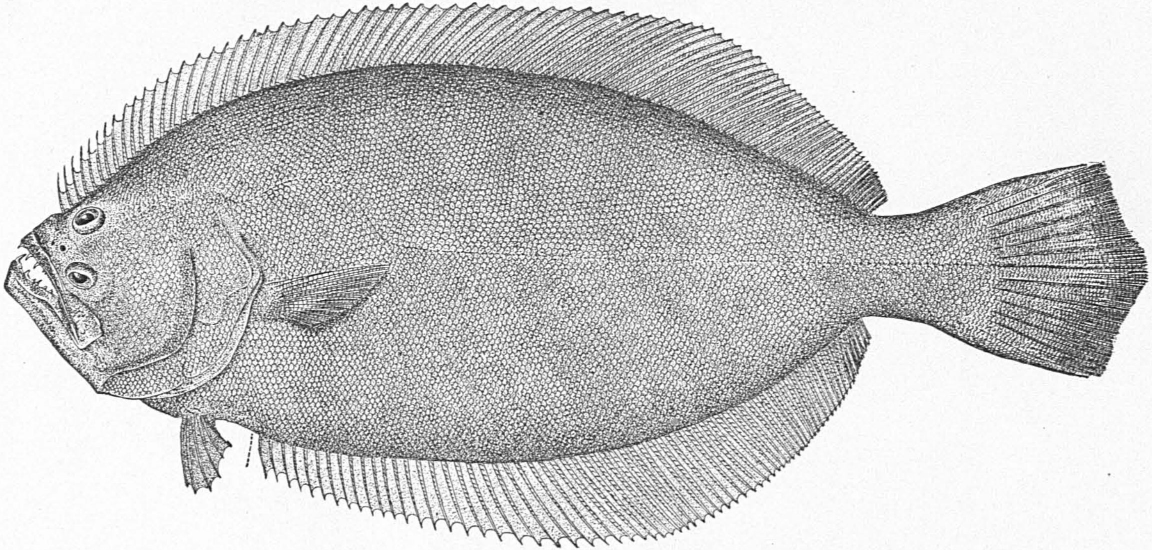


CHILOMYCTERUS SCHOEPFI (Walbaum). *Swell-toad; Burfish.*



PARALICHTHYS LETHOSTIGMA Jordan & Gilbert. *Southern Flounder.*

U. S. COMMISSION OF FISH AND FISHERIES,
JOHN J. BRICE, Commissioner.

REPORT

ON THE

FISH AND FISHERIES

OF THE

COASTAL WATERS OF FLORIDA,

TRANSMITTED TO

THE UNITED STATES SENATE BY THE COMMISSIONER
OF FISH AND FISHERIES, JANUARY 28, 1897.

Extracted from Report of Commissioner for 1896. Appendix 6, Pages 263 to 342.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1897.

6.—THE FISH AND FISHERIES OF THE COASTAL WATERS OF FLORIDA.*

By JOHN J. BRICE,
United States Commissioner of Fish and Fisheries.

UNITED STATES COMMISSION OF FISH AND FISHERIES,
Washington, D. C., January 28, 1897.

SIR: I have the honor to transmit the accompanying report on the fish and fisheries of the coastal waters of Florida, in accordance with the following Senate resolution of February 15, 1895:

Resolved, That the Commissioner of Fisheries is hereby directed to make inquiry in reference to the extent, methods, and present condition of the coast fisheries of Florida—more particularly the sponge and oyster fisheries—and to report as to the desirability of establishing a station for investigation, experiment, and fish-culture at some suitable point on the coast.

Investigations pursuant to the resolution of the Senate were begun in 1895, under the direction of the late Commissioner, but it was not feasible to complete the inquiries until the present year, when a party consisting of Dr. Hugh M. Smith, Prof. Barton W. Evermann, Mr. John N. Cobb, and Dr. W. C. Kendall, of this Commission, visited the southeastern and western coasts of the State, made observations, and collected information on which this report is in part based. Previous investigations had been conducted on the east coast of Florida in the years 1895 and 1896, which put the Commission in possession of data regarding the extent and condition of the fisheries of that region. Reference is made to the following recent reports on the Florida fisheries relating to the subject under consideration: "Notes on Biscayne Bay, with reference to its adaptability as the site of a marine hatching and experiment station," which appears in the report of this Commission for 1895, and "The fisheries of Indian River, Florida,"† being a report of the Commissioner of Fish and Fisheries transmitted to the Senate on January 5, 1897, in accordance with the act approved March 2, 1895, making appropriations for the sundry civil expenses of the Government for 1896, a clause of which directs "the Commissioner of Fisheries to make special investigation relative to the extermination of migratory fishes of the Indian River, Florida."

*This paper was first issued as Senate Document 100, Fifty-fourth Congress, second session.

†Printed as Senate Document 46, Fifty-fourth Congress, second session.

The following report deals first with the natural-history features of the Florida fisheries, and then considers the general importance of the industry and the extent, leading aspects, and condition of the fisheries in each of the prominent fishing regions or centers. The question of establishing a Government hatching and experiment station on the Florida coast is discussed.

This opportunity is taken to invite special attention to the value of the fishery resources of Florida and the necessity for action on the part of the State that will place the fisheries on a more substantial basis and assist the development of the industry without depleting the resources. To this end some suggestions are offered which seem warranted by the investigations recently made.

Very respectfully,

J. J. BRICE,
Commissioner.

To the PRESIDENT OF THE SENATE.

THE COAST FISHERIES OF FLORIDA.

GENERAL IMPORTANCE AND EXTENT.

Fishing is one of the most prominent industries of Florida, and in some parts of the State is of greater importance than any other branch of business. In comparison with other States the rank of Florida is tenth. Massachusetts, Maryland, New York, Virginia, New Jersey, California, Alaska, Maine, and Connecticut are the only States which surpass Florida in the value of their fishery products, and the margin between some of these, whose fisheries have about attained the height of their development, is so small that they will doubtless be outranked by Florida within a comparatively few years.

No State has a greater variety of valuable food-fishes and other water animals than Florida, and in few, if any, States do they exist in such abundance and under such favorable conditions for capture. Besides an immense assortment of food-fishes, there are valuable reptilian, crustacean, molluscan, and other resources. The fisheries are, with few exceptions, only imperfectly developed along most parts of the coast. With a coast line exceeding 3,500 miles in length (following indentations and including islands), the fishing is largely concentrated in a few places, leaving unoccupied long stretches of coast with ample supplies of fish, etc., awaiting the time when increase in population and extension of transportation facilities will make new demands on the water resources.

Florida is the only State having a sponge fishery, which is one of the most prominent branches of the fishing industry. Other fisheries in which Florida leads are the mullet fishery, the red-snapper fishery, the pompano fishery, the kingfish fishery, and the green-turtle fishery. Besides these, there are important fisheries for squeteague, grunts, minor snappers, sheepshead, groupers, Spanish mackerel, red drum, and oysters.

The principal coast fishing centers of Florida are Key West, Tampa, St. Petersburg, Cedar Keys, Apalachicola, Pensacola, Jacksonville, Fernandina, the Indian River region, and Lake Worth. By far the most extensive fisheries are prosecuted from Key West and Pensacola. The west coast maintains much more prominent fisheries than the east coast, and takes precedence in the yield of every important product.

The approximate extent of the commercial fisheries of the coastal waters of Florida at the present time is as follows:

Persons employed	6, 100
Capital invested	$1, 300, 000
Annual value of catch	$1, 200, 000

COMMERCIAL SPONGES OF FLORIDA.

SPONGE-GROUNDS.

The Florida sponge-grounds are in three principal localities: Vicinity of Rock Island, Anclote Key, and the Florida Keys.

The Rock Island grounds extend along the coast from Cedar Keys to Apalachee Bay, a distance of about 90 miles, and sponges are found in greater or less abundance over the entire region. The best grounds are said to lie off Piney Point between latitude 29° 40′ and 29° 50′, or just above Deadman Bay at the mouth of the Steinhatchee River. Other good grounds are in Ocilla Bay off the mouth of the Ocilla River, and above the mouth of the Suwanee River at a place called Pepperfish Key. Sponges are reported to be abundant in Suwanee Bay, but the water is seldom clear enough to permit their being seen.

The Anclote grounds extend from the vicinity of Johns Pass, just below Clearwater Harbor, to Cedar Keys. The best ground at present is St. Martin Reef, lying off Homosassa and Crystal River, between latitude 28° 40′ and 28° 50′. The center of this ground is crossed by the 83d meridian. Southwest of St. Martin Reef is what is known as the "New Ground," where excellent sponges are obtained in 42 to 45 feet of water. Another center of abundance is said to lie off Bayport. Nearly the entire region between Johns Pass and Cedar Keys, however, is regarded as good sponging-ground if not too closely fished. That portion off the Anclote Keys would be particularly productive if allowed to recuperate. It is believed by many that sponges are abundant off Egmont Key at the mouth of Tampa Bay, but the water is rarely clear enough to permit the grounds to be worked. South of Tampa Bay commercial sponges do not occur in sufficient numbers to justify the working of this coast until after passing Cape Sable.

The Florida Keys grounds extend from Key West eastward and northeastward at least as far as Cape Florida. On these grounds the sponges are found in the shallow water among the keys and along the reefs in all suitable places.

Good grounds are about the Matecumbe Keys, Stirrup Key, Bahia Honda, and Horseshoe Cove. The greater part of Biscayne Bay is an excellent sponging-ground.

SPECIES.

The commercial sponges of Florida are regarded as belonging to five different species. They all belong to the genus *Spongia*, and, named in the order of their importance, are as follows:

1. **The Sheepswool Sponge,** *Spongia equina glossypina.*
2. **The Yellow Sponge,** *Spongia agaricina.*
3. **The Grass Sponge,** *Spongia graminea.*
4. **The Velvet Sponge,** *Spongia equina meandriniformis.*
5. **The Glove Sponge,** *Spongia officinalis tubulifera.*

Several varieties of these sponges have been described and numerous grades of each are recognized by the dealers.

SHEEPSWOOL SPONGE.

The sheepswool sponge is found at various places along the Florida coast from Apalachicola on the west to Cape Florida and the head of Biscayne Bay on the east. The centers of greatest abundance are near Cedar Keys and Anclote Keys, though the entire region from off St. Marks to Charlotte Harbor produces this species. This is commonly called "the bay," and sponges from here are known as "bay sponges."

Below Charlotte Harbor the sheepswool is not found in any abundance until beyond Key West among the Florida Keys. Important grounds are about Knight Key, Bahia Honda, Matecumbe, and in Biscayne Bay.

The best quality of sheepswool sponges comes from the Anclote and Rock Island grounds. These are regarded by many as the best of all sponges. According to some, the key sheepswool were formerly regarded as the best, but now those obtained there seem to have deteriorated in quality. The best key sponges are said to come from the vicinity of Matecumbe Keys.

The sheepswool sponge grows upon hard, rocky, or barry bottom; in the shallower water, however, it is frequently found on grassy bottom. It is rarely found on soft mud or sandy bottom, and appears not to thrive under such conditions. The hard, rocky bottom is usually, perhaps always, of coral growth or origin.

The majority of the sheepswool sponges now obtained are secured in water ranging in depth from 30 to 50 feet. Some are found in water as shallow as 10 or 12 feet, but they are kept pretty closely fished out in these shallow depths. Formerly the principal and best grounds were in shallow water, but it is now found necessary to resort to deeper and deeper water year after year.

Whether the sheepswool sponge grows in any abundance at greater depths than about 50 feet is not definitely known. The method by which the sponges are secured is such as can not be applied in a depth greater than 50 feet. The majority of the spongers believe, however, that sponges grow in abundance beyond a depth of 50 feet. On the other hand, some think that, on the Florida coast, the commercial sponges do not occur in any numbers at greater depths than 50 or 60 feet. It is held by these that in depths greater than this the bottom is chiefly of sand and consequently unsuited to the growth of sponges. This opinion is based upon the observed fact that the better kinds of sponges, while doing well in shallow water if upon rock bottom, do not thrive upon sand bottom at the same depths, and the further fact that such investigations as have been made along the Florida coast show that the rock bottom upon which the sponges thrive does not ordinarily reach greater depths than 60 feet, but that beyond that depth a sand or mud bottom is found. Sufficient experiments in securing sponges by diving have not been made to throw much light upon this question.

According to Mr. E. J. Arapian, who possesses a wide and intimate acquaintance with all the important sponging-grounds of the world, the commercial sponges of the east coast of Africa are obtained in depths as great as 110 feet, but there the bottom is of rock; the bars are much larger and more uniformly solid, while our bars are limited in area and surrounded by sand. The African bars are said to be of solid, flint-like rock, while those of Florida are broken and discontinuous.

The sheepswool is not only the most important commercially of all the Florida sponges, but is by some regarded as the most abundant species; others say that the grass and the yellow are really more numerous, though, owing to their less commercial value, fewer are marketed.

The sheepswool sponge attains quite a large size. Some have been found weighing as much as 3 to 4½ pounds. However frequently this may have occurred formerly, sponges of that size are rarely, if ever, seen now. Those obtained now run from 4 to 12 inches, or occasionally 15 inches, in diameter. The average size probably does not exceed 8 to 10 inches in diameter and 8 inches in height. One of the Key West buyers estimates that those being brought in now average about 12 to 16 to the pound.

The form of the individual sponge is said not to change much as the sponge gets older, but to remain essentially the same, however long the sponge may be permitted to remain unmolested. Any important irregularities in form or departure from the typical shape are due to interference with its growth through crowding or contact with other objects. On the whole, the sheepswool is probably the most regular and uniform in shape of any of the sponges. It is said to grow pretty well scattered, rather than in colonies, interspersed among gorgonians, corals, and other sponges.

Accurate information regarding the rate of growth of the sheepswool sponge is not as complete as might be desired. It is believed by many observers to grow the most rapidly of any of the sponges. Some experiments performed and observations made by Mr. J. T. Sawyer and others lead them to believe that this species may, under favorable conditions, grow from the beginning to one-tenth of a pound weight in six months.

As illustrating the short-sighted policy of the spongers in pulling the sponges just so soon as they have attained the minimum lawful size, and even sooner, a case may be cited in which 1,250 sheepswool sponges were sold for $5. If these 1,250 small sponges could have been allowed to grow for six months longer it is estimated that they would have sold for at least $390.

The opinion that this sponge will grow from the spat to good commercial size in one year is practically unanimous. The spongers all testify that grounds which were thoroughly fished out one year are found to yield large numbers of commercial sponges twelve months thereafter.

It does not appear that sponges have many natural enemies. Many persons more or less conversant with the business think that crabs do some damage. The spongers say that in many instances, when the sponge is brought up on the hook, a crab is found occupying a cavity in the base of the sponge, and it is generally believed that the crustacean has eaten the sponge tissue away, thus forming the cavity which it may afterwards occupy; others think that the crab finds the cavity already existing and simply uses it as a place of retreat, and this would seem to be the more reasonable view.

The greatest injury to the sponges, according to the spongers, is that caused by the so-called "black water" or "poison water." Just what this is does not seem to be definitely known, although knowledge of the occurrence of the phenomenon dates back many years. The more prevalent opinion is that heavy rains cause a strong flow of fresh water from off the land into the sea, and this water, being heavily impregnated with decaying vegetable matter and spreading out over the sponge-grounds, poisons the sea water and kills the sponges. It is claimed that the poison water always follows immediately after unusually heavy and continued rains. An objection urged against this belief is that this water, being fresh, merely spreads out over the surface and does not reach the sponges except in very shallow water. Those who hold this view maintain that the failure of the sponging vessels to bring in good fares at the time of the prevalence of the black water is not because the sponges have been killed, but because the spongers are unable to see them through the colored water. Attempts have even been made to devise a water-glass which would enable the sponger to see the sponges below the black water. Some are inclined to the belief that the poison water comes not from the land, but rather from subterranean eruptions. It is claimed that sponges have been really killed in this way only once in the last twenty-five years.

A peculiar malady among the sponges between Knight Key and Cape Sable occurred in 1895. It is said that the sponges appeared all right until brought to the surface of the water, when the whole inside would drop out, leaving nothing but a mere shell. What could have caused the decay of the inside no one has yet been able to explain. According to one witness, these sponges were hollowed out when brought up, and usually a crab was found occupying the cavity.

Whatever the black water may be and whatever may be its effect, it is certain that the sheepswool sponge is decreasing in numbers very rapidly. All are agreed upon this point, and the cause of the decrease is not difficult to understand. While 500 bunches are now considered a good cargo, a few years ago 1,000 to 1,500 or even 1,800 bunches were often brought in at a single trip. The decrease continues from year to year, the bulk of the fishing is done in deeper and deeper water, and the sponges are harder to get each succeeding year. Grounds which are fished out one year are visited and raked over again the next year, without giving them sufficient time to recuperate.

The present law of the State of Florida governing the matter makes it unlawful to take any sponge under 4 inches in diameter. It is admitted, however, that this provision is not enforced. According to this law the size of a sponge is determined by taking its diameter, measuring across the top of the sponge, no attention being given to the height. Some dealers think that the minimum size should be increased to 5 inches, and all are in favor of enforcing the law.

VELVET SPONGE.

This species is more limited in its distribution than the sheepswool, is more rare than any of the other commercial sponges, and seems to be decreasing more rapidly than any other. It is found rarely, if at all, on the Rock Island or Anclote grounds, but seems to be confined to the vicinity of the reef and the keys between Key West and Biscayne Bay. The best beds are said to lie about the Matecumbe Keys and between the reef and the chain of keys in what is known as the Hawks Channel. It usually grows on live coral bottom, in rather shallow water. The depths given by different persons vary from 3 to 25 feet, with 15 to 18 feet as the usual depth. It is said to grow in all sorts of shapes, and is consequently less regular or uniform than other species. In size it runs from 3 to 12 inches in diameter, the average being about 8 inches. It probably grows less rapidly than the sheepswool, though some of the spongers say that it will reach a commercial size in a year.

YELLOW SPONGE.

The distribution of the yellow sponge seems to be nearly the same as that of the sheepswool. It grows on the same bottom with the sheepswool and grass sponges on the Rock Island and Anclote grounds and among the keys. It is probably most abundant among the keys. All agree, however, that those from the keys are of much better quality than those from "down the bay," as they are much softer and tougher. It is found usually on rock bottom, interspersed among the sheepswool, though it often grows on grassy bottom with the grass sponge.

Among the keys it is found in 3 to 10 feet of water, while elsewhere it usually occurs at greater depths. In size those gathered range from about 4 to 8 inches in diameter. It is a very common species, ranking next in abundance to the grass sponge.

Among the keys it is said to be decreasing very rapidly, but, owing to the poorer quality of those found down the bay, it is not much sought after there, and is probably not decreasing so rapidly.

GRASS SPONGE.

This is the most abundant of all the Florida sponges, and is found on each of the three important sponging-grounds. Large numbers come from Rock Island and the Anclote grounds, as well as from among the keys and Biscayne Bay. The best beds on the Anclote grounds are said to be off Bayport and Big Bank, about 25 or 30 miles north of Tarpon Springs. The sponges from these grounds are of superior quality, though many claim that the best grass sponges come from the keys.

Among the keys and in Biscayne Bay the grass sponge is obtained in 3 to 10 feet of water, while on the west coast it is found in water somewhat deeper. It grows on either rock or sand bottom, but usually upon the former. It is more easily obtained than the sheepswool, chiefly, no doubt, because it is more abundant in shallow water.

There seems to be more variation in the form of this sponge than in the other species. It is usually more or less cup-shaped and can readily be distinguished. It seems to attain a very large size, perhaps larger than any other species. The small grass sponges, 4 or 5 inches in diameter, are of little or no commercial value.

A decrease in abundance is reported for this as for the other species.

GLOVE SPONGE.

The glove sponge is the most circumscribed in its distribution of any of the Florida commercial sponges. It is abundant among the keys from Key West to Biscayne Bay, but probably does not occur on the Anclote or Rock Island grounds. It is common about Key West in rather shallow water. The usual depth at which it is obtained is 3 to 10 feet, though it occurs in deeper water. It grows on rock or barry bottom, mixed with the yellow and the sheepswool sponges. Its rate of growth is about the same as that of the sheepswool. Commercially the glove is the least important of any of the species, and for that reason it probably has not suffered so greatly from overfishing.

SPONGE-CULTURE.

The artificial propagation of sponges has never received much attention in Florida. A number of years ago Mr. J. Fogarty, of Key West, carried on a series of experiments in propagating sponges from clippings. An account of these experiments has been given* as follows:

> The sponges were all raised from cuttings; the localities in which they were planted were not the most favorable for sponge development, and their growth was, therefore, less rapid and perfect than might otherwise have been the case. They were fastened to the bottom, in a depth of about 2½ feet of water, by means of wires or sticks running through them. The four specimens sent to Washington were allowed to remain down a period of about six months before they were removed. Fully four months elapsed before they recovered from the injury done them in the cutting, which removes the outer "skin" along the edges of the section, and the actual growth exhibited was for about two months only. The original height of each of the cuttings was about 2½ inches. One was planted in a cove or bight, where there was little or no current, and its increase in size was very slight. The other specimens were placed in tideways, and have grown to from four to six times their former bulk. Two hundred and sixteen specimens in all were planted at the same date, and at the last accounts those that remained were doing finely. The chief obstacle to the artificial cultivation of sponges at Key West arises from the fact that the sponge fishermen infest every part of the region where sponges are likely to grow, and there is no legal protection for the would-be culturist against intruders. The enactment of judicious laws bearing upon this subject by the State of Florida, or the granting of special privileges conferring the right to occupy certain prescribed areas for sponge propagation, would undoubtedly tend to increase the annual production of this important fishery.

*Fishery Industries of the United States, sec. V, vol. 2, p. 832.

In the same volume of the Fishery Industries report is given a full account of the very extended experiments which were carried on by Mr. Buccich at the island of Lesina, in the Adriatic Sea, on the coast of Dalmatia. This report contains so much important information that it is proper to give a summary of it here:

After Prof. O. Schmidt, in an article in the *Wiener Zeitung*, and in his work on the sponges of the Adriatic,* had expressed the opinion "that if a perfectly fresh sponge is cut into suitable pieces, and if these pieces, properly protected, are again placed in the sea, they will grow, and finally develop into complete sponges," the government and a number of prominent merchants of Trieste had some experiments made during 1863–1872, and established a station on the bay of Socolizza, at the northeastern point of the island of Lesina, which in May, 1867, was placed under the direction of Mr. Buccich. This establishment was closed in November, 1872, as its continuance became impossible, because, in spite of Mr. Buccich's oral and written remonstrances, it was continually disturbed by the fishing nets and was actually robbed several times. A species of worm which destroyed the woodwork appeared harmless compared to the hostile attitude of the population, which showed an utter want of respect for the property of other persons, and manifested deep-rooted prejudices against any innovations, as well as a reluctance to break with old habits.

The most favorable season for raising sponges from cuttings is winter. It is true that the growth of the sponge and the new formations on the cut sides goes on slower in winter than in summer, but a high temperature of the air often endangers the entire crop, on account of the tendency of the sponges to rot. In winter a sponge may remain on the dry land for several hours, while in summer it will perish in a few minutes, especially if it has been injured and if it is not constantly moistened with sea water. Mr. Buccich exposed sponge cuttings to the air in a shady place for eight hours during February, when the temperature of the air was 48° F., and still they all took root.

The best localities are bays, where the waves are not too strong, but where the surface is not entirely smooth either, with a rocky bottom covered with green algæ and exposed to a gentle current. It is a well-established principle that the mouths of streams and rivers and of subterranean springs should be avoided. The fresh color of the algæ is a sure indication that the choice of locality has been fortunate. The worst enemy of sponge-culture is mud. Under certain circumstances it would be well to close the entrance to the bay to vessels by a chain.

The sponges which are to be cut should be very carefully gathered by experienced persons. * * * The sponges are brought up either with their base—and this is the most favorable way—or they must be torn from the base, which operation frequently tends to injure them. * * * In gathering sponges for cutting, it is entirely unnecessary to select nice-looking specimens, for misshaped pieces which would be worthless in trade are just as good for this purpose as beautifully rounded ones. These latter should not be cut, but should be reserved for the trade. * * *

Mr. Buccich found that it was not expedient to place the sponges, as they were gradually gathered, into a vessel, to keep them there until they were to be cut, because they were injured by pressing against each other or by being shaken too violently. He therefore provisionally fastens them with wooden pegs to the inner side of a sort of fish box, which is held in tow by the fishing boat. If the sponges are injured, the injured portions should be immediately removed; the remainder is likewise fastened with wooden pegs, either as it is, or subdivided into large pieces.

When the temperature is low during the cold season, the sponges can be prepared for raising as soon as the place is reached where the process is to be carried on,

* "*Die Spongien des adriatischen Meeres*," Leipzig, 1862, p. 22. See also O. Schmidt, "*Supplement der Spongien des adriatischen Meeres*," Leipzig, 1864, p. 24; and especially Brehm, "*Thierleben*," 2d edition, vol. 10, Lower Animals, by O. Schmidt, 1878, p. 534.

while during the warm season it will be found profitable to wait a little in order to see whether there are any indications of putrefaction. This can be recognized by the darker color and the softening of the respective portions. If anything of the kind is noticed, the sponge should be watched to see to what extent the process of disintegration has progressed. Small sponges will almost entirely fall a prey to it, while in large ones the evil may be confined within certain limits. The cutting should be done rapidly, either with a common knife or—as Mr. Buccich found more advantageous—with a blade resembling a fine saw, which is less liable to be injured by the many foreign bodies inclosed in sponges. In cutting, the sponge had best be laid on a small board moistened with sea water. The size of the cuttings is generally about 26 square millimeters. It is well if every piece has as large a surface as possible of intact outer skin. The cuttings should be fastened immediately to those objects where they are expected to grow.

A healthy piece of sponge soon grows firmly on any object with which it is brought in close contact. The sponges which have been cut will again grow together. Those cuttings which have only a single cut surface will soon grow fast to their new base, stone, wood, etc. Mr. Buccich thinks that during a calm lasting twenty-four consecutive hours, cuttings should simply be sowed on a rocky bottom and would soon grow. He has seen pieces laid on gently slanting rocks grow fast to them during a perfect calm. Induced thereby, and also by the natural occurrence of sponges, Mr. Buccich tried flagstones, about 53 millimeters thick, as a basis. He bored holes in them and fastened the cuttings by means of wooden pegs, which were driven into the holes; but it soon became apparent that the mud and sand at the bottom, perhaps also the excess of light, were injurious to the further growth of the sponges. Experience has shown that light and mud are among the worst enemies of the sponge, and their influence must be avoided or limited by every possible means. Stones form the natural basis of sponges. They are cheap, and are not attacked by the *Teredo*.

Originally, Prof. O. Schmidt used wooden boxes, closed on all sides but perforated, to whose inner sides the pieces of sponge were fastened with metal or wooden pegs. This exceedingly simple arrangement did not prove efficient, because the boxes when let down into the deep water became full of mud, and the holes being stopped up no light whatever could enter. The sponges began to look pale and sickly. It is not good to fasten them with metal pegs, for it seemed to retard their growth. The rust which forms very soon causes the pieces of sponge to become loose, and will ultimately destroy them. Laths or boards placed obliquely, on whose upper side there were floating contrivances in the shape of tables, to the lower side of which the sponges were fastened, were likewise used. With the former the want of covering was keenly felt, and with the latter the rays of the sun proved injurious, as well as all the different little objects floating on the surface of the water, which may be grouped together under the collective name of "dirt." Mr. Buccich at first prepared an apparatus consisting of two boards crossing each other at right angles, with a third board serving as a sort of lid, and after this had proved unsatisfactory he adopted the apparatus which I shall now describe, and which he preferred to all others because the cuttings were exposed on all sides to the sea water and assumed the favorite round form. This apparatus consisted of two boards, 63 centimeters long and 40 centimeters broad, one forming the bottom and the other the lid. Both were kept in a parallel position, one above the other, at a distance of about 42 centimeters, by two props about 11 centimeters distant from each other, between which stones may be placed as ballast. On the outer side of the lid there was a handle. Both boards had holes at a distance of 12 centimeters from each other, the total number of holes in each board, therefore, being 24. Mr. Buccich did not fasten the pieces of sponge singly to the apparatus, but he placed several of them on one peg and then stuck the pegs in the holes. For these pegs he used bamboo, whose hard, smooth bark defies all attacks of worms. These pegs were 42 centimeters long, and perforated horizontally, the holes being at the distance of 12 centimeters from each other, and the lower end was split. Three pieces of sponge were put on each peg and pushed up high enough to be above the horizontal holes, through which a wooden peg was pushed, thus fully securing the sponges.

If the pieces of sponge are simply to be fastened with wooden pegs, a three-cornered stiletto will suffice for making the holes in sponges; but when they are to be strung upon pegs this or any similar instrument can not be used, because too great a pressure would have to be exercised to make a sufficiently large opening for the passage of the pegs. Any pressure will injure the sponges to some degree, and to limit its extent or force as much as possible should be the first object. Mr. Buccich bored the holes with a trepan 6 millimeters wide, fastened to a vertical turning table, which was kept in rapid motion by a fly wheel. One hand pressed the sponge lightly against the trepan, the other turned the wheel, and the operation was finished in a few seconds. The hole in this manner is perfectly smooth, none of the fibers have been pulled out, and none of the sarcode has flowed out. As soon as a peg has been furnished with sponge cuttings, its split end is stuck in one of the holes of the apparatus and a wedge is driven through the crack. As lid and bottom hold 24 pegs, each with 3 cuttings apiece, such an apparatus can hold 144 cuttings. During this whole process the sponges should be continually moistened with sea water, especially during summer. As soon as an apparatus has been filled it should immediately be let down into the water if the temperature is high, while in winter a delay will not prove injurious. The letting down and raising of the apparatus had best be done by means of a small anchor, and it should be let down to a depth of 5 to 7 meters. Mr. Buccich does not consider it necessary to have the apparatus suspended from a sort of scaffolding. All the woodwork should be well tarred, as this will prove the only, though by no means always efficient, protection against worms. The *Teredo* does not only cause an increase in the capital to be employed, because it makes new apparatus necessary from time to time, but it also diminishes the results, because the pegs will gradually get loose and fall off. It would, therefore, be best to dispense with wood altogether, and either construct the apparatus of stone, taking the necessary precautions against mud and excess of light, or construct Mr. Buccich's exceedingly practical apparatus of iron.

If, after three or four weeks, the sponges have grown firmly to their base, they are sure to develop successfully. Their most characteristic tendency is the desire to grow round. In order to facilitate this in all directions, Mr. Buccich strung the sponges on pegs. As regards the development of the sponge cuttings within certain given periods, we have only very imperfect information, as it was impossible to make continued undisturbed observations. Mr. Buccich says that the cuttings grow two or three times their original size during the first year. He also mentions that the cuttings grew better during the first and fourth year than during the second and third. It is his opinion that, although some pieces will grow to a considerable size in five years, it will require seven years to raise completely matured sponges which are fit to become an article of merchandise. I can not pass by the fact that besides well-developed and growing sponges there were some which outwardly looked perfectly healthy, but had ceased growing.

In conclusion, Mr. Buccich discusses the question whether the enterprise can, on the whole, be called profitable, and says that he must answer it in the affirmative. He thinks that if all the lessons taught by experience are carefully observed, the cuttings will always develop successfully, and that the loss would at most be 10 per cent, taking into account unexpected accidents and the stationary character of some of the sponges. Calculating the expense of an establishment for 5,000 sponges at 300 florins and the loss at 10 per cent, the price realized by 4,500 sponges would indicate the profits. Mr. Buccich calculates the value of 4,500 sponges at 900 florins. This sum is, in my opinion, much too high, as the wholesale sponge-dealers in Trieste receive an average price of 8 and a maximum price of 10 florins per kilogram of Dalmatian sponges.

Sponges fetching the price given by Mr. Buccich ought to have a very considerable size, and their slow growth justifies the supposition that even after seven years they will not yet have reached that size. It must also be taken into account that the market value of sponges which have been raised on pegs is one-third less than that of naturally grown ones, on account of the hole in the center. The profitableness of sponge-culture would be far more evident if there was not such a long interval between planting and harvesting—in other words, if the sponges would grow more rapidly. This was certainly looked for when the enterprise was started; but it is dispiriting to have to wait for your crop for seven long years. And, in order that when that period has been reached there may be crops every year, it will be necessary to invest the same annual amount of capital for a period of seven years. The apparatus, moreover, is not so simple that every fisherman could easily construct it himself, for experience has shown that wood, which would be the easiest material for working, can not be used on account of the ravages of the *Teredo*.

As far as our present knowledge goes, it is certain that sponge-culture will not be profitable for poor men, but that it can only be carried on successfully on a very large scale, either by wealthy individuals or by joint-stock companies. It would be very encouraging to know more concerning the progressive development of the sponge in its natural condition, and especially to know that this development was just as slow as that of the cuttings. Prof. O. Schmidt inclined to this opinion. But if it should prove erroneous, it would be more than questionable whether it is profitable to cut to pieces a sponge which uncut would have quicker reached the same size and weight than all the cuttings together in seven years. Under such circumstances sponge-culture had better be confined to the transformation of flat, and therefore worthless, sponges into round ones, which, though small, would find a ready market. Possibly several especially misshaped pieces of sponge might be made to grow together and form larger and better-shaped ones. The experiments made by Cavolini and those of Mr. Buccich, above mentioned, show that there is no difficulty in doing this.

Recently Mr. Ralph M. Munroe, of Cocoanut Grove, Fla., carried on an extended series of experiments in Biscayne Bay, an interesting account of which is given in the report on that region already alluded to.

These experiments by Mr. Fogarty and Mr. Munroe seem to demonstrate conclusively that the Florida sheepswool sponges grow very much more rapidly than did those experimented with by Mr. Buccich. Their cuttings grew to good commercial size in six months' time, and this agrees with the observations of all the dealers and spongers who were consulted about the matter.

This rapid growth of the sheepswool sponge and the high degree of success attained in the experiments which have been tried show very clearly that the artificial propagation of sponges in Florida by means of clippings is entirely practicable. That the adoption of methods of artificial sponge-culture would inure greatly to the benefit of the Florida sponge industry scarcely admits of question. Not only would it permit an expansion of the trade and fishery in the interests of the dealers, vessel-owners, and fishermen, but it would furnish employment to many other people, put the sponge business on a more substantial and permanent basis, and invite new capital. It should not be difficult to secure proper legislation on the part of the State by means of which the industry would be advanced and the interests of all concerned properly guarded.

MR. ARAPIAN ON THE FLORIDA SPONGES.

In compliance with a request, Mr. E. J. Arapian, the well-known sponge-dealer of Key West, furnished the following interesting and valuable information concerning the commercial Florida sponges. Mr. Arapian has been in the sponge business for many years, and is familiar not only with the sponge-grounds of Florida, but with those of other parts of the world:

Distribution.—Sponges on the coasts of Florida are to be found starting from Biscayne Bay and vicinity, on the southeast of Florida, and around all the keys in south Florida, more or less in places; then, proceeding toward the west coast of Florida, they are found at Gasparilla Island, Osprey, New Pass, Sarasota Key, Mullet Key, Sand Key, Clearwater Key, Long Island. Anclote Keys, up to Cedar Keys, and from Cedar Keys up to Apalachicola Bay.

The fiber of sponges of the same spec.es found on the above-mentioned sponge bars differs somewhat, according to the location of these bars. Those from a place called Fishbone Key sponge-grounds are of much thicker fiber, and thereby stronger and much heavier in weight than sponges gathered at other places. Fishbone Key is about 25 miles from Cedar Keys. At Pepperfish Key, about 12 miles from Fishbone Key, the sponges are also of thick tissue or fiber and of heavy weight, but not quite as much so as those from Fishbone Key. At another place, called Ocilla Bay, in contrast to the two above-mentioned places, sponges are of very thin fiber; therefore of light weight. Ocilla Bay is about 40 miles northwest of Pepperfish Key.

Character of the bottom.—The bottom on which sponges grow is of a ridgy or undulating rock, which looks alive to the eye, so to say, and is invariably covered with a species of short moss and tall sea feathers. The rocky bottoms on which there is no growth of moss and sea feathers have always been found to be bare of sponges also. This moss is of several colors, viz, either red, brown, or white.

It is my impression that the root of a sponge is of the same color as the rock on which the said sponge has been growing. It has certainly been noticed that every species of sponge, in its natural condition, and before being artificially bleached, has either a red or a brown or a white colored root, which corresponds with the color of the rock on which the sponges have been growing. It is also my belief that the color of the sea moss and the sea feathers is the same as that of the rock on which such moss and sea feathers are growing. If the bottom is of red rock, the sponges growing on it will also have red roots, and the sea moss growing on the same rock will be of red color. If the bottom is of brown or white rock, the roots of the sponges growing on it, as well as the sea moss, will have the same colors.

Depth of water.—Sponges are to be found at present at a depth of from 12 feet to about 50 feet. In deeper waters the bed rocks are generally scattered, few in number, and of short extent. The bed rocks in deeper waters than 56 feet seem to be of a different nature, and barren. The bottom on the west coast of Florida is generally sandy at greater depths than 56 feet, according to the general reports of the oldest of the sponge fishermen here.

Abundance.—Sponges are still abundant on the coast of Florida, but the almost continual bad weather at sea during the last three years has prevented the securing of as large quantities as formerly.

Relative size.—The different species of sponges in Florida waters attain sometimes quite large proportions. The species called sheepswool, yellow, and grass sponges attain the largest sizes. There are frequently seen sheepswool sponges measuring 15 inches in diameter by 20 inches in depth. The heaviest sheepswool sponge that I have come across weighed 17 pounds. It was secured in the Northwest Channel near Key West. Other species, as the glove sponge and the hardhead sponge, do not usually grow to larger sizes than 8 inches in diameter and 4 to 5 inches in depth. Some few larger specimens have been secured at times, however.

Enemies.—I do not know of any, but it is the prevailing opinion here, among sponge fishermen, that during some years poisonous water comes out of the Suwanee River near Cedar Keys, and that this water runs into the sponge-grounds near by and then kills the sponges. The fishermen state that some years they have found many sponges floating loose on the surface at the sponge-grounds in the vicinity of Cedar Keys. This opinion may perhaps be correct, but personally I do not share it, because I do not think that even if poisonous water was actually flowing out of the Suwanee River it could reach the sponge-grounds at sea, nearly 50 miles from the mouth of that river, and that the said poisonous water could then sink to a depth of at least 30 feet to reach and injure the sponge bottom. I am inclined to believe that some submarine convulsions, perhaps, are the cause of these uprootings of the sponges which have been found floating loose on the surface of the water at times.

As one of the causes injurious to the growth and propagation of the sponges, I would mention submarine diving apparatus. This is the greatest enemy to the growth of the sponges, as has been proved by its continual use on the grounds of the Archipelago Islands in Europe and on the east coast of Africa, in both of which places the submarine diving has left the grounds almost entirely bare. The iron shoes of the divers walking on the sponge beds in the bottom are said to have killed the sponges. Up to a few years ago the sponge gathering in the Archipelago Islands in Europe had been performed by the means of iron hooks attached to long poles, in the same method as it is used in Florida at present, and also by means of naked divers. Some few years back, however, someone introduced the use of the submarine diving apparatus for sponge gathering in the Archipelago Islands.

Soon after the extensive sponge-grounds on the east coast of Africa were discovered, and the submarine diving apparatus was put to use there at a lively rate by the Greek sponge fishermen of the Archipelago Islands. The consequence was that inside of a few years the submarine diving fleet, which had started gathering the sponges first on the east coast of Africa, at the depth of only 8 to 10 feet, were obliged to dive at greater depths gradually in order to find the sponges, and inside of a few years they had cleaned out almost the whole extent of the newly discovered and extensive sponge-grounds to the depths of 70 to 80 feet. I understand that lately they are obliged to dive to the depth of 100 feet and more in order to find the sponges. These experiments and solid facts are sufficient to convince one that submarine diving for the sponge with diving apparatus is extremely injurious to the life and growth of sponges, and I believe it is its greatest enemy. Sponges do not grow any more on the grounds on which the submarine diver's shoes have walked.

Decrease or increase in recent years.—Since 1892 there has been a gradual and marked decrease in the quantity of sponges gathered yearly in Florida waters, owing principally to the almost continual bad weather at sea, and secondly to the careless and continual gathering of very young and small-sized sponges by the fishermen, which naturally tends to hurt the growing crops.

Sponge cultivation.—Regarding the artificial culture of the sponges, I would say that experiments, some of which have been on a large and very costly scale, have been tried unsuccessfully by some merchants of Trieste, and others in Europe. These experiments have been made on the sponge-grounds of the Archipelago Islands, in the Mediterranean Sea, and in every instance they have proved a failure. The methods employed have been to use the small cuttings from a live sponge and to fasten these cuttings to the rocks by the means of a wire. Submarine divers have been necessary to perform the work of this so-called planting of the sponges; the cutting of the sponge and the planting of same were performed by these divers while under water, and without bringing the cuttings to the surface.

The only practical and successful method I can think of regarding the cultivation of sponges is to let nature do its work by allowing it sufficient time. This can be done by dividing the area of the sponge-grounds at sea into squares each of 100 miles, more or less, and then allowing the fishermen to gather sponges only in certain squares each season of the year.

According to all reports, on some grounds sponges grow much faster than on others. They have been noticed to grow to full size inside of four months in certain localities along this coast, while at other localities it takes young sponges at least six months to grow to full size. This fact can be put to advantage by restricting sponge gathering during several months on certain grounds, during which time the sponge fishermen can gather the sponges on the other parts of this coast. However, as it is necessary to the sponge fishermen to have not only good weather but also clear water, so as to enable them to see the bottom and to locate the sponges, it may happen that when they are out on their expeditions they may meet with muddy water on the unrestricted sponge-grounds of the season, while on the restricted grounds during that season the water may be clear and just in condition to allow them to locate and to gather the sponges. However, as the benefit that sponge fishermen could derive from the above restriction of certain grounds during certain seasons of the year would soon be important and lasting, it seems to me that no proper objections could be offered to the method.

Legislation needed.—The legislation needed for the protection of the sponge beds on the coasts of Florida would be to reach the three following essential points:

1. To divide the sponge-grounds on the coast of Florida into sections or squares of 100 miles, more or less, each, and to allow the gathering of the sponges on each section at certain intervals of time only, thus leaving the sponges which are on the other sections or squares at rest during that time, to grow and to reach the seeding sizes.
2. To prevent the gathering of small or undersized sponges.
3. To forbid the use of the submarine diving apparatus on the sponge beds, so as to prevent parties who at any time may perhaps undertake the use of some to the injury of the sponge beds.

OYSTERS.

The oyster does not occur on the coast of southern Florida in any abundance, but on both coasts in the northern part of the State important beds are found. At various places on the east coast, between Fernandina and Biscayne Bay, are grounds which are worked to some extent, those in Nassau County being the most extensive and productive. The beds in Indian River are sufficiently important to supply the local demand and furnish a considerable surplus for shipment. The best beds are apparently in the southern end of the river.

Oysters are not known to occur in any numbers in Lake Worth, but in Biscayne Bay there are beds which can probably be made to produce a fair yield. Below Biscayne Bay no oysters of commercial value are known until Charlotte Harbor is reached, on the west coast. It should be stated, however, that this portion of the coast has never been systematically examined for the purpose of locating any oyster beds that may exist. It is not at all improbable that such an examination would show the existence in that region of oyster-grounds of some value.

The most southern beds of importance on the west coast are located at the mouth of Manatee River, in Sarasota Bay, and at Cape Haze, in Charlotte Harbor. Besides these, there are other small beds at various places along this coast which are worked to some extent. The supply from all these beds is said to be steadily decreasing, and it is the general opinion that unless something is done to protect the beds they will soon become entirely depleted. Some years ago Tampa drew its supply principally from Old Tampa Bay, but the beds at that place became entirely depleted and have not been worked at all for the last few years. Some attempts have been made at planting oysters about the mouth of the Manatee River, but, owing to the absence of any protection from the State, the matter was not gone into very extensively.

There are some native oysters about the mouth of Anclote River, and Mr. H. A. Smeltz, of Tarpon Springs, has done something toward improving and increasing the supply. Mr. Smeltz's experiments were carried on between the Pithlachascootie and Anclote rivers, whose mouths are about 5 miles apart. In 1892 he planted several bushels of Chesapeake Bay oysters, scattering them among the native oysters. To facilitate the fixation of spat, he drove a number of stakes at different places on and about the beds. These stakes were of yellow pine, cedar, and palmetto, one inch thick and of various widths, and were placed upright, generally on mud bottom. About 400 stakes were set at various times from April to July, 1893. Those set in May and June collected the largest number of spat; about equal numbers were collected by those put down in April and July, but considerably less than by those set out in May and June. Spat collected upon these stakes in April grew to good-sized edible oysters by the February following.

Besides making the small plant of Chesapeake Bay oysters, Mr. Smeltz transplanted to his grounds the native oyster from several different places along the Florida coast, and was surprised to find that the seed oysters from the Chesapeake proved the more hardy. The topography of the beds with which Mr. Smeltz has been experimenting, as well as the salinity of the water, seem quite favorable, and with proper protection these grounds would be very productive. Stealing oysters from the beds has been of such frequent occurrence that Mr. Smeltz has practically discontinued his attempts to improve the beds.

Small beds of native oysters are found at various places on this part of the coast. They were at one time very extensive beds, but are now practically depleted. The oysters are said to have been of good shape and excellent quality.

The next beds above Anclote Keys are about the mouth of Crystal River, some 40 miles up the coast. These beds are not of great extent, but have long been noted for the good quality of their oysters. They have been worked so assiduously during the last few years that they are said to be showing signs of depletion. They are worked chiefly by people living at the towns of Crystal River and Homosassa.

On the coast of Levy County oyster beds of considerable importance are found. The best are said to be in No. 4 Channel, between Cedar and Derrick keys, connecting Wacassassee and Suwanee bays; on Pelican Reef Bar, which runs from just above No. 4 Bar up Suwanee Bay about 2½ miles; on Fishbone Bar, which extends from the north side of Suwanee River up the coast several miles; on Corrigan Reef, which runs for 4 miles south of Cedar Key, and on the Wacassassee Bar, near the mouth of the river of the same name. The best of all of these are the beds in No. 4 Channel.

These beds have been very productive, but all agree that the demand made upon them has been too great and that it is now much more difficult to obtain a boat load than formerly. Attempts have been made at transplanting by Mr. William H. Anderson, of Cedar Keys, and the results were very satisfactory until stealing the oysters from his bar became too frequent. The laws of the State do not afford adequate protection to those who strive to increase the natural output of the beds, and all who have experimented in that line have become discouraged and given up the matter. The recent severe freezes and the great storm of September, 1896, also did much toward destroying the oyster beds of this region.

There are a few small beds in what is known as Spring Creek Bay, near Shell Point, in Wakulla County, but they have not as yet been much worked. Small beds near Carrabelle are fished to some extent.

Perhaps the most important, as well as the most extensive, oyster-grounds on the Florida coast are those in Apalachicola Bay and vicinity. These grounds have recently been carefully surveyed by the U. S. Fish Commission steamer *Fish Hawk*, and are the subject of a special report.* The most important beds are said to be on Sneeds, Peters, Bulkhead, East Hole, Porter, North Lump, Greenpoint, and Lilly bars.

The general opinion among those consulted is that the supply of oysters in this region is steadily decreasing, yet there are those who deny that any considerable decrease has occurred. The causes of the decrease are several, among which may be mentioned freezes, severe storms, and the method of fishing. Many of the oyster beds are said to be out of water at extreme low tide, and a severe freeze occurring at that time kills the oysters. Recent storms swept many oysters off the beds on to mud bottom, where they smothered.

It was found that most of the dealers, as well as the oystermen, are in favor of the State leasing the beds to those who desire them. By this means they believe that the yield can be greatly increased.

Valuable oyster-grounds exist along the coast west of Apalachicola, the most extensive being in St. Andrews, Escambia, East, and Perdido bays. Considerable quantities of oysters are taken in St. Andrews Bay, but owing to their very thin shells they can not be shipped to distant points, and most of them are consequently used locally or at Pensacola. No particular change in the condition of these beds has occurred. The important oyster-grounds in the vicinity of Pensacola have suffered greatly from natural causes. The principal beds were almost wholly destroyed in July, 1896, by a storm which swept some of the reefs clean and flooded others with mud; an accompanying freshet did further damage to the surviving oysters. The demand in this section is in excess of the natural supply, and the planting of oysters has been carried on, although to only a limited extent. This business would doubtless develop much more rapidly if the planters

*Report of a survey of the oyster regions of St. Vincent Sound, Apalachicola Bay, and St. George Sound, Florida. By Lieut. Franklin Swift, U. S. N. (Report United States Fish Commission, 1896, pp. 187–221.)

were protected in their rights. The depredations of poachers, combined with losses incurred from storms, have greatly hampered the plan of increasing the supply by cultivation, and the tendency is to abandon the business unless ample protection is afforded.

FISHES.

During the conduct of the investigations covered by this report the food-fishes of the principal fishing centers of Florida were studied, with the object of determining the food-fishes of the different sections, the relative abundance, distribution, spawning habits, food, and enemies of each. Information was sought regarding the present abundance, size, and condition of the various species as compared with former years. The chief inquiries were made in Indian River, Lake Worth, Biscayne Bay, at Key West, Tampa, and Tarpon Springs.

As regards the number of species of fishes handled by the fishermen, Key West is by far the most important fishing center in Florida. This is due to the fact that in the waters about Key West are found more species of fishes which are used for food than can be found at any other single locality in the United States. If to the food-fishes of Key West are added all the other species found there, a list of more than 225 species known from that region is obtained. The species which are used as food are not fewer than 100 in number.

The investigations indicate that there has been no serious decrease in the abundance of any of the food-fishes of this region. The methods are calculated to conserve the fisheries to the fullest extent. Few fishes are lost for want of a market. Only such as are thought salable are brought into market, and there they are kept alive until they are sold. So long as these methods continue, no serious diminution is likely to occur with any of the numerous food-fishes of Key West.

The more important food-fishes of Key West are briefly discussed in the following pages. The different species are considered by groups approximately in the order of their commercial value. The common names given are those in use among the Key West fishermen. The Spanish names in use among the Cuban fishermen of Key West are given in many cases.

1. **Grunt, Common Grunt, White Grunt, or Ronco,** *Hæmulon plumieri* (Lacépède). The most abundant of all the Key West food-fishes, and caught all the year round, the best season being during the fall. Their spawning season is during August and September, at which time they gather up into schools on shoal, feathery, rock bottom, where they spawn. Each roe is from 1 to 2 inches in length. The eggs are said to be "gritty" to the touch and about the size of a No. 10 shot. When ripe they separate and flow freely from the fish. When done spawning the schools break up and the fish scatter. They are so abundant, however, that they can usually be found in large numbers anywhere on suitable bottom. The best fishing is always on rock bottom, Crawfish Bar being one of the best grounds.

   These fish grow to about 18 inches in length and a maximum weight of 4 pounds. They are not often seen, however, weighing more than 2 pounds, and the average weight does not exceed one-third of a pound.

2. **Yellow Grunt or Ronco Amarillo,** *Hæmulon sciurus* (Shaw). Less common than the preceding species, but very plentiful. Found in schools on rock bottom. One fisherman reports that he has often caught 500 to 600 in a single day. It is most common in summer; cold is said to affect it seriously. The best fishing for this species is in August. The best bait is a long worm which the fishermen get from the stem of a tall grass which grows on the bars. The yellow grunt reaches a weight of 1 pound or less. Nothing could be learned concerning its spawning habits, except that it probably spawns in August.
3. **Margate-fish,** *Hæmulon album* Cuvier & Valenciennes. The origin of the common name of this fish is not generally understood. It appears, however, to have been derived from Margate, a seaport and watering-place in Kent, England, situated on the Isle of Thanet, 64 miles east by south of London. Some of the fishermen of the Bahamas came originally from Margate and applied the name to one of the fishes which they found in the Bahamas. Many of the Bahama fishermen (Conchs) have come to Key West and brought the name with them. The name Margate is, at Key West, sometimes corrupted into "Margat" and "Margaret," while in Biscayne Bay it is "Margat," "Market," or "Margarite." The Margate-fish is a common and important species at Key West. It reaches a weight of 8 or 10 pounds, the average being about 4 to 6 pounds. It is found in deeper water than the preceding species, and is said to be most abundant on the reef. It spawns early in the summer, probably in July, on rock bottom, at which time it is said to school. One intelligent fisherman says, however, that it does not school at Key West, though it does at the Bahamas. It is generally found on rock or barry bottom, around shoals. At night it comes into more shallow water to feed, crabs, crawfish, worms, etc., constituting the bulk of its food. The bait used for it is crawfish or crabs. Cold is said not to affect this fish to any great extent.
4. **Sailor's Choice,** *Hæmulon parra* (Desmarest). This species, which is not the sailor's choice (*Lagodon rhomboides*) of the south Atlantic coast, is abundant about Key West. It collects into schools in July and August, at which time it spawns on rocky bottom. It reaches a weight of 2 pounds, the average being about half a pound. The best fishing for this species is in summer.
5. **French Grunt,** *Hæmulon flavolineatum* (Desmarest). Not uncommon, but nothing of importance was learned regarding it.
6. **Tom-tate,** *Bathystoma rimator* (Jordan & Swain). Said to be common. Only a few examples noticed, and nothing was learned of its habits.
7. **Porkfish,** *Anisotremus virginicus* (Linnæus). Common about Key West. It schools from June to August, which is the spawning season; found then about the shoals, but soon retires to deeper water. It spawns all through the channel about the shoals, and is then caught in greatest numbers. About a month after the spawning season immense numbers of young are seen on the shoals. This fish reaches a length of about a foot and a weight of 2 pounds. The average weight of those brought to market probably does not exceed one-third of a pound.
8. **Saucer-eyed Porgy,** *Calamus calamus* (Cuvier & Valenciennes). Common. The average weight is about half a pound, the maximum being about a pound. The principal fishing season for this species is in the winter, but it is taken throughout the year. Nothing was learned of its spawning habits.
9. **Little-head Porgy,** *Calamus proridens* Jordan & Gilbert. This species is found with the saucer-eye and is equally common. It reaches a weight of 2 pounds, the average being about half a pound.
10. **Sheepshead Porgy,** *Calamus penna* (Cuvier & Valenciennes). Common with the preceding, reaching a weight of 4 pounds, the average being about a pound. It is most abundant in winter.

11. **Grass Porgy,** *Calamus arctifrons* Goode & Bean. This species is also common about Key West. While all the other species of this genus are usually found on rock bottom, this is most abundant on grassy bottom, as its common name indicates. It seldom exceeds 2 pounds in weight, averaging not over half a pound.

12. **Jolt-head Porgy, or Bajonado,** *Calamus bajonado* (Bloch & Schneider). This is the most important of all the species of Key West porgies. It reaches a weight of 8 or 10 pounds, and an average of 5 or 6 pounds on the reef, but smaller in the "bay."* Its maximum length is about 2 feet. It frequents smooth, rock bottom, upon which it spawns in July and August. It is found throughout the year. At Miami the name of this fish is by some corrupted to "juffle-head porgy."

13. **Bream,** *Lagodon rhomboides* (Linnæus). A common, small pan-fish.

14. **Bream,** *Archosargus unimaculatus* (Bloch). Less common than the preceding.

15. **Chub,** *Kyphosus sectatrix* (Linnæus). Not widely distributed about Key West, but very abundant in certain places. It is found all the year round about the shoals in the channels, and is said to school in the summer. It attains a weight of 9 pounds, with an average of 3 or 4 pounds. It is one of the gamiest fishes of Key West and is well worth the angler's attention.

16. **Rock Hind,** *Epinephelus adscensionis* (Osbeck). Said to be very common on rocky elevations in deep water. It reaches a maximum weight of 15 or 16 pounds, but the average of those brought in does not exceed 2 or 3 pounds. It will take any kind of bait, and probably spawns in the fall.

17. **Nassau Grouper,** *Epinephelus striatus* (Bloch). Common; reaches a weight of 50 pounds or more, but those brought to the market seldom exceed 10 pounds. They are found all the year round and are said not to school.

18. **Red Grouper,** *Epinephelus morio* (Cuvier & Valenciennes). One of the important food-fishes of Key West. Found at all times, chiefly on rock bottom and about the reef. They are said not to school. The maximum weight is 20 to 25 pounds, the average from 8 to 15 pounds. They spawn in March among the rocks. They are voracious and will take any kind of bait.

19. **Black Grouper,** *Garrupa nigrita* (Holbrook). This large grouper is not uncommon about Key West. It reaches a weight of 400 or 500 pounds.

20. **Jewfish,** *Promicrops guttatus* (Linnæus). This is one of the largest fishes of this region. The weight of those caught usually runs from 100 to 250 pounds, though the maximum is as great as 400 or 500 pounds. Those weighing more than 250 pounds do not sell well, as they are said to be too coarse and dry, without much fat. These fish are common in summer in rather shallow water about rocky shoals, old wrecks, and the like. Cold weather seems to drive them away into deeper water. They probably spawn in August, when they collect into schools and go to some place with rough, rocky bottom. One spawning-ground is said to be located in the channel about 1 mile from the fort. They feed upon crabs, crawfish, and fish. One example, weighing about 250 pounds, was seen.

21. **Yellow-fin Grouper,** *Myctoperca venenosa* (Linnæus). This grouper is not uncommon and is a good food-fish. Its maximum weight is about 20 pounds, the average about 6 pounds. It is present throughout the year.

22. **Scamp,** *Myctoperca falcata phenax* Jordan & Swain. Common throughout the year; most abundant on the reef. It reaches a weight of 10 or 12 pounds, averaging about 2 or 3 pounds. Nothing was learned of its spawning habits.

23. **Gag,** *Mycteroperca microlepis* (Goode & Bean). Common; reaches a weight of 10 pounds or more, the average being about 2 pounds. It is found at all times, and is a good food-fish.

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* At Key West the fishing grounds of that portion of the Gulf of Mexico adjacent to the Florida coast are called "the bay."

24. **Gray Snapper,** *Neomænis griseus* (Linnæus). This is the most abundant species of snapper found at Key West. A warm-water fish, found most abundantly in shallow water during the summer, retiring to deeper water during the winter. They always run in schools. They reach a length of 3 feet and a weight of 18 pounds, though the usual weight is 5 pounds or less. They spawn in July and August, usually on the shoals. The eggs are not adhesive, but separate from each other at spawning. Sardines and pilchards are the bait used for catching this fish. One of the best fishing-grounds is in Jack Channel, northwest from Key West.

25. **Dog Snapper,** *Neomænis jocu* (Bloch & Schneider). Not very common. Reaches a weight of 20 pounds, the average being very much less. It is found most frequently in the fall and winter.

26. **Schoolmaster,** *Neomænis apoda* (Walbaum). This fish is rather scarce at Key West. The maximum size is said to be 7 or 8 pounds, the average 3 pounds for those caught on the reef, or one third of a pound for those from the "bay."

27. **Mutton-fish or Pargo,** *Neomænis analis* (Cuvier & Valenciennes). One of the abundant and most valued food-fishes of Key West. They occasionally reach a weight of 25 pounds, but 15 to 18 pounds is as large as they usually get; the average is probably not over 5 pounds. They are found on rock bottom in 3 to 9 fathoms and are very gamy, taking the hook promptly and and fighting well. Found throughout the year, but scarcest in July and August, which is the spawning season. They school at spawning time. The eggs are nonadhesive and are about the size of a rice grain.

28. **Lane Snapper,** *Neomænis synagris* (Linnæus). Abundant about Key West, reaching a weight of 4 pounds, the average being about half a pound. The best season for catching this species is during the winter. The spawning time is said to be in October, at which time they gather in schools.

29. **Yellow-tail or Rabirubia,** *Ocyurus chrysurus* (Bloch). Even more abundant than the lane snapper, and the principal fish served at the Key West hotels and boarding houses in the fall. Plentiful throughout the year, except during winter, when the cold drives them away. During the warmer weather they are found at depths of 2 fathoms and over; the best depth is 5 fathoms. Generally found around shoals where there is some mud bottom. July is the principal spawning season, when they are found about the reef all the way from Miami to the Tortugas. The yellow-tails are quite gamy. They are caught with sardine bait. They reach a length of 2 feet and a weight of 3 or 4 pounds or more. The average weight of those seen in the Key West market is not over a pound.

30. **Hogfish,** *Lachnolaimus maximus* (Walbaum). One of the common food-fishes, reaching a weight of 10 pounds, or an average of about 3 pounds. Found all the year round.

31. **Kingfish or Cero,** *Scomberomorus cavalla* (Cuvier). This is, next to the grunt, the most important of the Key West food-fishes. Its flesh is firm and of excellent flavor. It usually appears in large numbers from November until April, when it is caught by trolling. The usual weight is about 10 pounds, sometimes reaching 50 pounds. The largest of which there is any record dressed 52 pounds. Examples weighing 40 pounds are not unusual. Said to school at spawning time, which is believed to be late in the winter.

According to Mr. William H. Abbott, who studied the fisheries in 1891, the average weight of kingfish, as caught by the fishermen of Key West, is about 6 pounds. The larger fish, weighing from 15 pounds upward, are never as abundant as those weighing under 15. When the fisherman desires to catch large kingfish, he directs his course to the inshore grounds, lying in about 3 fathoms of water and from 1½ to 3 miles from shore, where the water is muddy; and when small ones are desired, the fishing is done farther offshore along the edge of the Gulf Stream, where the water is much clearer.

They are almost invariably found in two separate schools. The spawning grounds of the kingfish are "down the bay." The first of the winter a great many of the fish have large roes, but it is very seldom that one is taken that has a roe fully matured. If the weather has been very cold in the bay early in the fall, the kingfish will leave before they have spawned, and it is during such seasons that fish containing ripe spawn are most frequently taken.

32. **Spanish Mackerel,** *Scomberomorus regalis* (Bloch) and *Scomberomorus maculatus* (Mitchill). Both of these species occur at Key West, but are not distinguished by the fishermen. The former is probably the more abundant. They are both taken by trolling in the winter. The maximum size is said to be 12 pounds, the average about 3 pounds.

33. **Amber Jack or Amberfish,** *Seriola lalandi* Cuvier & Valenciennes. Not uncommon in the winter and an important fish. Maximum size 80 pounds or more, average about 35 pounds. Caught chiefly by trolling.

34. **Almicore or "Almaco,"** *Seriola dumerili* (Risso). Perhaps scarcely as common as the preceding. Maximum size 25 pounds, average 8 pounds. Taken in the winter by trolling.

35. **Jack,** *Caranx hippos* (Linnæus). Common in winter. Reaches a weight of 3 or 4 pounds. It is taken either by trolling or bottom fishing.

36. **Runner,** *Caranx crysos* (Mitchill). Common in winter with the preceding and caught in same way.

37. **Horse-eye Jack,** *Caranx latus* Agassiz. Perhaps more common than either of the two preceding species. Goes in schools and is taken by trolling.

38. **Moonfish,** *Selene vomer* (Linnæus). Not uncommon in winter. Reaches a weight of 2 pounds and is regarded as an excellent fish. The average weight is a half pound or less.

39. **Pompano,** *Trachinotus carolinus* (Linnæus). The pompano is taken about Key West only in winter, when the cold weather drives it south. It reaches a weight here of about 5 pounds, the average being about $1\frac{1}{2}$ pounds. It is taken by hook and line and is, of course, regarded as an excellent food-fish.

40. **Permit,** *Trachinotus goodei* Jordan & Evermann. This species is not very common at Key West. It reaches a weight of 40 pounds, the average being about 8 pounds. It is taken in the winter both by hook and line and seine. The "permit" of Indian River is *Trachinotus falcatus*, a different species.

41. **Bluefish,** *Pomatomus saltatrix* (Linnæus). The bluefish is not common at Key West. It is taken by trolling. The maximum size is 6 pounds, the average about 3 pounds.

42. **Black Angel,** *Pomacanthus arcuatus* (Linnæus). Not uncommon. Reaches a weight of 6 pounds, or an average of 2 pounds. Found throughout the year.

43. **Yellow Angel,** *Angelichthys ciliaris* (Linnæus). Perhaps more common than the preceding. Reaches about the same size.

44. **Tang,** *Teuthis hepatus* Linnæus. Not uncommon. Reaches a weight of 2 pounds. This and two other species of tang (blue tang, *Teuthis cœruleus*, and the ocean tang, *Teuthis bahianus*) are often taken with the "grain" or in traps.

45. **Common Mullet or Callifavor Mullet,** *Mugil cephalus* Linnæus. This is the most abundant and most important mullet found at Key West. Others are the blueback or white mullet (*Mugil curema*) and the fantail mullet (*Mugil trichodon*). A fourth species, known as the red-eye mullet (*Mugil gaimardianus*), also occurs there, but not in abundance. The mullets are most common at Key West in the winter, when considerable quantities are taken. They are far less abundant here, however, than on either coast of the mainland.

There are many other species of fishes found at Key West which are used to a greater or less extent as food. Among them are the bonefish (*Albula vulpes*), tenpounder (*Elops saurus*), barracuda (*Sphyræna barra-

cuda), wahoo (*Acanthocybium solandri*), bonito (*Gymnosarda alleterata*), whiting (*Orthopristis chrysopterus*), and many others of less importance.

The fishes of Biscayne Bay are not very different from those of Key West. The chief difference lies in the fewer species at Biscayne Bay; many of the species used as food at Key West are either entirely absent or quite rare at Biscayne Bay. Commercial fishing in Biscayne Bay and vicinity has only recently begun, and it is improbable that overfishing will occur for some years yet. The fishes of the bay are considered in a report recently published by the Commission. The development of the fisheries of Lake Worth has only recently begun. The species there are essentially the same as those of Indian River, which have been discussed in the special report to the Senate already referred to.

The most prominent fish on the Florida coast between Key West and Pensacola is the mullet, which exists in incredible numbers and is taken in enormous quantities. Tampa is the principal receiving center for mullet on the west coast, and a large part of the mullet taken in the counties of Lee, De Soto, Manatee, and Hillsboro pass through the hands of Tampa dealers, together with large catches of other species.

The results of the methods here are far from satisfactory. During one day in November, 1896, several thousand mullet were seen at Tampa, which had been thrown away because they were too badly spoiled for shipping. From the most reliable data obtainable, it is estimated that the annual loss of mullet on the west coast of Florida amounts to about 500,000 pounds. This loss is due to two principal causes, (1) adverse winds, preventing collecting vessels from returning promptly from the fishing-camps, and (2) the failure to supply the vessels with sufficient ice. Such waste is unfortunate and in large part unnecessary. Other species suffer in the same way to some extent, but the great loss is with the mullet.

Other prominent shallow-water fishes of the west coast are sheepshead, redfish, squeteague, Spanish mackerel, pompano, bluefish, ladyfish, and crevallé. These are generally distributed and abundant, and are represented in the catch at most of the fishing centers. The offshore fishing-grounds yield red snappers (*Neomænis aya*) and groupers (*Epinephelus morio*) in largest quantities. The fishery, which is centered at Pensacola, is prosecuted chiefly on the "snapper banks" in the Gulf of Mexico, although some fishing is done near shore and about the keys. The abundance of groupers is far in excess of the present demands, but the red snappers seem to be decreasing in numbers and fishing has to be done at greater distances from the land than formerly in order to produce satisfactory results. The abundance of the species is specially referred to in the chapter on the Pensacola fisheries. The red snapper is one of the most highly prized of the Florida fishes and ranks next to mullet in commercial value. It attains a weight of 40 pounds, but the average weight is not over 10 pounds.

REPTILES.

The most valuable reptiles of the United States are represented in the waters of Florida, and some of these occur there in greater abundance and are commercially more important than in any other State. The most prominent resources of this class are the alligator, diamond-back and other terrapins, and three species of very large turtles. The last named are the only important reptiles in the coastal waters and their annual value exceeds that of all the other products of this group.

The green turtle (*Chelonia mydas*), the most highly esteemed of the marine turtles, is found on the Atlantic seaboard from Long Island to Brazil, and hence along the entire length of the Florida coast, where it is especially common among the Florida keys. Overfishing and the destruction of its eggs have greatly reduced its abundance in this State, and the annual catch is now much less than formerly.

The green turtle breeds on the coast of Florida from April to July, during which time the female seeks the sandy shores of keys or the mainland in remote situations. She arrives at night, and with her flippers digs a hole 1 or 2 feet deep in the sand, above high-water mark, in which she proceeds to lay her eggs, numbering between 100 and 200. The turtle then scoops the sand back over the eggs, smoothes the surface to effect concealment, and rapidly retreats to the water, leaving the eggs to hatch without further attention. The hatching occurs in a few weeks, and the young make their way to the water; many, however, fall a prey to carnivorous birds and perhaps other animals. The turtle returns two or three times to the same spot during the season, each time depositing the number of eggs stated, so that the total number of eggs laid by a full-grown turtle in a year is from 300 to 600. The green turtle attains an immense size. Examples weighing 600, 800, and even 1,000 pounds have been taken in Florida waters, although such large individuals are very rare and the average weight in recent years is probably under 150 pounds. In some parts of the State, where fishing has been excessive, the average weight is much less than formerly; for example, on the east coast it is under 50 pounds.

The loggerhead turtle (*Thalassochelys caretta*) occurs along the Atlantic coast from Virginia to Brazil, and is common on both the east and west coasts of Florida, although much less numerous than formerly. It is the least valuable of the marine turtles, and there is little demand for its flesh as food, although more eggs of this species are taken than any other. It reaches an immense weight, surpassing the green turtle in this respect. The maximum weight is 1,500 or 1,600 pounds, but the average weight in Florida is not much more than 200 pounds, although occasional examples weighing 600 pounds are taken. According to Mr. H. A. Smeltz, of Tarpon Springs, loggerhead turtles were very abundant some years ago in the vicinity of Stump Pass, De Soto County, where he made some interesting observations of their habits when they came ashore to lay their eggs at night during the full moon in June. The female turtle proceeds some distance from the water, and without turning around scoops out a hole in the sand, using first one flipper and then another. Then, with the posterior part of the body over the excavation, the turtle begins laying the eggs. The latter are extruded in lots of 3, 4, or 5 at a time, with short intermissions between the lots until the process is completed. The total number of eggs in each of 7 nests examined ranged from 80 to 115. When the full complement has been laid the turtle returns to the water, after carefully covering the eggs with sand. While engaged in laying, nothing can disturb the turtle or drive her away. Striking her with a stick or jumping up and down on her back apparently produced no effect on her.

It has been supposed by some that the turtle returns to the nest at the time the eggs are hatching in order to head the young to the water, but it seems probable that this view is not correct. It is true that the turtle returns in about three weeks, but this is for the purpose of laying more eggs, and this is repeated from four to six times during the season, so that as many as 700 eggs may be deposited by one animal. The eggs are thought to hatch in about three weeks, and the young would therefore appear at about the time the turtle returned for the next laying.

The hawksbill or tortoise-shell turtle (*Eretmochelys imbricata*) is found on the southern coasts of Florida, and thence to the West Indies, the Bermudas, and South America. The flesh is eaten to a slight extent, although it is not highly regarded, and the eggs are also gathered for food and for the manufacture of oil; but the great value of this turtle is in its horny covering, which is the tortoise shell of commerce.

The hawksbill turtle attains a smaller size than either the green or the loggerhead turtle, but large individuals are sometimes taken, and the maximum weight is probably over 400 pounds; on the Florida coast those with a greater weight than 100 pounds are not common. The shell of the smaller turtles is thin and of little use, but it increases in thickness and value with the size of the turtle.

CRUSTACEANS.

The crustacean resources of Florida include shrimp, crabs, and the spiny lobster or crawfish.

At least two species of shrimps (*Penæus setiferus* and *P. brasiliensis*) are taken in the Florida fisheries, but the fishery is not important and the abundance and distribution of these animals are not known. In the coastal States, both to the north and west of Florida, shrimps are commercially valuable.

The stone crab (*Menippe mercenarius*) is found along the southern coast from Charleston to Key West and along the entire west coast of Florida. It lives in holes in the mud in estuaries and also in crevices in rocks. On the west coast of Florida it is found in cavities in rocks and in deep holes which it excavates in the sand. It attains a large size, adults often measuring 7 or 8 inches across the shell. People living along the coast esteem it highly as an article of food, and considerable quantities are taken for sale and local consumption.

The common blue crab (*Callinectes hastatus*) is distributed along the entire coast of Florida in the bays and estuaries, and often in fresh-water rivers and lakes having close connection with the salt water. It lives in the shoal waters during the warmer months, but retires to deep water on the approach of cold weather. The period of spawning and shedding extends over several months, possibly the entire summer, for some individuals are found carrying spawn and others in a soft state during the whole season. While shedding its shell and until the new shell has become sufficiently hard to protect it, the crab remains hidden in the mud or among the seaweeds. The average size of the blue crab is about 6 inches across the shell. It is so generally abundant that people can, in most places, obtain all they desire without much trouble, and it has therefore given rise to no special fishery.

The spiny lobster (*Panulirus americanus*) is very abundant at Key West and generally among the Florida keys, where it lives on the bottom, concealed among the coral. It attains a length of more than a foot and has excellent food qualities, resembling in flavor the common lobster. It is at this time of commercial importance only at Key West, where large quantities are taken annually for food and for bait in the line fisheries.

FISHERIES OF THE NORTHEAST COAST.

That section of the Florida coast north of Indian River, comprising parts of the counties of Volusia, St. Johns, Duval, and Nassau, and containing the important cities of St. Augustine, Jacksonville, and Fernandina, has valuable salt-water fishery resources and interests. It was not feasible to canvass this section in the recent investigations of the Florida coast fisheries, but it is possible to make a statement of the nature and general extent of the fisheries based on inquiries conducted in 1891.

The most important fishery product of this section is the oyster, which is taken in all the counties named, but is most valuable in Nassau County, in which there is a large oyster fishery and canning business centering at Fernandina. The mullet is the most prominent of the fishes, the catch in Duval County being larger than in the other three counties combined. Other fishes of this region of noteworthy commercial importance are squeteague, channel bass, and sheepshead. Turtles, terrapins, shrimps, crabs, and clams are taken in small quantities. The principal part of the fish caught are taken in gill nets and seines, although cast nets, lines, and pound nets are also used.

In 1890 the fishing industry of this section gave employment to 493 fishermen and 150 shoresmen. The vessels and boats used numbered 329, with a value of $11,655. The apparatus of capture was valued at

$9,250, and the shore property and cash capital at $34,340, making a total investment of $55,245. The quantity of products taken was over 2,000,000 pounds, valued at $49,585, the species being represented as follows: Channel bass, 129,955 pounds, $4,201; mullet, 796,567 pounds, $12,473; sheepshead, 87,500 pounds, $2,761; squeteague, 180,049 pounds, $6,235; other fish, 183,764 pounds, $5,543; oysters, 93,350 bushels, $13,300; turtles and terrapins, 19,350 pounds, $2,150; shrimp, 62,625 pounds, $2,397; and other products having a value of $525.

FISHERIES OF INDIAN RIVER.

Previous report on this river.—The resources and fisheries of the Indian River have been considered in a special report submitted to the Senate on January 5, 1897, pursuant to a clause of the act making appropriations for sundry civil expenses of the Government for 1896, requiring "the Commissioner of Fisheries to make special investigation as to the extermination of migratory fishes of the Indian River of Florida." This report appears to render unnecessary at this time an extended account of the fisheries of this region. The examination of the river was made in January and February, 1896, by a party from this Commission, and the following information is abstracted from the report based on that inquiry.

Development of the fisheries.—The fisheries of this region have attained considerable prominence within a comparatively few years, and in 1895 contributed several million pounds of food-fish to the public markets. The business of taking green turtles antedates the civil war, but the fisheries proper did not begin until 1878, when a Connecticut vessel visited one of the inlets and caught fish for the Savannah market. It was not until 1886, however, after the river had been brought into railroad communication with Jacksonville, that the fisheries became regularly established. Prior to that time the river was almost inaccessible except by water; the surrounding country was very sparsely settled, and the very valuable fishery resources remained latent.

In 1885 an oyster business was started at Titusville at the head of the river, and in the following year a fishery was inaugurated at that place. The building of a second railroad to Titusville and its extension along the entire length of the river in 1893–1895, resulted in the establishment of new fishing stations farther and farther south, and led to a great increase in the industry. In 1895 there were 19 firms engaged in the fisheries of the river. These were located at Titusville, Cocoa, Eau Gallie, Melbourne, Sebastian, Fort Pierce, Eden, Jansen, and Stuart. The places at which the most extensive fishing centered are Fort Pierce, Titusville, Cocoa, and Eden.

As to the further increase of the fisheries of this body of water, the report cited states:

> While the resources are great, the area of fishing-ground is comparatively limited, and the fishing firms realize that the present tendency to over-fishing will result in the ultimate destruction of their business, unless counteracted by the enforcement of certain restrictive laws or adequate artificial propagation.

Fishery resources.—The water animals of this region which are the object of special fisheries are the pompano, mullet, turtle, and oyster. Besides the fishes named, a number of others are caught incidentally and in the aggregate amount to a large quantity. Compared with more southern parts of Florida, the resources of Indian River are not remarkably varied; although a number of fishes, etc., having recognized food qualities, which are now regarded as of little value, will doubtless be utilized in time. Only about 20 species of marketable fishes are prominently represented in the catch of the Indian River fishermen; among these are the bluefish, sheepshead, trout or squeteague, redfish or red drum, black drum, whiting, crevalle, sergeant-fish, mangrove snapper, permit, croaker, and Spanish mackerel.

More than half of the quantity of fish taken for market consists of mullet, which is very abundant, but less so than on the west coast of the State. The fish abounds throughout the river, but the principal catch is taken in the upper part. The poor price commanded by the fish has deterred the fisherman of the lower river from taking as many as the conditions warrant.

The pompano is the most highly esteemed fish of the river. It is taken at all seasons, although most plentiful during the fall and winter. After the excessively cold weather of February, 1895, the pompano became very scarce, and up to the end of January, 1896, had not appeared in its former abundance. The catch in 1895 was much less than for a number of years. In the opinion of some of the fishermen, overfishing has led to a decrease in the abundance of pompano, while others regard the present scarcity as largely the result of natural causes.

Such fishes as sheepshead, sea trout, channel bass, snappers, crevalle, black drum, etc., which are locally known as bottom fish, are generally plentiful in all parts of the river and have apparently undergone no diminution in numbers in recent years. The most highly esteemed of the bottom fishes is the sheepshead. In quantity of catch it ranks next to the mullet, and in value it is exceeded only by the mullet and the pompano. Bluefish and Spanish mackerel are ordinarily scarce; at times, however, these fish enter the river in considerable numbers.

The only reptilian product of the Indian River fisheries is the green turtle. It is not common, and in the past two or three years has undergone a noticeable decrease in abundance, while the average weight has also diminished. The turtle is found in the river at all times, but the principal fishing season is between November and March.

Oysters of good size and flavor occur in various parts of Indian River and are one of the principal fishery resources, although they have had comparatively little attention. Their further utilization appears to be one of the chief lines along which the development of the Indian River fisheries will take place.

Crabs are abundant, but are not utilized. These and other crustaceans—such as shrimp—will no doubt in time receive the attention of commercial fishermen.

Indian River originally abounded in alligators, but owing to very active hunting operations during the past ten years they have become very scarce and do not now support an industry.

Fishing apparatus and methods.—Most of the fishing is done with gill nets, which are of two kinds, according to whether they are set for mullet or pompano. A few seines are hauled for bottom fish, large-meshed nets are employed for turtles, and tongs are used for oysters.

Mullet fishing is carried on along the entire length of the river, and is the most important branch of the industry. It is most extensively prosecuted from Titusville, Cocoa, and Fort Pierce. Mullet gill nets are about 250 yards long and 12 to 14 feet deep. The 58 nets used in 1895 had a combined length of 46,800 feet, or about 9 miles. These nets are thrown around the schools of mullet seen jumping at the surface, and the fish become meshed by being frightened after the ends of the net are brought together. The catch consisted of over 1,600,000 pounds, with a market value of about $12,000.

Pompano fishing in 1895 was most extensive at Titusville, Fort Pierce, and Eden. The nets used are 200 or 250 yards long, but a number of nets are often fastened together, forming pieces from 600 to 2,000 yards long. The 163 pompano nets employed in 1895 were 115,500 feet, or nearly 22 miles, long. The mesh is relatively large (5½ to 6 inches), and owing to this fact and the peculiar shape of the pompano the fish are not gilled but are caught by the pectoral and ventral fins, and also by a short spine in front of the dorsal fin. Pompano fishing is done only at night, and preferably when there is no moon. If the fish can see the netting, they will avoid it. The nets are left to drift several hours before being visited. Besides pompano, bluefish, sheepshead, sea trout, redfish, snappers, and crevalle are incidentally taken. The pompano catch in 1895 was only 149,000 pounds, but the value, $9,475, was nearly as much as that of the mullet, which was taken in ten times the quantity.

Turtle fishing is not extensively carried on. It is regularly followed only from Sebastian, Fort Pierce, and Eden, but turtles are incidentally caught in nets at a number of other points on the river. Turtle nets are like gill nets, but have a very large mesh and are constructed of coarse thread. They are from 85 to 115 yards long. Turtles are caught by being entangled in the meshes, some of the nets being fastened to stakes, while others are left to drift freely. In 1895 the number of turtles taken on the river was 519, having a weight of about 18,900 pounds; their value was $1,320. It is apparent from the comparative statistics available that turtle fishing on the Indian River is much less productive than in previous years.

The oyster industry, while not of great importance, is more extensive than any other branch of the fisheries with the exception of the gill-net fishery. It is followed from Titusville, Cocoa, Eau Gallie, and Fort Pierce, the oysters being taken with tongs from natural beds in the vicinity of the places named. The yield in 1895 was a little over 6,000 bushels, with a value of $2,115. Twenty-nine persons were engaged in the business. The conditions seem very favorable for the expansion of the oyster industry, provided cognizance is taken of the methods which in other States have proved satisfactory, namely, the allotment of land for oyster cultivation, the spreading of oysters on prepared grounds, the planting of seed and cultch, etc.

Statistics of the fisheries.—In 1895 the fisheries of Indian River gave employment to 254 persons. These were distributed as follows among the different branches:

How engaged.	Number.
General fisheries	172
Oyster fishery	29
Turtle fishery	12
Preparing products	41
Total	254

The capital invested in the Indian River fisheries in 1895 was $41,512, representing vessels, boats, apparatus, and shore property, as follows:

Item.	Number.	Value.
Vessels	2	$1,400
Boats	106	5,390
Gill nets	221	7,400
Turtle nets	66	660
Seines	2	265
Tongs	26	182
Shore and accessory property	....	16,115
Cash capital	....	10,100
Total	....	41,512

The aggregate quantity of fishery products of the Indian River in 1895 was 2,659,815 pounds, having a value of $37,657. The catch was made up as follows:

Species.	Pounds.	Value.
Black drum	10,900	$140
Bluefish	33,086	703
Channel bass or red drum	142,400	2,115
Crevallé	14,700	184
Flounders	9,000	136
Mangrove snapper	76,900	1,137
Mullet, fresh	1,585,869	11,501
Mullet, salted	25,000	750
Pompano	149,111	9,475
Sailor's choice	11,560	157
Sheepshead	301,141	4,445
Spanish mackerel	1,100	66
Trout	200,735	2,872
Whiting	25,800	375
Other fish	11,516	166
Turtles	*18,909	1,320
Oysters (meats)	†42,588	2,115
Total	2,659,815	37,657

*519 in number. †6,084 bushels.

FISHERIES OF LAKE WORTH.

Origin and development.—Although turtle fishing has been prosecuted in this so-called lake for a number of years, the fisheries owe their origin to the extension of the railroad to this section from the Indian River in 1894 and the opening of large hotels in the winter of 1894–95. Lake Worth is a shallow arm of the sea, 22 miles long and from ½ to 1¼ miles wide; 4½ miles from its northern end it is connected with the ocean by a narrow inlet. The lake has been a somewhat important fishing-ground for net and seine fishermen, and the adjacent ocean has also been resorted to by line fishermen. Fish are very abundant throughout the lake at times, but it is not yet known whether the supply in such a shallow and narrow body of water will permit the expansion of the industry or even continue to support the fisheries in their present extent.

Fishery resources.—Among the principal fish which enter Lake Worth and which are taken by the fishermen are sheepshead, bluefish, pompano, Spanish mackerel, mangrove snapper, groupers, redfish, spotted squeteague, sailor's choice, and croaker. The tarpon and many species having no commercial value at present also frequent the lake. The pompano, bluefish, and Spanish mackerel are the most highly prized of the fishes. These come in from the ocean in December and remain three or four months; by April most of them have returned to the ocean. Since the building of a railroad bridge across Lake Worth at West Palmbeach (at about the middle of the length of the lake), it is reported that the pompano is not found in the southern part, which formerly had some of the best fishing-grounds. The other fishes are in the lake in more or less abundance at all seasons. The green turtle is found in limited numbers and of small size, 25 pounds being the average weight.

The principal fishes obtained in ocean fishing off Lake Worth are sheepshead, Spanish mackerel, kingfish, redfish, groupers, bluefish, red snapper, and mutton-fish, all of which are comparatively abundant.

Fishing apparatus, methods, and season.—Within the lake the apparatus used consists of gill nets and haul seines for fish and nets for turtles; in the ocean only hand lines are employed. A small vessel belonging in this section fished for turtles off the Biscayne Bay region in 1895.

The gill-net fishing is mostly done at the northern end of the lake. The nets are about 400 yards long and 30 meshes deep, the size of the mesh being 5¼ to 6 inches. The 4 nets used in 1894 took 24,900 pounds of fish, valued at $857, and the 7 nets in 1895 secured 45,173 pounds, valued at $1,423. The fish taken in largest quantities is the sheepshead, but the most valuable species is the pompano.

The principal seining is done near the ends of the lake and in the small coves that exist along the lake shores, the same fishermen who use seines also operating gill nets. The seines are about 500 yards long, 10 feet deep, and have a 2-inch-stretch mesh. Two seines were used in 1894 and 3 in 1895, chiefly in winter. The most prominent species taken are pompano, sheepshead, and bluefish, in the order named, but a great many others are caught in small quantities. The yield in 1894 was 37,600 pounds, worth $1,036, and in 1895 was 53,680 pounds, valued at $1,604.

The local turtle fishing is not important. Only 126 turtles were taken in 1894 and 153 in 1895. The fishing each year was done by 6 fishermen, who employed 24 nets. The latter are similar to those in the Indian River. They are set at all seasons, being fastened to stakes and visited night and morning. This branch yielded $238 in 1894 and $269 in 1895.

The line fishing in the ocean from Palmbeach is mostly of a semi-professional character, being done chiefly by boatmen engaged in taking out pleasure parties of sportsmen and tourists during the winter months. The catch is largely sheepshead, although bluefish, snappers, mutton-fish, kingfish, groupers, Spanish mackerel, and other species are also taken in considerable quantities. In 1894 this fishery yielded 45,500 pounds, valued at $1,208, and in 1895, 90,852 pounds, worth $2,422.

About two-thirds of the catch is shipped by rail to northern markets, and the remainder is sold locally to hotels, etc. In 1895 about 165 tons of ice were consumed in the preservation of fish prior to and during shipment; this quantity of ice cost the fishermen and dealers $990.

Extent of the fisheries.—The following tables show the extent of the fisheries of the Lake Worth region in 1894 and 1895. In the latter year 70 persons are shown to have been engaged in the industry, $3,965 was invested, and 193,548 pounds of products were taken, having a value of $5,718.

Persons employed.

How engaged.	1894.	1895.
Gill-net and seine fishing	8	14
Turtle fishing	6	6
Line fishing	30	50
Total	44	70

Vessels, boats, apparatus, etc.

Items.	1894.		1895.	
	No.	Value.	No.	Value.
Boats	24	$800	38	$1,250
Gill nets	4	200	7	350
Seines	2	200	3	300
Turtle nets	24	240	24	240
Lines	60	15	100	25
Shore property	....	1,300	....	1,800
Total	....	2,755	....	3,965

Products.

Apparatus.	Species.	1894.		1895.	
		Pounds.	Value.	Pounds.	Value.
Gill nets	Sheepshead	11,700	$176	22,800	$342
	Pompano	8,300	581	12,500	875
	Bluefish	4,400	88	7,873	158
	Spanish mackerel	100	5	500	25
	Mangrove snapper	300	5	900	14
	Redfish	100	2	600	9
		24,900	857	45,173	1,423
Seines	Sheepshead	20,400	306	25,200	378
	Pompano	8,100	567	13,500	945
	Bluefish	5,100	102	6,200	124
	Spanish mackerel	300	15	700	35
	Mangrove snapper	400	6	1,300	20
	Squeteague	500	7	980	15
	Redfish	200	3	400	6
	Grouper	1,100	17	1,900	29
	Croaker	600	9	1,100	16
	Sailor's choice	500	8	1,200	18
	Flounders	400	6	1,200	18
		37,600	1,046	53,680	1,604
Lines	Sheepshead	29,800	447	59,300	889
	Bluefish	4,100	205	8,400	420
	Spanish mackerel	1,000	80	3,100	155
	Grouper	1,700	85	3,252	163
	Kingfish	2,700	135	5,500	275
	Red snapper	1,200	60	2,200	110
	Mutton-fish	2,500	125	5,300	265
	Angel-fish	900	45	2,000	100
	Others	1,000	26	1,800	45
		45,500	1,208	90,852	2,422
Turtle nets	Green turtle	3,407	238	3,843	269
	Grand total	111,407	3,349	193,548	5,718

FISHERIES OF BISCAYNE BAY.

The remoteness from the markets and the absence of shipping facilities for perishable products like fish have retarded the development of the fisheries of this section. The extension of the East Coast Railroad from Lake Worth to Biscayne Bay and the establishment of steamer connections with Key West, which occurred in 1896, will, however, undoubtedly give an impetus to the fishing industry of this region, and it has already led to some expansion of the fish trade. There are a number of reasons why this part of Florida should greatly extend its fisheries in the next few years, now that it is in closer communication with other points of the State.

1. The general food-fish fisheries should increase in order to supply the new demands coming from a larger resident population and from the numerous winter visitors attracted by the salubrious climate of the Biscayne region. The inauguration of a fish trade with northern markets is also to be expected when satisfactory express rates are arranged.

2. Attention will doubtless soon be given to oyster planting and the utilization of the beds already in the bay. The oysters now used are brought from Indian River.

3. The bay should become the regular headquarters of many sponge and turtle vessels operating in the vicinity that now go to Key West

to land, sell, and ship their catch. For many years the bay has been temporarily resorted to by some vessels of this class. Cheaper supplies and more ready communication ought to produce quite an exodus of fishermen from Key West and other remote keys.

The commercial fisheries of this bay have never been important. When this region was visited by a representative of the Fish Commission in 1895, the only economic fishing ascertained to exist during the previous years was a limited business in turtles and line-caught fish, in addition to the sponging done by Key West vessels. By October, 1896, when the region was again visited by employees of the Commission, but few changes had taken place, although there had been a slight increase in the amount of local fishing and in the extent of the retail trade.

The principal fishing in the Biscayne Bay region is for sponges, which are practically all taken by Key West fishermen. Pens for the cleaning and bleaching of sponges have been located at various points around the bay. It is thought that sponge fishing in this section might be profitably undertaken by local fishermen.

The capture of green turtles is the most important fishery in which the people of the bay are engaged. In 1894, when the business was less extensive than formerly and the season very poor, a few boats belonging at Lemon City, Miami, and Cocoanut Grove spent a short time in turtle fishing in Biscayne Bay and on the adjacent reefs. The turtles are taken by means of nets and pegs. About 205 turtles, with an aggregate weight of 6,175 pounds, and with a value of about $708, were caught in the year named, about 175 of these being secured in the bay. Turtles are sent in sailing vessels to Key West, whence they are shipped north. According to the fishermen's testimony, this fishery is much less remunerative than formerly, because of the increasing scarcity of the turtles. The green turtle, which is one of the most valuable of the water resources of Florida, has undergone a noteworthy diminution in abundance in this region within a comparatively few years, and it is generally thought that some protective legislation is necessary in order to preserve it from practical extinction. Mr. Ralph M. Munroe, of Cocoanut Grove, one of the best-informed persons on the bay, states that green turtles are now very scarce, and if their extermination is to be prevented they will have to be artificially propagated if the present indiscriminate methods are continued. Formerly they bred in large numbers in the bights of the keys forming the eastern boundary of the bay and young could frequently be seen. Now but few resort to this place to breed and the supply is practically exhausted.

Loggerhead turtles are comparatively abundant, but there is no regular fishery for them, and they are taken principally for family use. Several hundred, with an average weight of 300 pounds, are taken each year in the spring by people living around the bay. In 1894, however, this species was less plentiful than usual, and only about 100 were secured, against 300 or 400 in previous years. The eggs of this turtle are utilized in large quantities.

No fish are shipped from Biscayne Bay, those caught being sold to meet the local demand. All fishing is done with hand lines at the inlets or on the ocean reefs. Groupers and grunts constitute fully three-fourths of the catch, besides which there are taken porgies, yellow-tails, redfish, kingfish, Spanish mackerel, and numerous other varieties. In 1894 only four men made a business of taking fish for sale, and these caught only 11,000 pounds, valued at $400.

In 1895 some impetus was given to the local fishing by the opening of a canal route between Lake Worth and Biscayne Bay. Eight persons were engaged during a part of the year in taking fish with hand lines and trap nets, and twenty-two others were employed in the turtle fishery. The investment in the fishing industry amounted to $4,798, of which $3,970 represented 2 vessels and 11 boats and $828 the apparatus and accessories. The two vessels referred to were owned on Indian River and Lake Worth, and engaged in turtle fishing off Biscayne Bay in 1895. The aggregate yield of the fish was 86,282 pounds, valued at $2,603. The turtle fishery yielded 425 green and hawksbill turtles and 436 pounds of tortoise shell, the whole having a value of $3,076. The following table shows the quantity and value of each of the principal species:

Species.	Pounds.	Value.
Groupers	14,100	$744
Grunts	16,600	272
Snappers	11,500	733
Mutton-fish	1,500	65
Yellow-tail	3,500	162
Porgies	9,900	217
Porkfish	1,600	14
Sailor's choice	4,300	61
Margate-fish	1,287	92
Kingfish	8,500	119
Hogfish	1,100	45
Turbot	1,115	30
Other fish	1,280	43
Green turtle	30,000	1,505
Hawksbill turtle	25,000	276
Tortoise shell	436	1,295
Total	131,718	5,679

For a detailed description of Biscayne Bay and an extended account of its fishery resources, fisheries, etc., reference is made to an article in the report of the Commissioner of Fish and Fisheries for 1895.

FISHERIES OF KEY WEST.

Importance and principal features.—The commercial fisheries centering at Key West are not only much more important and extensive than those of any other locality in Florida, but are also more valuable than the salt-water fisheries of all the rest of the State. This preeminence, which has been enjoyed for many years, is chiefly due to the rendezvousing of the numerous sponge fleet at this place and the discharging of the cargoes there, although the principal part of the catch is taken far from Key West. The local fisheries are, however, important, and in some features surpass those of any other part of the State; the turtle fishery, the kingfish fishery, and the grunt fishery, for instance, are more extensive than at all other centers combined.

THE SPONGE FISHERY.

Importance.—The sponge fishery is of more importance to the citizens of Key West than any other branch of business. While less extensive than the manufacturing of cigars, it is in most respects more beneficial to the people who have property interests or are regular residents of the city. The outlay for supplies and utensils required by the numerous sponge fleet, amounting to $100 or $200 per vessel each trip, is no inconsiderable factor in the industrial condition of the place, while the large cash sums put in circulation by the sponge-buyers constitute the principal source of ready money for a large proportion of the population.

Apparatus and methods of the sponge fishery.—The sponge fishery at this time presents few new features that need be referred to at length. With one or two exceptions the methods and apparatus are the same that have been employed for many years and have been fully described in reports of the Commission.

The sponge fishery is carried on with vessels of a schooner or sloop rig ranging from 5 to 47 tons (averaging about 13 tons), which resort chiefly to the grounds in the Gulf of Mexico, and with smaller vessels, mostly sloops of less than 5 tons' burden, which make most of the catch on the grounds about the keys of the southern and eastern Florida coasts. The larger vessels carry from 5 to 13 men and the smaller ones from 3 to 5, the number almost always being odd. Two men go in each of the dingies or small boats from which the sponging is done, the odd man of the crew being left in charge of the vessel. The larger vessels have a market value of $500 to $4,500, exclusive of their outfit. The latter consists of boats, fuel, food, cooking utensils, and the sponge apparatus, and is valued at $1,000 to $1,500. The average value of the smaller vessels is about $430, including outfit.

Sponges are taken by means of a 3-toothed hook attached to a long pole. Poles of various lengths are used, to correspond with the different depths of water in which the sponging is done. Before the depletion of the shoaler grounds comparatively short poles were employed, but as the spongers have extended their operations into deeper and deeper water longer poles have been required, until at the present time the limit seems to have been reached in a length of 50 or 52 feet. On the larger vessels four or five different lengths of poles may be used, but on the small craft that frequent the shore grounds poles of one or two lengths (18 to 25 feet) are usually sufficient. A vessel with a crew of 11 men will have 15 or 18 poles and hooks, while a small shore-sponger will require only 2 or 3 poles.

About 1888 a slight change was made in the construction of the sponge-hook. This change was found to be necessary when, owing to the depletion of the sponge-beds lying at a depth of 3 to 5 fathoms, the spongers were obliged to seek grounds farther from shore and in deeper water. In hooking the sponges in deep water it is not an easy matter to bring the light pole (one-half to 2 inches in diameter) to bear on the sponge, owing to the buoyant action of the water, the presence of strong currents, and the movements of the boat. In the efforts to overcome these difficulties it was found that by attaching weights to the pole near its lower end the work of the spongers was facilitated, and the use of weights in this way suggested the further improvement which has since been generally adopted, namely, the making of a sponge hook with a longer and much heavier shank than had been previously used. The so-called "long-shanked hook" enables the sponger to more readily sink and keep in position the end of the pole, and is now used in all of the deep-water fishing, although in the fishing around the keys and in shallow water generally the shorter and lighter hook continues to be employed. Instead of having the shank only 6 inches in length, as is the case with the smaller hooks, the improved hook measures over 2 feet in the shank and weighs about 5 pounds against 1½ to 2 pounds.

The only other apparatus required in taking sponges is the very simple but effective water-glass. This is an ordinary water-bucket, the bottom of which has been replaced with glass. By means of it the sponger is able to distinguish objects on the bottom with great clearness, even in comparatively deep water, and he finds it is an essential article in all of the sponging now carried on, except in shallow water. One glass is the complement of each boat. While one man is steadying or propelling the boat with an oar, the other member of the crew leans over the side of the boat and manipulates the water-glass and the pole, and as the sponges are brought into view by the aid of the glass, he detaches them by inserting the hook beneath them and pulls them to the surface. When a sponge that has been loosened from the bottom becomes separated from the hook great difficulty is experienced in securing it, and it may become what the spongers call a "roller" or "rolling John."

When first taken from the water the sponges are black and slimy. The essential treatment they subsequently receive before being sold consists (1) in exposing them to the action of the sun and air on the vessel's deck until they are killed, which usually requires several days; (2) in placing them for about a week in the crawls or pens where the decay of the gurry or animal matter that began on the vessel is continued; (3) in beating the sponges while wet with a wooden paddle to drive out the decomposed animal matter and in scraping with a knife those sponges to which the black scum still adheres; (4) in squeezing them to force out the remaining gurry and water and placing them on shore; (5) in stringing them by means of a large needle threaded with coarse twine and tying them in bunches about 5 feet in circumference. Some attention is given to the selection of sponges of similar size and quality in making up the different bunches, but the main point in view is to put on just enough damp sponges to fill the string.

The use of the Mediterranean diving system in the Florida sponge fishery has been experimentally tried. This was suggested by the necessity for extending the operations into comparatively deep water and by the possibility of finding sponges in abundance in water too deep to be reached with poles. In 1884, Mr. E. J. Arapian, of Key West, engaged three Greek sponge-divers to come to Florida and try the same methods employed in the Grecian Archipelago and elsewhere in the Mediterranean Sea in taking sponges. An experienced diver from New York was also employed in conjunction with the Greeks. It is reported that a thorough test of the feasibility of this method was made and that it it was found impracticable, although the evident disloyalty of the foreign divers to their employer may have had considerable effect on the outcome of the experiment. The principal reasons for abandoning this attempt to introduce improved methods into the fishery are said to have been as follows: (1) The expense of maintaining a crew of divers (the salary of each being $150 per month) was out of proportion to the value of the sponges taken. (2) It is stated that sponges were not found anywhere in very dense beds, and that a hooker could secure more sponges than a diver on the same grounds and in the same time. (3) The uneven character of the bottom is reported to be unfavorable for divers. (4) The heavy and cumbrous diving apparatus had the effect of destroying the growth of young sponges, a result that had been observed in Europe and in Turkey, and had led to the passage of a law prohibiting the use of the diving method on the sponge-grounds.

In 1889, a law was enacted by the Florida legislature, which is still in force, forbidding the taking of sponges by diving either with or without diving suits.

The discovery of a method of utilizing the sponge-grounds now beyond the reach of the hookers in water, say, from 50 to 75 feet deep, would prove a great boon to the sponge industry. Not the least important outcome of such a discovery would be the opportunity afforded the shallower grounds to recuperate by the diversion of the spongers' operations. In this connection, attention may be drawn to the advisability of experimenting with an apparatus constructed on the principle of the so-called "deep-water oyster tongs," by means of which oyster-beds beyond the reach of the ordinary tongs become readily accessible.

The tongs in question, of which there are several types, consist essentially of two curved iron bars riveted together near the middle, to permit free motion. These are attached on one extremity to the teeth and cradles, and on the other to the ropes by means of which the apparatus is lowered and raised. Beneath the crossing point of the two arms a weight is suspended. To the upper bar of one side an iron link or loop is attached by means of a staple, and on the lower bar, just below the link, is a small iron peg or stud, over which the link fits when the teeth are separated to their widest extent. When oystering begins, the arms are locked by means of the loop and peg and the tongs lowered to the bottom. By suddenly dropping the tongs from the height of a few feet from the bottom the loop slips off the pin by virtue of the weight referred to, and the teeth will then approach each other when the ropes are hauled taut. The weight and the loop and peg may, however, if desired, be dispensed with by attaching a line to the crossing point of the two arms and placing weights at the upper ends of the latter, the tongs being lowered by means of the middle line and kept open by the weights mentioned.

The great simplicity of this apparatus is an argument in favor of its use in the oyster fishery and suggests its employment in the sponge fishery. It is open to the objection of being somewhat heavier than the ordinary oyster tongs and in deep water requires the use of a small windlass attached to the mast or elsewhere on the boat, by means of which it can be raised and lowered. The cost complete is about $15. If the principle embodied in this apparatus is found to be adapted to the sponge fishery, a modification in the line of lightness and cheapness could doubtless be made. The number of teeth and the carrying capacity of the tongs required in the oyster fishery might be reduced and the apparatus made to consist practically of two opposing hooks, such as are now used in the sponge fishery.

The sponge-grounds and their condition.—The principal grounds resorted to by the larger sponge vessels are known as the "bay grounds," and are located off the west coast of Florida, between Anclote Keys and Apalachee Bay. The region around Anclote Keys is known as the "Anclote grounds," north of which are the "Rock Island grounds." The small vessels usually frequent the waters around the keys, between Key West and Cape Florida.

The chief feature regarding the sponge-grounds to be noted at this time is the continued extension of operations into deeper water consequent on the depletion of the more shallow grounds. In the vicinity of Anclote Keys the grounds in 10 to 12 feet of water were exhausted before the civil war, but during the war the sponge beds had a chance to recuperate and later afforded some good fishing. They were very soon depleted, however, and have not since borne sponges in any noteworthy quantities. This is the general history of the "bay grounds." Deeper and deeper bottom has to be resorted to in order to make the fishery profitable, until now some fishing is done in water as deep as 45 feet, which seems to be about the maximum depth in which it will be possible to employ the present methods. The usual depth at which sheepswool sponges are now taken is about 30 feet.

Occasionally good fares are taken on the inshore and key grounds. The latter, in depths of 10 to 20 feet, seem to recuperate more rapidly than the bay grounds and produce excellent crops some seasons, but they have in general shown the same depletion as the other grounds, and the spongers have to work over a larger area and more assiduously than was necessary a few years ago.

Even the deepest grounds now frequented are showing the effects of overfishing, and would doubtless soon prove nonproductive of marketable sponges if the weather and water were always favorable to the spongers, the preservation of the beds depending on the prevalence of storms or muddy water during some seasons or parts of seasons.

The most valuable of the Florida sponges—the sheepswool—has naturally had its abundance on the bay and key grounds most markedly affected by unrestricted fishing, but all of the other species of marketable sponges have also been gathered beyond the recuperative powers of the grounds. The valuable velvet sponge, which is obtained on the Florida reef, has become comparatively scarce. The yellow sponge, which is taken in considerable quantity on the Rock Island grounds, but is of best quality on the key grounds, is decreasing like the sheepswool. Even the cheap grass and glove sponges, which come principally from the keys, are not so abundant as formerly.

Good sheepswool grounds are reported to exist between Key West and Cape Romano. The sponges are said to be abundant and of very good quality. This region is not extensively fished on, however, as the water is usually muddy, and it is only one year in five that the water is clear enough to permit of fishing.

Condition and extent of the fishery.—The Key West sponge fishery during the year 1895 presented about the average condition in recent years. The excessive fishing on the beds of the best grades of sponges has necessitated the seeking of the deeper grounds, where the additional labor required, supplemented by rather unfavorable weather, has resulted in a somewhat short catch.

During the winter season of 1895–96 the prevalence of bad weather at sea for several months compelled spongers to work on the inshore grounds, where sponges are chiefly small. The result was that the cargoes contained a large proportion of sponges of a proscribed size—less than 4 inches across the top—and this led the State authorities to warn the fishermen against further violation of the law. The short crop, combined with the active demand for sponges on the part of purchasing agents of New York firms, raised prices to a very high figure, notwithstanding the small size of a great many of the sponges.

The hurricane of September 29, 1896, did considerable injury to the sponge fishery. A number of sponge vessels engaged in the bay fishery were lost, with their crews; some were driven a number of miles into the woods, and others were sunk and otherwise damaged while at anchor. A Key West sponge-dealer, writing under date of October 10, 1896, to the Oil, Paint, and Drug Reporter, of New York, made the following references to the effects of the storm and the outlook for the fishery during the winter of 1896–97:

During the past fortnight events that are bound to leave their mark in the history of the Florida sponge fishery have happened. You have learned of the hurricane that struck the west coast of Florida, during which the damages to the sponge fleet have been very great. Several of the vessels have been thrown into the woods in the vicinity of Cedar Keys, while 17 vessels of the fleet are not heard from up to the present writing. It is supposed that these vessels and their crews have been lost at sea, 40 bodies having been washed ashore at Cedar Keys. Under the above circumstances the owners of vessels and the ship-chandlers are feeling very much discouraged, as from their past experience of hurricanes and severe storms they all know that since this last hurricane the undertow of the sea will make the water very muddy at the sponge-grounds of Rock Island and Anclote for a long time to come; and thus it will add to the general difficulties and risks of the business.

The Rock Island sponge fleet, that had returned to Key West just before the hurricane, has again made a broken trip. Only half a dozen vessels brought in from 140 to 300 bunches of wool sponges each. The balance of the vessels have not succeeded in securing more than from 40 to 80 bunches of sponges each, which quantity is, as you understand, next to nothing. The trouble is actually that the sponge-grounds on the west coast of Florida are getting bare of sponges in most places, as the fishermen for several years past have kept pulling up the small-size sponges, and naturally this action has killed the growth and the seeds of the sponges. Besides this, some submarine convulsions are said to have taken place from time to time which uproot the sponges. Many sponges have been found at times floating loose on the surface, of fairly good sizes, and all rotten. Some of the old sponge fishermen here attribute this to poisonous waters coming out of some rivers on the west coast. I think the first theory is the more reasonable, but, be it as it may, sponges are not to be found now on most of the sponge bars on which five or six years ago the vessels could secure a load of fine sponges inside of two or three weeks of good weather and clear water at sea. At present, although the vessels meet very often with good weather and clear water, they can not find sponges in most places where they used to secure rapid and successful crops.

The December crop is generally the most successful crop of the year, but vessel-owners now feel discouraged, and while some of them are preparing their vessels to send them out to the Rock Island sponge-grounds, a large majority of them are not willing to risk the expenses necessary to send out their vessels. They think it is a hopeless case for a successful crop of sponges, and they say that they will save money by leaving their vessels at their anchorage. The situation, therefore, is very gloomy for a good supply of Florida sponges until the month of June, 1897, at which time the vessels may succeed in securing a supply of Rock Island sponges.

It has rarely happened in recent years that two successful seasons have come together. This was last the case in the winters of 1889–90 and 1890–91. According to Mr. E. J. Arapian, one of the principal Key West sponge-dealers, the season from October, 1890, to March, 1891, was the best in the history of the industry, and the crop was the largest ever obtained. Up to 1890 a crop of sheepswool sponges worth $70,000 to $100,000 was considered large. In December, 1890, the Key West dealers bought sponges to the value of about $160,000 from vessels that had been on the grounds in October, November, and December, and within six weeks the vessels were back at Key West with another trip of sponges, which sold for about $135,000. These sponges were chiefly from the same grounds off Cedar Keys and Apalachicola that had been resorted to the previous season, when the weather was good and the water was clear, and the catch was said to have been larger than for ten years or more. They were of fine quality and were mostly from water 35 to 40 feet deep. This noteworthy catch evidently depended on a growth of sponges in one season and strikingly illustrates their rapid growth under favorable conditions.

The Key West sponge fleet in 1895 consisted of 99 vessels of 5 tons and over, and about 183 vessels of under 5 tons' measurement. The vessels sufficiently large to take out customs papers had a combined tonnage of 1,204, carried 825 men, and were worth, with their boats, apparatus, and outfit, $216,754. Eighty-six of these vessels were schooners and 13 were sloops. The smaller vessels carried 594 men and had an aggregate value of $36,330, including boats, apparatus, etc. It is thus seen that 1,419 fishermen were employed in the Key West sponge fishery in 1895, and the capital invested was $253,084.

From information furnished by the dealers who bought the catch of the Key West sponge vessels, it appears that in 1895 the yield of all kinds of sponges was 280,372 pounds, having a first value of $344,015, this being an average price of $1.23 per pound. The quantity and value of the different kinds of sponges were as follows:

Species.	Pounds.	Value.
Sheepswool	207,717	$320,785
Yellow	28,454	11,566
Grass	20,249	5,162
Glove	14,857	2,882
Velvet	7,825	2,990
Others	1,270	630
Total	280,372	344,015

The Rock Island fishing in the fall and winter of 1896 was very poor, the season being almost a total failure. The vessels that arrived at Key West from the bay grounds in December had exceedingly limited cargoes, and the fishing, as a whole, did not pay expenses.

THE SPONGE TRADE.

Nearly the entire catch of the Key West spongers is sold locally to regular dealers, the only exception being a small quantity of sponges sometimes sold at points on the west coast of Florida nearer the sponge grounds than Key West.

The method adopted by the spongers for disposing of their cargoes is the one that has prevailed since the beginning of the business. The sponges from a given vessel are unloaded on a wharf and, after being inspected by the buyers, are bid on, as in regular auctions. The buyers however, have only one bid on each cargo, and make a written tender to the crier, who announces the different bids after all are submitted. No opportunity is afforded the buyers to weigh the sponges, and the calculation of the quantity of each species and grade of sponge and the probable value of the cargo has to be made rapidly from a mere glance at each bunch.

It can be readily understood that when a vessel load of sponges consists of half a dozen or more qualities, each with a different market price, great discretion is required to gauge its value even approximately. The most experienced buyers sometimes make costly mistakes, as there is usually great demand for the sponges, and in order to secure them the aim is to bid as high as practicable. It is possible to make or lose hundreds of dollars on a single cargo. The bids of well-informed buyers often vary greatly on the same lot of sponges. As an example of this, reference may be made to a cargo sold in January, 1896. This consisted of 402 bunches of Rock Island sheepswool sponges of inferior quality and small size, and the bids of six buyers were $411, $427, $469, $512, $540, and $857. The next lot sold on the same day contained 206 bunches of sponges of good size and quality from the same ground; the highest bid on this was $277. The owner and crew of the vessel of which these sponges were the cargo were naturally dissatisfied with this bid and refused to sell for less than $500.

From many points of view this anomalous method is so unsatisfactory to both seller and buyer that it is strange it has not long since been discarded. The wide fluctuations in prices make the business uncertain, and, in the language of the dealers, the present buying of sponges is little different from gambling or a lottery.

In 1895, the number of regular dealers or buyers at Key West was nine. These employed 65 laborers and teamsters in clipping, packing, and hauling sponges. The buildings occupied by the dealers were valued with their fixtures at $16,825, and the land on which they rested had an estimated value of $42,300. The teams and drays more or less regularly required by the business had a value of $2,150. The amount of cash capital required to conduct the trade was $135,000. The total investment in this branch was therefore $196,275. The quantity of sponges bought by dealers corresponds very closely with the quantity caught by the fleet. The quantity and cost of the sponges purchased in 1895 amounted to 267,810 pounds and $321,020, the different species being represented to the following extent:

Species.	Pounds.	Cost.
Sheepswool	195, 560	$297, 895
Yellow	28, 084	11, 473
Grass	20, 205	5, 150
Velvet	7, 825	2, 990
Others	16, 127	3, 512
Total	267, 810	321, 020

The loss in weight occasioned by the cleaning and trimming of sponges is generally reported as about 8 per cent, considering all kinds of sponges. Some lots will lose only 3 per cent, but such a low figure is rarely attained. This waste is no unimportant item, since in 1895 it amounted to about 20,000 pounds, worth, at $1.20 per pound, $24,000. A part of this loss, however, is recovered. Some of the dealers make no account of the clippings, but the softer parts of the sheepswool clippings are now being generally saved and utilized for various purposes, the wholesale value being about 5 cents a pound.

THE MARKET FISHERIES.

Importance.—Next in importance to the sponge fishery are the various branches of the industry comprehended under the general name of market fisheries, and consisting in the taking of food-fishes chiefly for local sale in a fresh condition. The number of persons who thus find employment, the number of boats and the quantity of apparatus used, and the amount and value of the catch make this branch not only of great consequence to Key West, but one of the most extensive in the State. This fishing is done from small welled-vessels, known as smackees, and carrying on an average two men. Hand lines of various kinds, adapted to the nature of the various species sought, are the apparatus principally employed; a number of other means of capture are used incidentally. The prominent branches of the market fisheries are the fishery for the smaller bottom fishes, the red-snapper fishery, and the kingfish fishery.

The bottom fishery.—The most extensive of the market fisheries is that for bottom fishes, carried on by a numerous fleet of well smacks. A few schooners (5 in 1895) barely large enough to take out custom-house papers, engage in this fishery, and some of the sponge vessels are at times so employed, but most of the vessels are of only 2 or 3 tons register. The fishing is carried on throughout the year, but is more assiduously followed in winter than in summer.

The fish par excellence of this fishery are the grunts (*Hæmulon*), which constitute fully one-third of the yield. The two principal species are the white grunt and the yellow grunt. These are found in extraordinary abundance at all seasons and on numerous grounds, and their size, cheapness (4 or 5 for 10 cents), and food qualities make them very popular. Numerous other desirable fishes are taken more or less throughout the year. In fact, a greater variety of food-fish are caught by the Key West line fishermen than are obtained in any other similar fishery in the United States. Those which deserve mention are the red grouper, black grouper, Nassau grouper, rock hind, jewfish, muttonfish, gray snapper, lane snapper, margate-fish, angelfishes, yellow-tail, porgies, chub, hogfish, porkfish, sailor's choice, and bream.

Notwithstanding the very large annual catch, amounting to about 1,500,000 pounds, the resources appear to have undergone no noteworthy depletion, and the vastness of the grounds and the abundance of the ground fishes will certainly permit a very much more extensive fishery than is now prosecuted. The principal grounds frequented by the smaller boats are in the Northwest Channel, but there are numerous other grounds in the vicinity where good fishing for the smaller fishes may be had. The best fishing for groupers, mutton-fish, snappers, and porgies is on the reef extending from Marquesas Rock to Rebecca Shoals; as this region is a considerable distance from Key West, it is only visited by the larger boats.

The question of bait, which in the line fisheries of many places is a very serious one, seldom causes any concern to the Key West fishermen. Suitable bait in almost limitless abundance is easily and conveniently obtained. The principal bait products are the rock lobster or crawfish and small fishes known locally as "sardines," "shad," and "pilchards." The meat of the conch is also used to some extent. The crawfish are taken by spearing, seining, and trapping, and the small fish are caught by means of improvised seines made of gunny sacks. In 1895 the small fish used for bait had an approximate weight of 121,000 pounds, with a market value of $3,025; the crawfish employed for the same purpose amounted to 126,000 pounds (equivalent to about the same number of these crustaceans), worth $2,720.

The most interesting feature of the Key West market line fisheries is that the fish are kept alive in wells while the boats are on the fishing-grounds and are transferred to live-cars or live-boxes after reaching market. The consumer is thus enabled to select his fish and have them killed on the spot, thus being sure that the fish is fresh. This method prevents the waste that too often characterizes the fisheries, as the fishermen do not take more fish than they can readily sell and do not start on a trip until the catch of the previous trip is disposed of.

The bottom fishery in 1895 was engaged in by about 105 persons; the number of boats employed was 91, and the catch, amounting to about 1,475,000 pounds, was valued at $58,901.

The kingfish and red-snapper fisheries.—The most prominent market fishery carried on during a definite time and for special fish is that for kingfish. The time of arrival of kingfish in this region and its abundance each fall are determined largely by the weather. The fish is not expected until after a "norther," and is apt to be most abundant during a severe winter with frequent northerly gales. In the early part of the season, which extends from about October 15 to March 15, the kingfish is sought as far north and east as Cape Florida, but after November 15 it is usually present in large numbers in the vicinity of Key West. The fish are caught from within a short distance of the keys to the edge of the Gulf Stream, but the principal grounds are from above Love Key to Sombrero Key.

Trolling is the method of capture employed in this fishery, a 36-thread cotton line, about 10 fathoms long, being used. Four lines, worth about 40 cents each, constitute the complement of each boat. When the fish are biting fast, the line may be shortened to 5 fathoms or even 2 fathoms. The preferred bait is a triangular strip of skin from the side of a kingfish.

When the catch is sold for local consumption, the fish are eviscerated and cut into steaks. If these are not sold the first day after being caught, they are lightly salted and dried in the sun, when they will keep for several weeks in favorable weather. The principal part of the catch has, however, usually been destined for the Cuban trade, the fishermen delivering the fish round to dealers, who pack them in ice and ship them to Havana by the regular steamer, which makes two trips a week from Key West.

The quantity of kingfish taken in 1895 was 420,000 pounds, valued at $7,000. The Cuban war has necessarily embarrassed the fishery, and the recent imposition of prohibitive duties on fish going to Havana has seriously affected the business and been much felt by the fishermen. The local consumption is far exceeded by the catch, and Cuba has been the only outlet for the surplus. Even when comparatively large shipments were made to Havana the fishermen were very desirous of extending their markets, as they did not take as many fish as they could, but only enough for the home market and to satisfy the Cuban demand. A number of other fish are incidentally taken in the kingfish fishery, the principal ones being amberfish, large groupers, and red snappers.

At times there has been quite an important fishery for red snappers carried on from Key West, but the fishery is not regularly followed, and in 1895 was unimportant. There are a dozen or more banks accessible to Key West fishermen on which red snappers are found in greater or less abundance at the proper season, but the fishery has been less profitable than the kingfish fishery, and has only been extensively followed when kingfish were scarce. The market for kingfish in Cuba does not extend to red snappers, and after the local Key West demands are supplied there is no other way in which to dispose of the catch. A very large red-snapper fishery could no doubt be carried on from Key West if the facilities for marketing the catch warranted it. This fishery is prosecuted, as a rule, by the same large boats that engage in the kingfish fishery. The inquiries of the Fish Commission in 1891 showed that the quantity of red snappers taken by the Key West fishermen in the two preceding years were about 100,000 pounds and 20,000 pounds, respectively, while in 1895 only 8,400 pounds were caught.

Other market fisheries.—Among the minor branches of the market fisheries are the mullet fishery, the crab fishery, the crawfish fishery, and the clam fishery.

A small mullet fishery is carried on by means of gill nets, although some mullet are also taken in cast nets and seines. The demand for mullet is not large, and in 1895 the fishery yielded only 43,800 pounds, valued at $1,372. During July, August, September, and October three small boats, equipped with gill nets engaged in this fishery, going out early in the morning and returning by noon. The fish are handled by boys, who peddle them about the city.

A few seines are hauled on sandy beaches and smooth shoals by Key West fishermen. The catch consists largely of bonefish, grunts, groupers, moonfish, and snappers, the first-named species predominating. Most of the seines are operated very irregularly. The owners usually rent them to anyone who desires to fish, and thus frequently a dozen persons have used one seine during a year.

The bottom fishermen at times use trail lines for Spanish mackerel, runners, jacks, bluefish, barracuda, and other surface-swimming fish. The catch in this way is small.

A few small wire traps or pots of a peculiar type, introduced from the Bahama Islands, are used by the Key West bottom fishermen; in 1895, 24 of these, with an average value of $3, were set. They are baited with crawfish or fish and are set chiefly on reefs in convenient places. Although they are not operated with great regularity and take mostly small fish, their annual catch is considerable, amounting in 1895, according to the best estimates obtainable, to 92,745 pounds, worth $3,900. The fish composing the catch are chiefly grunts, angel-fish, chub, small groupers and snappers, hogfish, porkfish, porgies, yellow-tail, tang, and turbot.

Crawfish are taken for food in the same manner they are obtained for bait—that is, with "grains," dip nets, etc. The local sales in 1895 were 31,500 pounds, valued at $630. A small fishery for stone crabs is carried on. The crabs are drawn from their holes by means of hooks. The taking of conchs for food and bait is unimportant; $30 worth of conch meats represents the extent of the business in 1895, in addition to which five pearls, valued at $85, were secured.

An unimportant fishery for hard clams or quahogs is carried on from Key West. The clams are gathered by hand on Pavilion Key, near the mainland of Monroe County, and sold at Key West. The demand is limited and but one small vessel is engaged in the business, making three or four trips a year. The number taken in 1895 was 3,600, for which $36 was received. The clams are of large size and the supply is far in excess of the present needs.

Statistical summary of the market fisheries.—In 1895 the foregoing fisheries gave employment to 136 persons. The number of boats used was 97, valued, with their outfits, at $14,641. The following table shows the quantity and value of the products of the Key West market fisheries in 1895, including those used for bait. This branch is seen to have yielded nearly 2,500,000 pounds of fish, etc., with a value to the fishermen of over $80,000.

Species.	Pounds.	Value.	Species.	Pounds.	Value.
Amber-fish	18,600	$620	Porgies	98,200	$2,450
Angel-fish	34,100	1,410	Red snapper	8,400	240
Barracuda	31,000	1,24[illegible]	Other snappers	60,334	2,416
Bluefish	9,240	770	Sailor's choice	20,179	2,020
Bonefish	70,000	2,100	Schoolmaster	6,400	160
Chub	3,000	180	Spanish mackerel	34,650	1,155
Groupers	95,380	2,102	Sheepshead	9,252	417
Grunts	605,480	14,082	Yellow-tail	64,880	6,475
Hogfish	81,600	3,480	Other fish	123,136	11,675
Jack and runner	97,500	3,250	Sardines, etc	121,000	3,025
Jewfish	10,000	425	Crawfish	157,500	3,150
Kingfish	420,000	7,000	Conch	500	*a* 115
Margate-fish	13,500	785	Crabs	6,240	208
Mullet	43,800	1,372	Clams	1,800	36
Mutton-fish	196,600	6,890			
Porkfish	11,962	1,196	Total	2,454,233	80,444

a Includes $85, the value of 5 pearls.

Possibility of increasing the industry.—Opportunity for a very large expansion of the fishing industry of Key West is believed to exist, and warrants the attention of capitalists and fish-dealers. With a phenomenal abundance and variety of some of the finest food-fishes of the Atlantic coast, which may be readily caught at little expense, there is practically no outside trade. It is this feature that most forcibly appeals to one who is considering the increase of the industry, and it is in the augmentation of the export trade in fresh fish that the most important development must take place.

The remote situation of Key West has, of course, retarded the development of any outside business in perishable products, with the exception of the kingfish trade with Cuba (now discontinued) and some small shipments in winter by way of Tampa. The rather poor shipping facilities and the costliness of ice have also been factors in the non-expansion of the fisheries.

Careful inquiries, however, indicate that, even with the present conditions, a fish business may be carried on with New York that will prove profitable to the local dealers who may engage in the enterprise, to the men who catch the fish, and indirectly to the entire community.

Most of those interested in the fishing business of Key West think that the attempt to establish a fresh-fish trade with northern markets would be successful, and several people have considered or are now considering the matter of engaging in such an enterprise. It is reported that an experimental shipment of Spanish mackerel, pompano, or some other choice fish a number of years ago netted several hundred dollars.

The only shipping facility from Key West to the north that can now be considered in this connection is that afforded by the steamship line to New York, although it is possible that the railroads terminating at Tampa on the west coast and Miami on the east coast may be utilized if sufficiently low rates can be given. The New York steamers make regular weekly trips, requiring four days for the passage from Key West (Friday to Tuesday). The present rate on fish is 40 cents per 100 pounds. By the use of refrigerators, or even by the employment of large quantities of ice, the fish would no doubt arrive in good condition. The present wholesale price of ice at Key West is $7.50 a ton.

To make the shipping of fresh fish from Key West to New York profitable the business should probably be restricted to the winter months, say from November to March, when there is a comparative scarcity of salt-water fishes in the northern markets. At first the shipments might have to include only fishes now well known in the east, such as bluefish, sheepshead, kingfish, Spanish mackerel, pompano, red snapper, and the like, but there is no reason to doubt that in time all of the desirable local species could be profitably disposed of.

The value for canning purposes of the fish known locally as "pilchard," "herring," and "anchovy," which exist in great abundance in this region, should not be overlooked.

The spiny lobster or crawfish, which is extremely abundant, would doubtless meet with sale in a fresh condition in the northern markets after its food value became known, and it would undoubtedly prove a satisfactory substitute for the common lobster. The crawfish of the California coast, which closely resembles the Florida species, has been canned in limited quantities and is consumed fresh in very large numbers.

THE TURTLE FISHERY.

This is one of the most prominent of the Key West fisheries, ranking next to the sponge and bottom fisheries in number of persons engaged and value of products. While quite important, this fishery is much less valuable than formerly, owing to the decrease in the supply.

In 1895 this fishery gave employment to 76 persons, of whom 27 were on registered vessels and 49 on open sailboats or small sloops. The number of vessels and boats used was 29. The crews of some of the vessels numbered 5 men, but on the small boats only 2 men were carried. The apparatus consisted chiefly of nets, of which 54 were set, but some turtling was done by means of pegs.

Three species of turtles are caught, namely, the green, the loggerhead, and the hawksbill, but the green turtle is the most important. The average weight of the last is between 125 and 275 pounds. The loggerhead turtle, while quite common, is not sought to any great extent, as in food value it is inferior to the green and it is not in demand for shipment. It exceeds the green turtle in size. A few hawksbill turtles are taken each year. They average about 80 pounds in weight, although many small ones are caught. Their flesh has little value, but their shell (which is the tortoise shell of commerce) brings a high price. The average weight of the shell is about 3½ pounds, and it is worth from $2 to $4.50 per pound, depending on the quality.

The grounds extend for many miles along the keys, and also include the coast of the mainland of Monroe County and the Straits of Florida. The principal region is from Marquesas Key, 30 miles west of Key West, to Alligator Light, on the east coast; there is also good turtling in the Bay of Florida—that part of the Gulf of Mexico intervening between the western keys and the mainland.

Fishing is carried on throughout the year. Crawls or pens are located at convenient places, in which the turtles are kept pending collection and transportation to Key West, whence most of them are sent by steamer to New York. At Key West the turtles are sold at public auction, and are bought by agents of New York houses. Pending sale or shipment the turtles are kept in large pens near the docks.

Quite a business is done in loggerhead-turtle eggs. These are either taken from the female turtles that have been caught for market or are dug up from the sand where they have been buried by the turtles. The eggs taken directly from the female are yellow in color and bring the best price; those that have been laid are white and sell for about half the price of the others; the average value is 1 cent each; the eggs weigh about a pound to a dozen, and are 1½ inches in diameter. The number gathered in 1895 was over 45,000.

At Key West and throughout the key region there is the same testimony as to the decrease of green turtles, owing to excessive fishing. It is now much more difficult than formerly to obtain a good fare, and the boats are compelled to range over a wider territory. The opinion is freely expressed that unless something is done the business will cease to be remunerative. The fishermen comment upon the fact that for the past few years the green turtles have not been depositing their eggs on Key West and the adjacent keys. It is very probable that this is owing to the excessive hunting of this species, and that they now deposit their eggs on the more distant and inaccessible keys. This has cut off quite an important and profitable business, as the gathering of green-turtle eggs—which are better liked than those of the loggerhead—was carried on by a number of people.

The results of the turtle fishery in 1895 are shown in the following table. The 410,142 pounds of products taken are seen to have had a market value at Key West of $19,957.

Products.	Pounds.	Value.
Green turtles	337,400	$16,870
Loggerhead turtles	25,000	200
Hawksbill turtles	40,280	403
Tortoise shell	712	1,674
Turtle eggs	6,750	810
Total	410,142	19,957

FISHERIES OF TAMPA AND TRIBUTARY SECTIONS.*

Tampa's importance as a fishing center.—Owing to its exceedingly favorable situation and its railroad and steamship lines, which afford ample facilities for the rapid shipping of fishery products in every direction, Tampa has become the most important fishing and distributing center for fresh fish on the Florida coast, with the exception of Pensacola. There are only two bays on the west coast of the State which permit easy access to large vessels; these are Escambia Bay, on which Pensacola is located, and Tampa Bay, on an arm of which, called Hillsboro Bay, Tampa is situated. Tampa is now the receiving center for most of the fish taken in Hillsboro, Manatee, and Lee counties, and also for a large part of the catch of De Soto County. Considerable fresh-fish trade, however, is carried on at St. Petersburg on Tampa Bay in Hillsboro County, and at Punta Gorda on Charlotte Harbor, in De Soto County, both of these places being railroad termini. The railroad companies have directly encouraged the fishing industry by giving reasonable rates; in 1895 they contemplated an advance of

* Includes the counties of Hillsboro, Manatee, Lee, De Soto, and Pasco.

the rates on fish, but desisted on the representations of the Tampa dealers, who showed that there had been a large increase in the shipment by rail during the past few years and that Tampa would be unable to compete with other places in supplying certain sections if the shipping prices were raised.

One of the statements prepared by the dealers for the information of the railroad companies was the following table, showing the combined fresh-fish rail shipments by the three wholesale dealers during the month of October, from 1890 to 1895, inclusive:

Year.	Barrels.	Equivalent pounds.
October, 1890	875	175,000
1891	940	188,000
1892	1,125	225,000
1893	1,270	254,000
1894	1,583	316,600
1895	1,712	342,400

From the most accurate data obtainable, it appears that in 1895 over 4,000,000 pounds of fresh fish alone were shipped by rail from Tampa, to which should be added the very large trade in salt mullet, oysters, and other fishery products.

Most of the fish brought into Tampa are from fishing-camps located between Clearwater (Hillsboro County) and Naples (Lee County). A large number of small vessels are employed in taking the catch from the camps to the city. The camps are most numerous around the entrance to Charlotte Harbor and Caloosahatchee River; Grove City, St. James City, and Punta Rassa are the most important centers. Hunter Point, near the entrance to Tampa Bay, is a very important camp region. The camps consist of collections of cheap wooden buildings, sometimes constructed over the water on piling, but usually on the mainland or keys on leased ground, convenient to the fishing-grounds.

The mullet fishery gives to Tampa its chief importance as a fishing center, and is much more extensive than all other fisheries combined; but numerous other fish are taken, and there are sponge, turtle, oyster, and alligator fisheries in this region.

The mullet fishery.—In the extensive region under consideration, this fishery in 1895 gave employment to 699 fishermen, who used 356 gill nets (with an aggregate length of 225,520 feet) and 162 seines and stop nets (with a combined length of 75,450 feet). The boats and vessels used in catching and transporting the fish numbered 526. The value of the apparatus was $14,907, and of the vessels and boats was $98,554. The transporting fleet numbered 36 vessels and carried 87 men. The results of the fishery were as follows: 8,183,539 pounds of fresh mullet, worth $74,133; 2,182,556 pounds of salt mullet, worth $36,505; and 138,400 pounds of salt mullet roe, worth $9,895.

The stop net is the most important apparatus used in the capture of mullet. It is in reality a seine from 300 to 500 feet long, with a 3-inch mesh. During high water it is secured to stakes across the entrance to small indentations and creeks, and at low water prevents the fish from escaping. The regular haul seines for mullet are about 750 feet long and have a 3-inch mesh. The mesh of the gill nets is 3⅝ inches.

Mullet fishing is done more or less throughout the year, but is most extensive during fall and early winter, when the fish have matured roe, are in the best condition, and are most abundant.

An immense quantity of the mullet secured at the fishing stations is salted and either sold in the surrounding territory or shipped to Tampa, St. Petersburg, or Punta Gorda, to be distributed by rail. Prior to 1896 large quantities of salt mullet were sent in sailing vessels and steamers to Havana, but this trade has been practically abandoned owing to the excessively high tariff imposed on imported fish as a consequence of the Cuban war. The salt-fish trade with Cuba has heretofore been virtually controlled by Americans, but it has now fallen into the hands of the Cubans, who visit the Florida coast in their vessels and fish along the shores of the State. Although fishing in State waters by foreign vessels is prohibited, the sparse population and the general absence of revenue cutters make it easy for the Spanish subjects to ply their business uninterruptedly; they often come into the bays to fish, and sometimes even prepare their fish on the shore. This condition of affairs has greatly injured the local salt mullet fishery.

There is considerable waste in the mullet fishery, owing to the softening of the fish during transportation from the fishing-camps to the markets. If the vessels carrying the fish are delayed by head winds or calms, the whole cargo may be lost, as some of the stations are nearly 200 miles from Tampa. Insufficient ice is also a factor in the spoiling of fish. Careful inquiry among the Tampa dealers shows that during the principal mullet season, from September to December, inclusive, over 200,000 pounds of mullet are thrown away annually at that place, and it is estimated that the annual loss at other places on the west coast is over 300,000 pounds. These spoiled fish do not enter into the statement of the catch. Some of the loss is retrieved, however, by laying aside the ripe females and extracting their roe, which is salted.

The general gill-net and seine fishing.—Besides the gill nets used especially for mullet, there are pompano and Spanish mackerel nets, which are operated in conjunction with the mullet fishery. The pompano nets have a mesh of 4 to 5 inches, the mackerel nets a mesh of 3 or 3¼ inches, their length being from 450 to 850 feet. Besides the fish for which the nets are particularly set, numerous others are taken which, in the aggregate, are more important than the two species named; among these are bluefish, redfish, black drum, sheepshead, grunts, and trout. In 1895 the number of pompano nets in use was 80, with a value of $2,680; the Spanish mackerel nets numbered 70 and were worth $2,625. The fishery was most extensive at Punta Gorda and at the camps in Manatee County. The catch, a detailed statement of which follows, including those fish taken incidentally in the mullet fishery, amounted to 1,627,015 pounds, for which the fishermen received $45,573.

Species.	Pounds.	Value.
Angel-fish	17,100	$235
Bluefish	89,376	1,786
Channel bass	243,420	3,613
Crevallé	14,594	219
Grunts	23,000	345
Pompano, fresh	246,867	13,563
Pompano, salted	28,000	1,680
Sailor's choice or pinfish	39,202	588
Sheepshead	344,602	5,167
Snappers, gray, and others	31,333	480
Spanish mackerel, fresh	237,980	10,930
Spanish mackerel, salted	20,000	1,210
Trout	265,968	5,353
Other fish	25,544	404
Total	1,627,015	45,573

In the haul seines and stop nets operated primarily for mullet, considerable quantities of other fish are caught, the species being practically the same as taken in the foregoing gill-net fishery. The fish thus incidentally secured in 1895, as shown in the following table, aggregated 269,084 pounds and had a value of $5,494.

Species.	Pounds.	Value.
Bluefish	29,008	$580
Channel bass	67,103	1,007
Crevallé	6,015	91
Drum	28,000	425
Flounders	6,000	90
Grunts	13,210	198
Pigfish	3,000	45
Pompano, fresh	5,100	281
Pompano, salted	800	48
Sailor's choice or pinfish	2,000	30
Sheepshead	48,748	777
Snappers, gray, etc	5,100	102
Spanish mackerel	24,000	1,200
Trout	31,000	620
Total	269,084	5,494

Red-snapper fishing.—In 1895 a Tampa vessel of 17 tons burden, carrying 5 men, made a number of trips to the red-snapper banks, located about 75 miles southwest of Egmont Key Light, at the entrance of Tampa Bay. These trips were remarkably successful, and it is probable that other vessels will soon enter this fishery. The catch amounted to 300,000 pounds of red snappers, having a value of $9,000, and 24,000 pounds of groupers, worth $360.

Turtle fishing.—The turtle fishing in this extensive section is quite limited. It is reported that in the Tampa region the green turtles are nearly all killed off and that it does not now pay to follow the business, although in 1890, when an investigation of the west Florida fisheries was made by the United States Fish Commission, the fishery was comparatively important. In 1895 one small vessel from Tampa and two boats from Punta Rassa engaged in hunting turtles during a part of the year, four nets being used. The aggregate catch was 9,375 pounds (representing 55 turtles), valued at $563.

Alligator and otter hunting.—In Hillsboro, De Soto, and Lee counties considerable alligator and otter hunting is carried on by white men and Indians. The alligator industry is much less extensive than formerly, owing to excessive hunting of the alligators, which are being rapidly killed off, but the hunting of otters is now receiving more than usual attention, the otters having undergone a noteworthy increase in the past few years. The reason generally assigned for the increase in the number of otters is the decrease in the alligators, which are said to be the principal enemies of the otters.

In 1895, according to information obtained from the dealers in the three counties named who handled the alligator and otter skins, 214 persons were engaged in the business; their investment in boats, guns, traps, etc., was $7,421; and their product amounted to 16,750 alligator skins, valued at $11,925, and 2,750 otter pelts, worth $13,750.

The oyster industry.—Although the taking of oysters is one of the principal branches of the fisheries of this section, the business is far from being as extensive as the resources seem to warrant. The question of maintaining the supply and developing the industry is one of the most important related to the fisheries to which the attention of the people of this region can be drawn.

The principal oyster beds of the counties of Hillsboro, Manatee, and De Soto are located in Hillsboro Bay, at and near the mouth of Manatee River, in Sarasota Bay, and at Cape Haze in Charlotte Harbor. There are isolated oyster beds along the entire coast, but the foregoing have up to this time been the chief sources of supply.

Opinions differ as to whether the oysters are becoming scarcer, although most of the dealers and oystermen think they are decreasing each year. Some time ago Tampa drew most of its oyster supply from Old Tampa Bay, but the beds in that place are so depleted that it has not paid to work them for several years.

Most of the oystering is done from Tampa, although there is considerable oyster business at Punta Gorda. In 1895, 77 persons were engaged in taking oysters. These used vessels, boats, and apparatus (tongs) valued at $3,958. The product, amounting to 70,384 bushels, was worth $21,334, an average price of about 30 cents a bushel.

During the past few years some efforts at private oyster-culture have been made, consisting in the planting of seed oysters in Hillsboro Bay and on the worked-out Manatee beds, but the enterprise has thus far been unsatisfactory, owing to the robbery of the beds.

Clams are found in Sarasota Bay and elsewhere, but owing to the limited demand no regular fishery has been established and only a few thousand are taken annually.

The sponge fishery and trade.—The sponge business of this section centers at Tarpon Springs, in Hillsboro County, on the Anclote River. This river affords a good harbor, is adjacent to the Anclote sponge-grounds, and is the rendezvous of a large number of sponge vessels belonging at various places from Key West to Apalachicola. Nearly 100 "crawls," in which the sponges are cleaned, have been built near by. Quite a fleet of vessels that take out custom-house papers at Tampa, Cedar Keys, and elsewhere are owned at Tarpon Springs, although the principal part of the sponges landed here are from outside vessels.

The sponge industry of Tarpon Springs (or Anclote) is more extensive than that of any other place on the Florida coast except Key West. The recent increase in the business has been noteworthy, and it seems probable that the favorable position of the place with reference to the sponge-grounds will result in a still further development of the industry, which will make Tarpon Springs a formidable rival of Key West.

The sponge vessels which may be credited to this section in 1895 numbered 13. Their tonnage ranged from 6 to 20, and their crews consisted of 7 to 13 men. They are equipped similarly to the Key West vessels as to dingeys, hooks, poles, water-glasses, etc. The aggregate value of these vessels, with their outfits, was $23,340, and their combined crews numbered 125, fully 90 per cent of whom were negroes from the Bahama Islands. The stock of the vessels was from a few hundred dollars to over $4,800, depending on the number of trips and other contingencies, the average being about $1,800.

Besides the vessels of over 5 tons burden, there are a few others that engage in the sponge fishery in this region. These usually carry 3 or 5 men, and their catch is correspondingly small.

The foregoing fleet was augmented in the latter part of 1895 and in 1896 by a number of sponge vessels from Key West that were permanently transferred to this district, several of which have been credited to Key West in 1895.

The quantity of sponges taken by the sponge fleet of this section in 1895 was 18,393 pounds, valued at $30,875. The following table shows the extent to which each kind of sponge was represented in the catch. As will be seen, the quantity of other sponges besides the sheepswool taken in this section is insignificant. In quality the sheepswool sponges which enter into the trade of Tarpon Springs are unsurpassed and are worth considerably more per pound than are the sheepswool sponges handled at Key West, owing to the admixture of the less valuable key sponges at the latter place.

Species.	Pounds.	Value.
Sheepswool	17,188	$30,559
Yellow	465	102
Grass	740	214
Total	18,393	30,875

The lay on the Tarpon Springs vessels is somewhat different to that at Key West. The owner supplies the provisions and other outfit of the vessel and receives one-half the gross sales, the crew sharing the other half equally. The captain, however, is paid 8 per cent of the vessel's share, and the hookers are given a quarter share by the owner in addition to their regular shares. The cost of the outfit per trip is about $100, and from one to five trips are made each season.

In 1895 and 1896 there were three sponge dealers or buyers at Tarpon Springs. These had their sponge-houses near the mouth of Anclote River, a number of miles below Tarpon Springs. The sponges are sold at auction, as they are at Key West, and the prices are practically the same as at that place. The purchases of these dealers in 1895 amounted to about $60,000, and consisted of sponges caught not only by local vessels but by those from Key West, Apalachicola, and elsewhere.

Statistical summary.—In 1895 the fishing industry of this section gave employment to 1,251 persons. The vessels engaged in taking or transporting fishery products numbered 37, and had an aggregate tonnage of 402.35; these and 746 boats used in the shore fisheries were valued at $113,671. The value of the apparatus of capture was $24,209, and that of the shore and accessory property and cash capital was $107,695. The total investment in the industry was thus $245,675. The catch, amounting in value to $259,508, was divided as follows among the different classes of products:

Fish	$181,061
Oysters	21,334
Alligators and otters	25,675
Sponges	30,875
Turtles	563

FISHERIES OF CEDAR KEYS.

Geographical features and prominent fisheries of Cedar Keys.—At one time Cedar Keys seemed destined to occupy the first place as a fishing center on the west coast of the Florida peninsula, as it was the terminus of the only railway reaching the Gulf except one running to Pensacola. This advantage was lost, however, by the building of railway lines to Homosassa, St. Petersburg, Tampa, and Punta Gorda, and the fisheries, while important, are much less valuable than at a number of other points. Cedar Keys is located several miles from the mainland, on a key of the same name. The railroad is built partly on piles and partly on small keys. Owing to this necessary method of construction, communication is liable to interruption by storms washing away part of the tracks. Several such storms have occurred in the past few years; the worst of these was in September, 1896, when a great deal of damage was done to property in the town, especially to fish-houses on the wharf, and most of the railroad was washed away, the place being without rail communication for nearly two months.

The principal features of the fishing industry of Cedar Keys are the mullet, oyster, and terrapin fishing and the wholesale fish and oyster trades. The place is also the shipping-point for mullet and other fish taken at camps along the coast and brought in by transporting vessels. The wholesale trade is in the hands of seven firms; two firms handle fish, oysters, and turtles, and five handle oysters exclusively.

The oyster industry.—Oysters are found in considerable abundance in the vicinity of Cedar Keys. The principal grounds are as follows: No. 4 Channel, between Cedar and Derrick keys, connecting Suwanee and Waccassee bays; Pelican Reef Bar, which extends from No. 4 Channel 2½ miles up Suwanee Bay; Fishbone Bar, which extends several miles up the coast from the north side of Suwanee River; Corrigan Reef, which runs south from Cedar Keys a distance of about 4 miles, and Waccassee Bar, near the mouth of Waccassee River. The first of these is the best and most productive ground in this entire region, the beds occupying nearly 4 miles of the channel. Owing to excessive tonging, the supply has been decreasing for some years, and in 1895 the output was nearly 50 per cent less than in 1890.

In 1892 a Cedar Keys citizen leased a bar about 2 miles north of Cedar Keys, near the mainland, and the same year planted a number of small oysters taken from the natural beds. He continued this each year up to and including 1895, but suffered so much in the last two years from the depredations of tongers that he was compelled to abandon the business. What the tongers left on the bar were washed away in the great storm of September, 1896. All of the oyster-dealers and a number of the tongers are advocates of the system of increasing the supply by the formation of artificial beds, and it is probable that most of those interested will soon be believers in this system, as the natural beds become more and more exhausted.

In 1895 the oyster industry of Cedar Keys gave employment to 50 tongers; the boats used numbered 40, valued, with outfit and apparatus, at $1,040. The product consisted of 3,200 barrels of oysters, worth $1,870, or 19½ cents a bushel.

The sponge industry.—Although the best sponge-grounds in the Gulf of Mexico are located adjacent to Cedar Keys, the sponge fishery has received but little attention from the people, and in 1895 there was no sponge trade in the town. A number of vessels that were documented at Cedar Keys engaged in the sponge fishery from Tarpon Springs, but no sponges were landed locally. In 1890 one local vessel landed 4,160 pounds of sponges valued at $5,000. In 1878 the business of purchasing and preparing sponges was begun at Cedar Keys, but was discontinued after a few years, and only spasmodic attempts to reestablish the trade have since been made. A favorable opportunity appears to exist for carrying on an extensive sponge business at this place.

The gill-net fishery.—This is the most prominent of the Cedar Keys fisheries. More persons are employed in it than in all the other fisheries combined, and the product greatly exceeds that of the other branches. A very large variety of valuable food-fish is taken, although the mullet is the principal species. In 1895 this fishery gave employment to 108 fishermen, in addition to whom 39 persons were engaged in transporting the catch to market; 30 of the latter, however, were in other fisheries. The fishing boats numbered 48, and were valued at $1,440; the transporting boats consisted of 15 sailboats (used in the turtle fishery) and

3 small vessels (one of which was in the hand-line fishery). The value of the two vessels that were in no other branch was $3,580, including outfits. The gill nets numbered 50; they had a 3¾-inch mesh, and the average length was 576 feet; their total value was $1,146.

This fishery resulted in the capture of nearly 1,500,000 pounds of fish, having a value to the fishermen of $22,555. Over two-thirds of the catch were mullet. Following is a table showing the quantity and value of the different species:

Species.	Pounds.	Value.
Bluefish	19,900	$448
Channel bass	75,000	1,125
Croaker	1,109	22
Drum	9,855	197
Mangrove snapper	9,531	191
Mullet, fresh	974,068	14,076
Mullet, salt	126,000	1,620
Pompano	1,200	24
Sailor's choice	26,000	520
Sheepshead	119,782	1,198
Trout	109,421	2,462
Other fish	2,674	72
Total	1,474,540	22,555

Hand-line fishing.—The taking of fish by means of hand lines is an unimportant branch of the Cedar Keys fisheries. In 1895 some 15 semi-professionals, using hand lines from the railroad dock and from rowboats, caught sheepshead, Spanish mackerel, and trout, and 3 fishermen in a small schooner (of 15 tons) caught red snappers and groupers. The yield, which amounted to 59,724 pounds, was valued at $1,097, and was divided as follows: Sheepshead, 11,114 pounds; Spanish mackerel, 4,000 pounds; trout, 15,810 pounds; red snappers, 8,800 pounds; groupers, 20,000 pounds.

Sturgeon and shad in the Suwance River.—Sturgeon are found in nearly all of the rivers of the west Florida coast at certain seasons of the year, but very little attention is given to this valuable fish. In 1895 a Cedar Keys dealer sent a small party of fishermen with gill nets to the Suwanee River to make trials for fish and determine the best parts of the river for fishing. It was not expected that much would be done that year, as the visit was rather late, but as a result of the observations then made the matter was taken up again in November, 1896, fishing was actively begun, and a number of sturgeon had been secured at the time of the investigation.

In June, 1892, the Fish Commission made a plant of 750,000 shad fry in the Suwanee River, and on several occasions the catching of mature fish has been reported from that stream, but the results have been so meager that it was not supposed the experiment had been successful. The sturgeon fishermen who made a prospective trip to this river in 1895 reported that they had seen large quantities of shad going up the stream, and that they had caught a few and identified them as the "white shad" of the Atlantic coast. As some of these men were formerly engaged in shad fishing on Albemarle Sound, it is probable that they were correct in their identification. This year the sturgeon fishermen intend to use a number of shad gill nets in connection with their sturgeon fishing, and are in hopes of making profitable catches. A drawback to the use of nets on this river is the great number of stumps and sunken logs which interfere with the fishing. If shad are caught in paying quantities, it is probable that an effort will be made to improve the bed of the river in certain spots that are favorable for the use of drift gill nets.

Turtle and terrapin fishing.—In 1895 the taking of green turtles was engaged in by 42 Cedar Keys fishermen. These used 28 sail and row boats, valued at $5,405, and 43 turtle nets, worth $1,290. The number of turtles taken was 2,651, weighing 107,610 pounds and valued at $6,981. The average weight was only 40 pounds. In 1890 113 turtle nets were used in this place; these took 89,958 pounds of turtle, having a value of $6,297. The turtle fishermen and larger boys of Cedar Keys make quite a business of getting terrapins, which are usually caught with the hands. About 30 cents apiece is the average price received by the fishermen. In 1895 the catch amounted to 11,400 pounds, valued at $1,250. This was an increase over 1890, when the output was 4,180 pounds. The average weight of the terrapins is 3 pounds.

Summary of Cedar Keys fisheries.—In 1895 the fisheries of this place gave employment to 246 persons; of these, 230 were in the fisheries proper, 6 were engaged in transporting fishery products to market, and 10 were employed in various capacities on shore. The aggregate capital invested in this industry was $26,651. The leading items in the investment were 123 vessels and boats valued at $13,910, apparatus of capture worth $2,702, shore and accessory property valued at $1,539, and cash capital $8,500. The fishery products weighed 1,726,658 pounds, and had a value of $33,888; of this sum, fishes represented $23,652, reptiles $8,231, and mollusks $2,005.

The foregoing figures do not include the sponge vessels which take out papers at the Cedar Keys custom-house, but are owned or make their headquarters elsewhere.

THE FISHERIES OF APALACHICOLA AND VICINITY.

General character and extent.—The fisheries prosecuted from Apalachicola, Carrabelle, and other points in Franklin County are of a varied character and in the aggregate are quite important, although no single branch is of special prominence. The principal fisheries are the sponge, oyster, and mullet, although a number of other fish are taken in comparatively large quantities with gill nets, seines, and other apparatus. Apalachicola ranks next to Key West and Pensacola in the value of its fisheries, and this prominence seems quite remarkable in view of the exceedingly poor facilities for shipping the catch. The establishment of railroad communication, which is now assured, will greatly increase the fishing industry of Apalachicola and vicinity, as the resources are sufficiently great to permit a very large expansion of the fisheries over their present extent.

The oyster industry.—There are probably more extensive natural oyster-grounds in the vicinity of Apalachicola than elsewhere on the west Florida coast. The physical features of the entire coast of Franklin County are very favorable for oysters, a series of islands and reefs forming protected bays and sounds which have an abundant growth of oysters and are admirably adapted to oyster cultivation.

The oyster-grounds have been rather seriously damaged by natural causes within the past two or three years and their productiveness has been impaired, as shown by the comparative statistics available. The approximate location and extent of some of the principal grounds in the Apalachicola region are as follows:

Sneed Bar: This, the most important bed, is located east of Apalachicola in St. George Sound near East Point. It is about 2¼ miles long and one-quarter of a mile wide. There are no evidences of decrease on this ground. The freezes in December, 1894, and February, 1895, affected only the edges of the bed near the shore, but the hurricane of 1894 swept a great many oysters off the bar into deep water, where they were smothered in the mud.

Peter Bar: This ground is about 3 miles east of Sneed Bar, and is 2 miles long but quite narrow. It was ruined during the hurricane of 1894 and the two freezes mentioned. No oysters are now taken from it.

Bulkhead Bar: This ground lies south of Sneed Bar, and is practically a continuation of the latter. It is about a mile long and one-half to three-quarters of a mile wide. Only a few oysters are taken from it. It was affected somewhat by the hurricane of 1894.

East Hole Bar: This bar is south of Bulkhead Bar and is somewhat over a mile long and from one-quarter to one-half of a mile wide. The extreme cold in 1894 and 1895 killed some oysters, and the hurricane also did considerable damage. Oysters are taken from this ground every year.

Porter Bar: This lies east of Sneed Bar. It is several miles in length but quite narrow. A few years ago it was one of the most important oyster-grounds in this region, but its productiveness has been greatly reduced by the natural phenomena mentioned.

Silby Bar: This lies southeast from Porter Bar, near St. George Island. It is about half a mile long and very narrow. The oysters taken from this ground have been used chiefly for canning, as they have a thin shell which prevents their being shipped any great distance. The supply is reported to be increasing, probably on account of the small amount of tonging recently carried on.

West of the Apalachicola River, in St. Vincent Sound, and in the western end of St. George Sound, there are a number of small bars containing oysters of good quality, but the supply has been greatly reduced by storms and excessive tonging. Northeast of Apalachicola, in Apalachicola Bay, there are good oyster-grounds, the most important being the St. Mark Bars. The oysters from these bars are very large, and during the winter of 1895–96 a number of lots, when shucked, yielded about 1¼ gallons of meats to the bushel.

In 1895 and 1896, the United States Fish Commission steamer *Fish Hawk* made a survey of the oyster-grounds in the vicinity of Apalachicola. The report of the investigations appear in the United States Fish Commission Report for 1896 (pp. 187–221).

While natural agencies have undoubtedly done some injury to the oyster-grounds, excessive tonging without any efforts to replenish the beds has been a potent factor in the decrease. It has been the practice of many of the oystermen to move out into deep water to cull their catch; in this way all the spat and small oysters adhering to the old shells are destroyed, by being covered with mud, and the beds are further damaged by the removal of the materials to which new spat may adhere. This appears to have been done in violation of law, as there is a statute prohibiting the culling of oysters anywhere except over the bed from which the oysters were taken.

While some of the fishermen of this section say there has been no decrease in the oyster supply, the majority of those interested think differently, and the investigations of the Commission substantiate the latter view. The quantity of oysters taken in Franklin County in 1895 was only 27 per cent that in 1890. This decrease was in part due to a reduction in the extent of the canning business, which consumes a large quantity of oysters. There were two canneries in operation in 1890 and only one in 1895, but one of the main reasons for shutting down one of the canneries was the fact that the supply was not sufficient to keep both canneries running on full time. The manager of the cannery now in operation states that no difficulty is experienced in getting enough oysters for his purposes, but that he is compelled to use a quality that is inferior to that previously utilized, owing to the depletion of the best grounds. No attempts have been made to cultivate oysters in this county, but the conditions are very favorable for oyster planting, and the Commission's investigations have shown a large area suitable for this purpose.

In 1895 the oyster industry of Apalachicola and Carrabelle gave employment to 168 persons; of these, 128 were engaged in tonging and 40 in the canning business or in other capacities on shore. The oyster vessels and boats numbered 56 and were valued at $8,935. The apparatus with which oysters were taken (93 pairs of tongs) was valued at $635. The quantity of oysters taken was 60,389 bushels, for which the oystermen received $14,101, an average price of 23 cents a bushel. In 1890 the oyster output of this county was 218,326 bushels, having a value of $36,971—an average of 17 cents a bushel.

The sponge industry.—The sponge fishery of Apalachicola is engaged in by a small fleet of vessels and decked boats, with an average size of less than 6 tons. Only 7 of the fleet in 1895 were large enough to take out custom-house papers, the others, 11 in number, being of 3 or 4 tons burden. The vessels and boats, without their apparatus and outfit, had a value of $7,420. The crews numbered 86.

The Apalachicola sponge vessels usually go to the Rock Island grounds early in the season, then to Sea Horse Key, off Cedar Keys, then down the coast to the Anclote region. The grounds between Sea Horse Key and Anclote are those most resorted to. Most of the catch is sold to Tarpon Springs dealers. Nearly all of the sponge vessels engage in oystering a part of the year, and several of them are also employed in transporting fish.

The product of the sponge fishery of Apalachicola in 1895 was 7,356 pounds of sponges, almost all of the sheepswool variety, for which the dealers paid $11,981.

There are two sponge-dealers at Apalachicola who handle chiefly the catch of the local fleet. One of these also makes purchases at Anclote, where the principal part of this business was done in 1895. The handling of sponges gave employment to 19 persons. The value of the sponge warehouses and fixtures was about $4,150. The cost price of the sponges purchased in 1895 was $16,267. This sum, however, does not represent the value of the Apalachicola sponge fishery, as some of the vessels did not sell to local dealers and as the latter bought from outside vessels.

Seine and gill-net fishing.—The taking of fish by means of seines and drift gill nets is the most prominent feature of the fishing industry of Apalachicola and Carrabelle; more persons find employment in this branch, more capital is invested therein, and more products are taken than in any other fishery. The fishery is more extensive at Apalachicola than at Carrabelle.

In 1895 the number of persons who engaged in this form of fishing was 335; 147 of these used gill nets and 255 used seines, 67 persons employing both kinds of apparatus. The gill nets numbered 69, had an aggregate length of 44,400 feet, and were valued at $1,895; the mesh is from 3 to 3½ inches. Forty seines were operated; these had a combined length of 26,955 feet, and were worth $3,280; the mesh was 2½ to 3 inches. In the setting and hauling of the nets and seines, 78 sail-boats and 53 rowboats were used, and in transferring the catch from the fishing-grounds to the markets 19 small vessels were employed; the investment in boats and vessels was $10,200.

The principal fishes taken in the seine and gill-net fisheries of this county are mullet, sheepshead, Spanish mackerel, pompano, trout, redfish, spot, and whiting, a number of others being secured in small quantities. The mullet is the leading species, and is sold in very large quantities in a fresh and salted condition. The principal season for mullet is October and November, when the fish are near the shores, and are mostly taken in seines; in August and September the most of the catch is in gill nets, the fish then being in deep water. The principal spawning time of the mullet in this section is December, although ripe fish are found as late as February. The trout or squeteague ranks next to the mullet in value. It is taken in largest quantities during cold weather, when it congregates in deep holes and may be readily caught with a seine, while in warm weather the schools scatter. The sheepshead is most common from December to the last of March. The best season for pompano is from April 15 to May 15, and for Spanish mackerel from March 15 to May 1, though some pompano are taken in October and November. The redfish or channel bass is taken principally in February, March, and April.

Among the food-fishes of Franklin County that are not now utilized, although abundant, are pinfish, sturgeon, and catfish. Large quantities of pinfish are taken each year, but as there is no sale for them they are thrown back into the water. Sturgeon are reported to be very common in the rivers, but they are not sought. There are immense quantities of catfish in the streams, but their food value is not appreciated, and up to 1896 no attention was paid to them. In this year, however, an Apalachicola dealer began to purchase and ship them to various parts of the country.

The yield of these fisheries in 1895 was over 3,000,000 pounds, with a value to the fishermen of more than $73,000. The quantity taken with seines was nearly double that obtained with gill nets. Mullet, fresh, salted, and in the form of roe, constituted five-sixths the quantity and eight-ninths the value of the catch. The importance of each product is shown in the following summary of the yield:

Species.	Pounds.	Value.
Angel-fish	100	$2
Bluefish	410	11
Channel bass	42,865	721
Drum	800	12
Flounders	300	6
Kingfish	600	30
Mullet, fresh	932,012	11,072
Mullet, salted	1,524,000	47,146
Mullet roe, fresh	2,150	215
Mullet roe, salted	60,200	6,020
Pigfish	500	25
Pompano, fresh	903	28
Pompano, salted	5,000	250
Sheepshead, fresh	34,570	633
Sheepshead, salted	3,000	90
Spanish mackerel	1,320	37
Spots	3,400	93
Trout, fresh	359,000	5,459
Trout, salted	40,000	1,600
Whiting	1,300	20
Total	3,013,030	73,470

The red-snapper fishery.—A little fishing for red snappers and groupers was carried on from Carrabelle in 1895, a small sloop and a small schooner, each with 3 men, being employed. It is reported that one of the finest snapper banks off the Florida coast is located a few miles southeast of Dog Island, which is about 9 miles from Carrabelle. Owing to the very shoal water in the entrance to the harbor of this place, only very small boats can reach the wharves. The fishery, however, can not be successfully carried on except by boats large enough to remain on the grounds in moderate storms. The fishery, which was inaugurated in 1895, proved a failure, owing to the draft of water of the vessels employed, only 5,000 pounds of snappers and 2,500 pounds of groupers being landed. The fishery was not resumed in 1896.

Line fishing.—Besides the small snapper fishery alluded to, line fishing for both fresh-water and salt-water fishes is carried on from this county, and is a branch of considerable importance. The prominent salt-water species are sheepshead, trout, and redfish. The fresh-water fishes are black bass and other species of the same family found in the Apalachicola and New rivers.

In 1895 the line fishery for salt-water species was followed by 18 persons and for fresh-water species by 21 persons. The number of boats used was 39, valued, with their equipment, at $854. The catch, amounting to 54,600 pounds of salt-water fish valued at $1,010, and 43,400 pounds of fresh-water fish worth $1,897, was divided as follows among the different species: Redfish, 21,000 pounds, $365; sheepshead, 12,100 pounds, $217; trout, 18,000 pounds, $340; Spanish mackerel, 3,500 pounds, $88; black bass, 12,300 pounds, $465; bream, 17,300 pounds, $796; perch, 13,800 pounds, $636.

Alligator and otter hunting.—A small business in hunting alligators and otters for their skins is carried on from Apalachicola and Carrabelle. At the former place 21 persons and at the latter 17 persons engaged in this branch in 1895. Thirty-two boats, valued at $640, were used. The apparatus, consisting of guns for alligators and traps for otters, was valued at $506. The hunting is done in the fresh waters adjacent to the coast. Neither of the animals sought is as abundant as formerly, and the year's work resulted in the taking of only 550 alligators, whose hides were worth $285, and 186 otters, whose pelts had a value of $713.

Turtle fishing.—At Carrabelle an unimportant turtle fishery is prosecuted. In 1895 3 men in a small vessel, equipped with 3 turtle nets, sought turtles during a part of the year, frequenting grounds on the coast of Franklin County. Only 110 green turtles were obtained. These had an aggregate weight of 3,850 pounds, and yielded the fishermen $270, or 7 cents a pound.

FISHERIES OF PENSACOLA.

General character and importance.—Next to Key West Pensacola is the most prominent of the Florida fishing centers. Besides a vessel line fishery that is more extensive than any other in the State, Pensacola supports important shore fisheries with lines, seines, etc., and also an oyster fishery. The city is favorably located in respect to the important fishing banks, and has ample railroad facilities for shipping the products to eastern, northern, and western points.

The red-snapper fishery.—It is this fishery which gives to Pensacola its chief importance as a fishing center and has brought the place into prominent notice from a fishing standpoint. The taking of red snappers here not only reaches larger proportions than elsewhere in the United States, but the product is many times greater than at all other centers combined.

The red-snapper fishery is essentially a vessel fishery, although it is engaged in by a few small sailboats which frequent the nearer grounds. The snapper vessels now employed vary in size from 5 to 54 tons and carry from 5 to 10 men. Their average size is about 29 tons and their average crew is 7. Their average value, inclusive of outfit, is $5,587. With a very few exceptions they are schooner-rigged, only 2 sloops being employed in 1895. Each vessel carries two or more boats, from which a part of the fishing is done.

The lines used are valued at about $1 each. The usual complement is 2 to each man of the crew, besides which 3 or 4 lines to a man are kept in reserve. The boats engaged in the shore snapper fishery carry about 5 men each and are valued at $125 on an average. The lines are fewer and less expensive than those used in the vessel fishery.

During the six warmer months of each year the snapper vessels resort to those banks lying between Ship Island and Tortugas, and during the remainder of the year on the great Campeche Bank, lying off the coast of Yucatan. Snappers could probably be caught off the Florida coast during the colder months were it not for the very unsettled weather there encountered. On the Campeche Bank good weather prevails, the water is warmer, and the snappers can be caught with great facility. The location, depth, extent, and general character of the various fishing-grounds for snappers have been fully described in a number of reports of the Commission.* The bait used in the snapper fishery consists entirely of pieces of fish, the principal species being snappers, groupers, bluefish, sharks, lady-fish, menhaden, and other fish found on the banks. Salted lady-fish is a favorite and much-used bait. Some of the bait is carried from shore, but a fair proportion is caught on the fishing-grounds.

The usual time consumed on a trip to the more distant banks is two weeks, but a vessel may return from the nearer grounds in a week, or less. The average number of trips during a season is now about 22. Necessary repairs to the vessels and inclement weather occasion delays.

A change in the method of conducting this fishery has taken place in comparatively recent years. Ten years ago many of the vessels were well-smacks, and the fish as caught were placed in wells and landed

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*See especially the following:

Report of the discovery and investigation of the fishing-grounds made by the Fish Commission steamer *Albatross* during the cruise along the Atlantic Coast and in the Gulf of Mexico, with notes on the Gulf fisheries. Report U. S. Fish Com. 1885.

Report upon an investigation of the fishing-grounds off the west coast of Florida. Bulletin U. S. Fish Commission 1890.

The red-snapper fishery. Fisheries and Fishery Industries of the United States, Sec. V, vol. 1, 1887.

alive. In 1890 the well-smack had nearly gone out of use at Pensacola, and as repairs became necessary the vessels were made over into tight-bottom craft, and by 1895 there were no vessels of this class belonging at Pensacola. It is reported that they were given up owing to the losses sustained in bringing the fish from the cold water of the Gulf to the warmer waters encountered near shore. With the tight-bottomed vessels the fishing may be done in deeper water, and larger fares are obtained than when welled vessels were used. Now, as soon as the fish are caught they are killed and packed in ice in storage compartments near the center of the vessel. The larger vessels have storage room for 4,500 or 5,000 fish, the capacity of the others being proportionate to their size.

The arrangement between the vessel-owners and fishermen is as follows: The owners furnish the ice and bait, and when a vessel returns these items are deducted from the gross value of the fish. Of the remaining stock, 40 per cent is set aside as the vessel's share; out of the 60 per cent, the cost of the provisions and lines is taken. The balance is then divided among the men in the following proportions: The captain, first hand, and cook get 1⅛ shares each; other members of the crew 1 share each. The captain also receives 15 per cent of the vessel's share as a bonus. If a vessel has a broken trip or a poor catch, and has not secured enough fish to pay the expenses of a trip, the owners, on account of the difficulty of getting good crews, usually make no effort to collect the balance due them, as it has been found that under other treatment the crews are liable to give up their situations on returning with a small fare.

The cost of fitting out a vessel for red-snapper fishing is considerable. In addition to the lines and dories, the expense for ice, bait, fuel, provisions, and general stores for each trip of a large-sized vessel is about $175; ice, at $8 per ton, being the largest item.

Up to 1895 the snapper catch was divided into the following grades by the Pensacola dealers: Small snappers, or "rats," which weigh 3½ pounds or less; medium snappers, which weigh more than 3½ pounds and up to 7 pounds; large snappers, or "counts," which weigh over 7 pounds and average 10 pounds. The prices received by the fishermen for the various sizes were 4½ cents a pound for the small, 3½ cents a pound for the medium, 25 cents each for the large for the first 600, and 20 cents each for the remainder. On June 15, 1895, a new schedule of prices went into effect and this still prevails; it is as follows: For all snappers under 7 pounds in weight, 3½ cents a pound; for all snappers over that weight, 20 cents each for the first 1,000, 15 cents each for the second 1,000, and 10 cents each for the remainder. The price of groupers to the fishermen has remained at 1 cent a pound.

In 1895 the snapper fishery centering at Pensacola gave employment to 42 vessels, with an aggregate tonnage of 1,209.62 and with a value, including outfits, of $234,650. The number of sailboats employed was

12, with a value of $1,500. The value of the lines, hooks, and leads used was $1,114. The number of persons who engaged in the fishery was 280 on the vessels and 60 on the boats. The yield, amounting to 5,163,532 pounds, was valued at $155,714, and was divided as follows between the vessel and shore fisheries and snappers and groupers:

	Pounds.	Value.
Red snappers:		
Caught by vessels	4,587,715	$144,855
Caught by boats	195,815	6,959
Total	4,783,530	151,814
Groupers:		
Caught by vessels	358,514	3,685
Caught by boats	21,488	215
Total	380,002	3,900
Grand total	5,163,532	155,714

The history of the Pensacola snapper fishery during the past twenty years shows an almost unbroken annual increase in the number of vessels engaged, a consequent increase in the persons finding employment, and an augmented catch. During the season of 1874–75, the first year for which statistics are available, there were 11 snapper vessels at Pensacola. Their tonnage was 328, and their crews numbered 60. The subsequent growth of the fishery to 1895, when it was more extensive than in any other year, is shown in the following table, which covers all vessels that regularly landed their fares at Pensacola. A few vessels, each year, owned in other places, have made their headquarters at this port.

Year.	Number of vessels.	Tonnage.	Number of men.	Year.	Number of vessels.	Tonnage.	Number of men.
1875	11	328.22	60	1883	24	662.91	133
1876	13	376.95	71	1884	25	577.96	140
1877	11	323.47	57	1885	27	751.56	163
1878	10	297.10	64	1886	33	1,149.10	231
1879	11	282.12	60	1889	35	980.25	218
1880	14	302.11	71	1890	34	973.65	218
1881	21	458.03	108	1895	42	1,209.62	280
1882	26	732.39	150				

During a severe storm on July 7, 1896, the fishing fleet of Pensacola suffered some damage. Two snapper vessels of one company and 4 of another company were sunk at their docks. They were, however, raised and repaired at considerable expense.

The aggregate catch of red snappers by the fleet rendezvousing at Pensacola is known for the years 1889, 1890, and 1895, and may be given approximately for 1880 and 1884. The following comparative summary, with the average catch per vessel and per man, is quite instructive. The statistics show a steady increase in the yield, the output for 1895 being more than three times as large as in 1880. It appears that in 1880 the average catch of snappers to a vessel was

103,571 pounds and to a man 20,423 pounds, while in 1895 the averages were 109,231 pounds and 16,385 pounds, respectively. The apparent inconsistency of a diminished catch per man associated with an increased catch per vessel is explained by an average increase of about two men per vessel between 1880 and 1895.

Comparative summary of the Pensacola red-snapper catch.

Year.	Pounds.	Average catch.	
		Per vessel.	Per man.
1880	1,450,000	103,571	20,423
1884	2,380,800	95,232	17,006
1889	3,554,176	101,548	16,304
1890	4,144,842	121,907	19,013
1895	4,587,715	109,231	16,385

These bare figures do not suggest that there has been any noteworthy diminution in the snapper supply, but when considered in connection with an increased carrying capacity of the vessels and a more assiduous prosecution of the fishery, the more recent years show a decided decline. Had the conditions been the same, and had the fishermen in 1890 and 1895 made the same average catch as did those in 1880, the aggregate output of the fishery in 1890 and 1895 would have been 5,252,000 pounds and 6,766,000 pounds, respectively. In September, 1890, the Pensacola dealers issued the following joint circular to the trade, in which the decrease in the snapper supply was referred to:

On and after October 1, 1890, the price of all sizes of red snappers will be advanced one-half cent per pound from the prices now in use. The growing scarcity of red snappers and the increased cost of catching these fish have compelled us to make this advance. For a year past our smacks and crews have been doing a starvation business. Where formerly they were able to land a fare of fish three or four times a month, they can now only make two trips a month. They are now obliged to go from 200 to 400 miles from Pensacola to find fish in paying quantities.

The seine and gill-net fisheries.—Next to the taking of red snappers, the seine fishery is the most important branch of the fishing industry of Pensacola. In it both vessels and boats are employed, although by far the more extensive fishing is done from small boats, only two vessels being used in 1895.

The seines are hauled for what are known as "beach fish," consisting chiefly of bluefish, mullet, and Spanish mackerel, although a large variety of fishes is taken. The seines, which are about 500 feet long and worth from \$100 to \$150 each, have a 2½-inch mesh and are operated by five or six men.

In 1895 the number of persons engaged in this fishery in Pensacola, Warrenton, and the adjacent bays was 147, of whom 17 were in the vessel fishery. The number of seines in use was 29, with an aggregate length of 18,360 feet and a value of \$3,075. The tonnage of the 2 vessels aggregated 42.74. These were worth, with their outfits, \$3,400. The boats employed numbered 26 and were worth \$1,640.

The following table shows the quantity and value of the fishes taken in the Pensacola seine fishery in 1895. From this it will be seen that considerably more than half of the catch consisted of mullet. Of the 1,071,414 pounds credited to this fishery 1,030,000 pounds were taken in the boat fishery and only about 41,000 pounds in the vessel fishery.

Species.	Pounds.	Value.
Bluefish	83,202	$1,656
Channel bass	9,825	153
Mullet	612,071	7,981
Pompano	17,908	1,099
Sheepshead	40,662	764
Spanish mackerel	107,430	4,877
Spot	15,695	297
Trout	38,949	1,514
Jurel	63,388	761
Yellow-tail	9,010	119
Angel-fish	14,486	181
Crevalle	14,165	138
Bream	7,180	223
Lady-fish	22,655	227
Whiting	7,689	77
Other fish	6,659	135
Mobilians (terrapins)	440	14
Total	1,071,414	20,216

There is a gill-net fishery, carried on principally for mullet, which is of comparatively little importance. In 1895 it was engaged in by 18 persons, who operated 9 gill nets from 9 boats. The nets had an aggregate length of 4,320 feet, a 3½-inch mesh, and were valued at $1,118. The quantity and value of the species taken were as follows: Bluefish, 3,199 pounds, $132; channel bass, 922 pounds, $13; mullet, 86,558 pounds, $1,155; Spanish mackerel, 5,844 pounds, $292; trout, 6,440 pounds, $226.

Spanish mackerel and pompano have been decreasing in this vicinity during the past few years. Fifteen years ago pompano were very abundant, and brought better prices than they do now. At the opening of the season the dealers have paid as much as $1 per fish. When the price dropped to 15 cents per fish, the fishermen became discouraged. The present price is only 5 cents a pound, or about 10 cents per fish.

An apparent relation has been observed between the abundance of bluefish on the Atlantic coast and in the Gulf of Mexico. About ten years ago, when there was a period of scarcity of bluefish on the eastern seaboard, these fish were very abundant in the Gulf, but as soon as they reappeared in numbers on the Atlantic coast they became scarce on the west coast of Florida.

The oyster industry.—Although much less extensive than some of the other fisheries of Pensacola, the oyster fishery is of considerable importance and possesses some interesting features. The oysters are taken for market from both natural and cultivated grounds.

The principal natural oyster beds in the vicinity of Pensacola are in Escambia and East bays, oysters of excellent quality being found on all the reefs and bars. The supply of marketable oysters on these grounds, however, has never been very large, not even enough being taken to meet the demands of the local market. Owing to excessive tonging and the effects of storms, the supply has been steadily decreasing. The heavy storm of July 7, 1896, was especially destructive, and nearly effected the ruin of all the beds in both bays by sweeping some of the reefs clean and by flooding the others with mud. Accompanying the storm was a heavy rainfall which caused the Escambia and other rivers emptying into the bays to rise to a great height, making the water on the oyster-grounds so fresh that most of the oysters that had survived the storm were killed. The greatest damage was done in Escambia Bay. In the fall and winter of 1896–97, almost the only places where oysters could be secured were in East Bay and Blackwater Bay, an offshoot of East Bay, where the beds were somewhat protected.

Perdido Bay, which is on the line dividing Florida and Alabama, at one time contained a number of good oyster beds which yielded a large supply each year. The entrance to the bay from the Gulf is quite tortuous and some years ago, in an effort to straighten it by cutting new channels through several points, it is reported that the water was made too salty and the oysters died. The few oysters still surviving do not pay for the labor of tonging.

The decrease in the productiveness of the natural beds has led to the institution of oyster-culture, and it seems probable that the business of the future will depend largely on cultivation. It is stated that oyster-planting in this region began in 1888, when one person planted about 6,000 bushels on prepared ground in Escambia Bay and Santa Rosa Sound; in the two following years 7,500 and 12,000 bushels of seed, respectively, were planted. The seed were obtained in Escambia, East, and St. Andrews bays. From this the business increased until now there are a number of persons having beds of cultivated oysters in the vicinity of Pensacola. The bottom on nearly all sides of Escambia Bay is from 6 to 10 feet deep, and is a mixture of sand and mud that is thought to be well adapted to the raising of oysters.

No difficulty has been experienced in the business except that of keeping poachers off the beds. The stealing of oysters became such a nuisance and caused so much loss that owners of cultivated beds joined together for mutual protection and had several trespassers arrested and convicted. Lately the legislature passed a law providing that the owner of the shore front is the only one who can establish an artificial bed; he is allowed to take up 200 yards of shore extending out to the main channel. As a large part of the land along these bays belongs to nonresident persons who purchased it for the timber and who have no inclination to engage in oyster-culture, this law renders unavailable considerable good bottom. The planting of oysters and the claiming of ownership in the beds so planted is not popular among the tongers of Pensacola, and it would appear that sufficient protection is not afforded by the State. The artificial beds suffered equally with the natural grounds during the storm of July 7, 1896, and it is possible that some of the owners will not replant, especially as their business has entailed heavy losses up to the present.

In 1895 the oyster fishery of Pensacola and the adjacent bays gave employment to 66 persons, who used 34 sailboats and took 21,850 bushels of oysters having a value of $6,916. The oysters are all taken by means of tongs. The capital invested in this business, exclusive of the value of the oyster beds, was $4,112.

Statistical recapitulation.—The fishing industry centering at Pensacola had the following extent in 1895: Persons employed, 535; vessels, 42, valued at $234,650; boats, 99, valued at $6,940; value of apparatus of capture, $4,521; value of shore property and cash capital, $112,805; total investment, $358,916; pounds of products taken, 6,490,889; value of the catch, $184,664.

STATISTICS OF THE FLORIDA FISHERIES.

In the following series of tables, the extent of the fishing industry of the coastal waters of Florida is shown in detail by counties. The figures relate to the calendar year 1895, with the exception of those pertaining to the northeast coast, as explained in the preceding text.

The county tables will be found to differ in some minor respects from the figures credited to the principal regions, in the discussion of which the object was to show the importance of the fishing centering there, without regard to county limits.

Table showing by counties the persons employed in the coast fisheries of Florida.

Counties.	On vessels fishing.	On vessels transporting.	In shore fisheries.	Shoresmen and preparators.	Total.
East coast.					
Brevard		2	211	41	254
Dade	12		88	1	101
Duval			199		199
Nassau		4	126	130	260
St. John			80	15	95
Volusia			84	5	89
Total	12	6	788	192	998
West coast.					
Citrus			70	7	77
Calhoun			32	1	33
De Soto		14	230	25	269
Escambia	267		226	29	522
Franklin	54		574	92	720
Hernando			40	2	42
Hillsboro	117	26	303	25	471
Lafayette			32	2	34
Lee			267	9	276
Levy	18	6	238	10	272
Manatee		7	180	9	196
Monroe	839	10	716	76	1,641
Pasco			10		10
Santa Rosa	6		3		9
Taylor			136	3	139
Wakulla			200	9	209
Washington	26		196	14	236
Total	1,327	63	3,453	313	5,156
Grand total	1,339	69	4,241	505	6,154

Table showing by counties the vessels, boats, apparatus, etc., employed in the coast fisheries of Florida.

Counties.	Vessels. Fishing. No.	Fishing. Tonnage.	Fishing. Value.	Fishing. Value of outfit.	Transporting. No.	Transporting. Tonnage.	Transporting. Value.	Transporting. Value of outfit.	Boats. No.	Boats. Value.
East coast.										
Brevard	1	8.09	$375	$25	....	....	....	....	107	$6,390
Dade	2	18.21	1,800	125	....	....	....	....	53	3,295
Duval	....	....	....	....	....	....	....	....	97	2,350
Nassau	....	....	....	....	2	28.96	$750	$240	119	4,911
St. Johns	....	....	....	....	....	....	....	....	52	1,410
Volusia	....	....	....	....	....	....	....	....	59	1,994
Total	3	26.30	2,175	150	2	28.96	750	240	487	20,350
West coast.										
Calhoun	....	....	....	....	....	....	....	....	15	390
Citrus	....	....	....	....	....	....	....	....	43	1,260
De Soto	....	....	....	....	7	51.33	4,550	3,400	140	10,382
Escambia	37	1,116.66	95,775	123,360	....	....	....	....	99	6,940
Franklin	12	89.63	6,970	2,196	....	....	....	....	292	22,465
Hernando	....	....	....	....	....	....	....	....	20	700
Hillsboro	14	168.87	15,500	8,550	12	140.97	22,050	5,310	181	9,465
Lafayette	....	....	....	....	....	....	....	....	16	480
Lee	....	....	....	....	....	....	....	....	218	7,560
Levy	2	22.41	3,200	1,275	2	20.15	2,700	880	123	8,855
Manatee	....	....	....	....	2	18.77	2,200	1,320	202	17,640
Monroe	112	1,273.46	135,257	89,625	2	50.09	4,000	500	280	49,911
Pasco	....	....	....	....	....	....	....	....	2	10
Santa Rosa	1	13.29	1,200	1,478	....	....	....	....	2	200
Taylor	....	....	....	....	....	....	....	....	68	1,700
Wakulla	....	....	....	....	....	....	....	....	113	3,420
Washington	5	58.57	5,300	2,561	....	....	....	....	78	3,540
Total	183	2,742.89	263,202	229,045	25	282.21	35,500	11,419	1,892	144,918
Grand total	186	2,769.19	265,377	229,195	27	311.17	36,250	11,659	2,379	165,268

Counties.	Apparatus of capture. Seines. No.	Seines. Length (feet).	Seines. Value.	Gill nets. No.	Gill nets. Length (feet).	Gill nets. Value.	Turtle nets. No.	Turtle nets. Value.	Cast nets. No.	Cast nets. Value.	Pound nets and trap nets. No.	Pound nets and trap nets. Value.
East coast.												
Brevard	2	3,825	$265	221	162,300	$7,400	66	$660	....	....	1	$3
Dade	3	4,500	300	7	8,400	350	46	1,000	....	....	1	400
Duval	13	2,925	580	119	114,150	4,745	....	....	100	$500	....	....
Nassau	9	2,700	180	3	1,800	120	....	....	19	100	....	....
St. Johns	7	1,205	150	14	2,400	190	....	....	30	150	....	....
Volusia	11	4,125	450	35	15,750	980	50	250	20	110	3	60
Total	45	19,280	1,925	399	304,800	13,785	162	1,910	169	860	5	463
West coast.												
Calhoun	4	3,000	400	....	....	....	....	....	....	....	....	....
Citrus	....	....	....	27	16,200	540	....	....	....	....	....	....
De Soto	....	....	....	143	110,050	3,592	....	....	....	....	....	....
Escambia	26	16,740	2,700	9	4,320	360	....	....	27	150	....	....
Franklin	40	26,955	3,280	60	44,400	1,805	3	90	....	....	....	....
Hernando	....	....	....	20	12,000	440	....	....	....	....	....	....
Hillsboro	38	21,225	1,070	111	62,107	3,244	2	55	....	....	....	....
Lafayette	....	....	....	16	10,800	352	....	....	....	....	....	....
Lee	45	23,850	2,370	48	25,300	1,499	2	65	....	....	....	....
Levy	....	....	....	50	28,800	1,146	43	1,290	....	....	....	....
Manatee	78	30,150	2,350	206	149,400	6,094	54	1,890	27	180	24	72
Monroe	13	2,040	190	3	540	54	....	....	....	....	....	....
Pasco	1	225	25	2	450	19	....	....	....	....	....	....
Santa Rosa	2	1,080	250	....	....	....	....	....	....	....	....	....
Taylor	....	....	....	68	45,900	1,496	....	....	....	....	....	....
Wakulla	7	3,675	210	54	20,250	810	....	....	6	35	....	....
Washington	32	18,900	4,705	4	2,400	100	....	....	....	....	....	....
Total	286	147,840	17,559	830	522,917	21,641	104	3,380	60	365	24	72
Grand total	331	167,120	19,484	1,229	827,717	35,426	266	5,290	229	1,225	29	535

Table showing by counties the vessels, boats, apparatus, etc., employed in the coast fisheries of Florida—Continued.

Counties.	Apparatus of capture—continued.									
	Lines.		Tongs.		Guns.		Otter traps.		Value of sponge hooks and glasses.	Value of minor apparatus.
	No.	Value.	No.	Value.	No.	Value.	No.	Value.		
East coast.										
Brevard			26	$182						
Dade	256	$49								
Duval	250	25	12	60						
Nassau	100	10	14	70						
St. Johns	200	20	5	20						
Volusia	180	20	14	60						
Total	986	124	71	392						
West coast.										
Calhoun	24	5								
Citrus			20	160						
De Soto			6	48	44	$660	15	$9		
Escambia	1,271	1,114	39	347						
Franklin	90	36	93	625	33	495	17	11	$270	
Hillsboro	50	50	5	40	20	300	20	12	326	
Lee					150	2,250	150	90		
Levy	60	22	30	240					87	$4
Manatee			8	64						
Monroe	685	163							3,047	108
Santa Rosa	24	22								
Wakulla	30	5	4	32	50	750				
Washington	48	44	20	160						
Total	2,282	1,461	225	1,726	297	4,455	202	122	3,730	112
Grand total	3,268	1,585	296	2,118	297	4,455	202	122	3,730	112

Counties.	Value of shore and accessory property.	Cash capital.	Total investment.
East coast.			
Brevard	$16,115	$10,100	$41,512
Dade	1,841	1,000	9,763
Duval	8,650	5,000	22,310
Nassau	10,500	5,000	21,881
St. Johns	2,150	800	4,890
Volusia	1,740	500	6,164
Total	40,996	22,400	106,520
West coast.			
Calhoun	50		845
Citrus	430		2,390
De Soto	1,500	15,000	39,150
Escambia	42,805	70,000	343,401
Franklin	14,138	33,500	86,131
Hernando	50		1,190
Hillsboro	20,555	50,000	130,527
Lafayette	100		932
Lee	2,100	12,000	27,924
Levy	1,530	8,500	29,738
Manatee	1,100		30,768
Monroe	68,305	135,000	498,311
Pasco	440		494
Santa Rosa	100		3,250
Taylor	280		3,476
Wakulla	1,118	3,000	9,345
Washington	3,100		10,545
Total	157,710	327,000	1,223,417
Grand total	198,706	349,400	1,329,937

Table showing by counties the quantities and values of products of coast fisheries of Florida.

Species.	East coast.									
	Brevard.		Dade.		Duval.		Nassau.		St. Johns.	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Amber-fish			1,280	$59						
Angel-fish			2,100	105						
Bluefish	33,086	$703	22,473	702	4,130	$160				
Channel bass	142,400	2,115	2,300	35	68,354	2,040	11,172	$556	22,109	$840
Crevallo	14,700	184								
Drum	10,900	140			10,950	115	12,000	125	5,000	50
Flounders	9,000	136	1,200	18						
Groupers	800	12	19,252	936						
Grunts			17,887	364						
Hogfish			1,100	45						
Kingfish			14,000	394						
Mullet, fresh	1,585,869	11,501			563,516	8,453	1,310	52	23,618	690
Mullet, salted	25,000	750								
Pompano	149,111	9,475	26,000	1,820						
Porgies			9,900	217						
Porkfish			1,600	14						
Sailor's choice	11,560	157	5,500	79						
Sheepshead	301,141	4,445	107,300	1,609	38,100	1,194	3,600	175	9,000	332
Snappers, red			12,200	810						
Snappers, gray and others	76,900	1,137	5,200	134						
Spanish mackerel	1,100	66	4,300	215						
Spots and croakers	3,500	46	1,100	16	6,020	180	5,113	250	3,000	122
Trout	200,735	2,872	980	15	83,985	2,520	27,290	1,345	39,234	1,555
Whiting	25,300	375			6,020	180	5,000	250	3,000	115
Yellow-tail			3,500	162						
Other fish	7,216	108	6,815	303	66,635	1,990	7,386	335	30,080	1,155
Crabs					1,200	30	1,300	80	1,200	65
Shrimps					16,600	662	40,000	1,500	2,025	85
Turtles, green	18,900	1,320	33,843	1,774					2,000	200
Turtles, hawksbill			25,000	276						
Tortoise shell			436	1,295						
Terrapins					1,350	225	9,000	1,200		
Oysters	42,588	2,115			21,000	900	556,500	8,175	42,000	1,800
Clams									4,800	300
Total	2,659,815	37,657	325,266	11,397	887,860	18,649	670,671	14,043	187,066	7,309

Species.	East coast—continued.				West coast.					
	Volusia.		Total for east coast.		Calhoun.		Citrus.		De Soto.	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Amber-fish			1,280	$59						
Angel-fish			2,100	105						
Bluefish			59,689	1,505					9,164	$182
Channel bass	28,320	$765	274,655	6,351			800	$13	70,000	1,050
Crevallo			14,700	184						
Drum			38,850	430						
Flounders			10,200	154						
Groupers			20,052	948						
Grunts			17,887	364						
Hogfish			1,100	45						
Kingfish			14,000	394						
Mullet, fresh	185,523	2,497	2,359,836	23,193	13,000	$260	68,218	1,024	1,710,964	25,664
Mullet, salted	22,600	781	47,600	1,531	104,000	3,380	25,000	750	150,000	3,000
Mullet roe, salted					8,000	800			1,500	105
Pompano, fresh			175,111	11,295			312	12	80,915	4,655
Pompano, salted					5,000	250				
Porgies			9,900	217						
Porkfish			1,600	14						
Sailor's choice			17,060	236						
Sheepshead	36,800	1,060	495,941	8,815			22,200	334	100,000	1,500
Snappers, red			12,200	810						
Snappers, gray and others			82,100	1,271			6,333	127	2,000	40
Spanish mackerel, fresh			5,400	281					156,900	6,876
Spanish mackerel, salted					1,100	50				
Spots and croakers			18,733	614						
Trout	29,540	815	381,764	9,122			14,210	320	70,340	1,407
Trout, salted					8,100	324				
Whiting			39,320	920						
Yellow-tail			3,500	162						

Table showing by counties the quantities and values of products of the coast fisheries of Florida—Continued.

Species.	East coast—continued.				West coast—continued.					
	Volusia.		Total for east coast.		Calhoun.		Citrus.		De Soto.	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Other fish	19,430	$516	137,562	$4,407	27,000	$1,170				
Crabs			3,700	175						
Shrimps	4,000	150	62,625	2,397						
Turtles, green	7,000	525	61,752	3,819						
Turtles, hawksbill			25,000	276						
Tortoise shell			436	1,295						
Terrapins			10,350	1,425						
Alligator hides										$525
Otter skins										1,750
Oysters	33,950	2,425	696,038	15,416			8,295	$234	50,288	3,544
Clams	800	50	5,600	350						
Total	367,963	9,584	5,107,641	98,639	166,200	6,234	145,368	2,814	2,402,071	50,298

Species.	West coast—continued.									
	Lee.		Levy.		Manatee.		Monroe.		Pasco.	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Lbs.	Value.
Amber-fish							18,600	$620		
Angel-fish	2,000	$35					27,600	1,280		
Barracuda							31,000	1,240		
Bluefish	12,000	240	19,900	$448	50,115	$1,002	9,240	770		
Bonefish or lady-fish							70,000	2,100		
Channel bass	43,000	645	75,000	1,125	98,000	1,470			400	$20
Crevalle					8,094	122	97,500	3,250		
Drum			9,855	197	15,000	225				
Flounders					12,000	184				
Groupers			20,000	200			105,380	2,527		
Grunts			814	16	13,210	198	618,980	15,867		
Hogfish							81,600	3,480		
Kingfish							420,000	7,000		
Mullet, fresh	276,800	3,291	974,068	14,676	3,385,353	25,684	43,800	1,372	200	7
Mullet, salted	1,522,780	27,843	126,000	1,620	345,000	3,470			7,800	170
Mullet roe, salted	106,000	7,620			18,100	1,267				
Pompano, fresh	18,167	908	1,200	24	31,100	1,711	105,000	10,500		
Pompano, salted	10,000	600			18,000	1,080				
Porgies							98,200	2,450		
Porkfish							11,962	1,196		
Sailor's choice	2,100	32	26,000	520	15,102	226	20,179	2,020		
Sheepshead	73,142	1,097	130,896	1,366	81,213	1,219	9,252	417	300	30
Snappers, red			8,800	213			8,400	240		
Snappers, gray and others	1,000	15	9,531	191	11.000	165	262,334	9,466		
Spanish mackerel, fresh	3,400	170	4,950	198	30,203	1,510	34,050	1,155		
Spanish mackerel, salted	8,000	560			12,000	650				
Spots and croakers			1,109	22						
Trout	22,000	440	125,231	2,818	99,000	1,980	310	31	500	50
Whiting			600	12						
Yellow-tail							64,880	6,475		
Other fish			310	6			148,326	4,479		
Crawfish							157,500	3,150		
Crabs							6,240	208		
Turtles, green	4,375	263	107,610	6,981			337,400	16,870		
Turtles, hawksbill							40,280	403		
Turtles, loggerhead							25,000	200		
Turtle eggs							6,750	810		
Tortoise shell							712	1,674		
Terrapins			11,400	1,250						
Alligator hides		8,400								
Otter skins		10,000								
Sponge, sheepswool			2,048	3,767			207,717	320,785		
Sponge, yellow							28,454	11,566		
Sponge, grass							20,240	5,162		
Sponge, glove							14,857	2,882		
Sponge, velvet							7,825	2,990		
Sponge, other							1,270	630		
Oysters			67,200	1,870	1,400	150				
Clams			6,184	135			900	36		
Conchs							500	115		
Total	2,104,764	62,159	1,728,706	37,595	4,243,890	42,313	3,142,847	445,416	9,200	277

Table showing by counties the quantities and values of products of the coast fisheries of Florida—Continued.

Species.	West coast—continued.									
	Escambia.		Franklin.		Hernando.		Hillsboro.		Lafayette.	
	Pounds.	Value.	Pounds.	Value.	Pounds	Value.	Pounds.	Value.	Pounds.	Value.
Angel-fish	14,486	$181	100	$2			15,100	$200		
Bluefish	86,401	1,788	410	11			47,105	942		
Bonefish	22,655	227								
Channel bass	10,747	166	63,865	1,086	3,005	$45	99,523	1,455		
Crevalle	77,553	899					12,515	188		
Drum			800	12			13,000	200		
Flounders	734	34	300	6			18,444	277		
Groupers	350,502	3,605	2,500	25			24,000	360		
Grunts							23,000	345		
Kingfish	383	13	600	30						
Mullet, fresh	87,348	1,180	970,012	11,827	110,000	1,375	2,810,222	19,488	100,000	$2,200
Mullet, salted	611,311	7,950	1,524,000	47,140	43,000	1,200	156,976	2,022	103,596	3,108
Mullet roe, fresh			2,150	215						
Mullet roe, salted			60,200	6,020			12,800	903	8,000	800
Pompano, fresh	17,908	1,099	903	28			121,805	6,570		
Pompano, salted			5,000	250			800	48		
Sailor's choice							24,000	360		
Sheepshead, fresh	40,662	764	46,670	850	6,213	93	138,995	2,128	3,100	62
Sheepshead, salted			3,000	90						
Snappers, red	4,365,163	138,917	5,000	200			300,000	9,000		
Snappers, gray and others					1,000	20	22,433	362		
Spanish mackerel, fresh	112,274	5,169	4,820	125			71,486	3,574		
Spots and croakers	19,695	367	3,400	93						
Trout, fresh	45,389	1,740	377,600	5,799	21,000	473	105,628	2,146	9,414	377
Trout, salted			40,000	1,600						
Whiting	7,689	77	1,300	20						
Yellow-tail	9,010	119								
Other fish	8,722	241	43,900	1,922			4,100	78		
Turtles, green			3,850	270			5,000	300		
Terrapins	440	14								
Alligator hides				285				3,000		
Otter skins				713				2,000		
Sponge, sheepswool			6,368	11,703			15,139	26,852		
Sponge, yellow			590	130			405	102		
Sponge, grass			398	88			740	214		
Oysters	152,950	6,916	422,723	14,101			441,000	17,640		
Total	6,042,022	171,472	3,590,459	104,707	184,218	3,296	4,484,276	100,754	221,110	6,547

Species.	West coast—continued.									
	Santa Rosa.		Taylor		Wakulla.		Washington.		Total for west coast.	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Amber-fish									18,600	$620
Angel-fish									59,286	1,698
Barracuda									31,000	1,240
Bluefish	10,000	$200					21,951	$439	206,286	6,022
Bonefish	1,300	13					29,268	293	123,223	2,633
Channel bass	5,550	74			23,207	$339	4,480	61	497,577	7,549
Crevalle	1,100	17					22,442	231	219,204	4,707
Drum									38,655	634
Flounders	325	13			500	9	403	16	32,706	539
Groupers	7,000	70					22,500	225	531,882	7,012
Grunts					3,910	60			650,914	10,486
Hogfish									81,600	3,480
Kingfish									420,983	7,043
Mullet, fresh	49,000	657	881,768	$12,230	728,900	7,289	101,300	1,351	12,310,953	129,575
Mullet, salted			243,148	7,294	244,500	6,113	507,023	15,210	5,714,134	130,372
Mullet-roe, fresh									2,150	215
Mullet roe, salted			2,900	290	14,200	1,420	67,361	6,736	299,061	25,961
Pompano, fresh	4,800	314			900	45	12,472	732	395,482	26,598
Pompano, salted							25,300	1,265	64,100	3,493
Porgies									98,200	2,450
Porkfish									11,962	1,196
Sailor's choice									87,381	3,158
Sheepshead, fresh	7,145	143			9,157	138	7,769	155	676,714	10,296
Sheepshead, salted							4,137	124	7,137	214
Snappers, red	68,114	2,384					130,919	3,582	4,886,396	154,536
Snappers, gray and others									315,631	10,386

Table showing by counties the quantities and values of products of the coast fisheries of Florida—Continued.

Species.	West coast—continued.									
	Santa Rosa.		Taylor.		Wakulla.		Washington.		Total fo. west coast.	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Spanish mackerel, fresh	22,500	$1,125			800	$24	32,160	$1,248	474,143	$21,174
Spanish mackeral, salted							19,940	908	41,040	2,168
Spots and croakers	1,300	20			1,109	18			26,613	520
Trout, fresh	5,100	179			12,890	204	2,565	84	911,177	18,048
Trout, salted							30,823	1,593	87,923	3,517
Whiting									9,589	109
Yellow-tail									73,890	6,594
Other fish	814	12			5,840	117	1,636	29	240,648	8,054
Crawfish									157,500	3,150
Crabs									6,240	208
Turtles, green									458,235	24,684
Turtles, hawksbill									40,280	403
Turtles, loggerhead									25,000	200
Turtle eggs									6,750	810
Tortoise shell									712	1,674
Terrapins									11,840	1,264
Alligator hides						240				12,450
Otter skins						18				14,481
Sponge, sheepswool									231,272	363,107
Sponge, yellow									29,509	11,798
Sponge, grass									21,387	5,464
Sponge, glove									14,857	2,882
Sponge, velvet									7,825	2,990
Sponge, other									1,270	630
Oysters					14,700	350	35,070	1,503	1,193,626	46,308
Clams									7,084	171
Conchs									500	115
Total	184,048	5,221	1,127,816	$19,814	1,060,613	16,384	1,088,519	35,785	31,929,127	1,111,086

RECAPITULATION.

Species.	Grand total, east and west coasts.		Species.	Grand total, east and west coasts.	
	Pounds.	Value.		Pounds.	Value.
Amber-fish	19,880	$679	Spots and croakers	45,346	$1,134
Angel-fish	61,386	1,803	Trout, fresh	1,292,941	27,170
Barracuda	31,000	1,240	Trout, salted	87,923	3,517
Bluefish	325,975	7,587	Whiting	48,909	1,029
Bonefish or lady-fish	123,223	2,633	Yellow-tail	77,390	6,756
Channel bass or redfish	772,232	13,900	Other fish	378,210	12,461
Crevalle	233,904	4,891	Crawfish	157,500	3,150
Drum	77,505	1,064	Crabs	9,940	383
Flounders	42,906	693	Shrimps	62,625	2,397
Groupers	551,934	7,960	Turtles, green	519,987	28,503
Grunts	677,801	16,850	Turtles, hawksbill	65,280	679
Hogfish	82,700	3,525	Turtles, loggerhead	25,000	200
Kingfish	434,983	7,437	Turtle eggs	6,750	810
Mullet, fresh	14,670,789	152,768	Tortoise shell	1,148	2,969
Mullet, salted	5,761,734	131,903	Terrapins	22,190	2,689
Mullet roe, fresh	2,150	215	Alligator hides		12,450
Mullet roe, salted	299,061	25,961	Otter skins		14,481
Pompano, fresh	570,593	37,893	Sponge, sheepswool	231,272	363,107
Pompano, salted	64,100	3,403	Sponge, yellow	29,509	11,798
Porgies	108,100	2,667	Sponge, grass	21,387	5,464
Porkfish	13,562	1,210	Sponge, glove	14,857	2,882
Sailor's choice or pinfish	104,441	3,394	Sponge, velvet	7,825	2,990
Sheepshead, fresh	1,172,655	19,111	Sponge, other	1,270	630
Sheepshead, salted	7,137	214	Oysters	1,880,664	61,723
Snappers, red	4,898,596	155,346	Clams	12,684	521
Snappers, gray and others	307,731	11,657	Conchs	500	*115
Spanish mackerel, fresh	479,543	21,455			
Spanish mackerel, salted	41,040	2,168	Total	37,036,768	1,209,725

*Includes $85, the value of pearls.

CONCLUSIONS AND SUGGESTIONS.

The important water resources within the borders of Florida and along the shores of the State must always be the main dependence of a comparatively large part of the population and one of the chief attractions to the visitors who annually resort to this region for health and pleasure; and if these are to be preserved some legislation is necessary. Already the alligator, one of the most interesting and valuable of the water animals of Florida, is rapidly approaching extinction owing to the unrestricted and often wanton killing during recent years, and other important products may share the impending fate of the alligator unless proper attention is bestowed on the question of their protection.

FISHES.

The only fishery for food-fishes that seems unnecessarily destructive is that for mullet, the most important of the State's fishery products. If the supply of this species is to be maintained a close season should be established, covering its principal spawning period. This might have to vary somewhat on the two coasts.

TURTLES.

The green turtle, one of the most valuable of the State's fishery products, needs protection to prevent its extermination. For a term of years, at least, the animal should be unmolested during the period when it seeks the shores to lay its eggs. There should be a minimum limit of weight for turtles that are taken to be shipped or sold locally, in order that the destruction of immature turtles may be prevented. The pernicious and destructive practice of gathering the eggs of this and the loggerhead turtle should be prohibited.

OYSTERS.

Experience has shown that the preservation of the oyster supply rests largely on the leasing or selling of grounds on which oyster cultivation may be practiced. The oyster resources of Florida are not unlimited, and it appears desirable to provide for their preservation and development by encouraging oyster-culture by private individuals. The present Florida law has in it much to commend and seems to make adequate provision, under present requirements, for oyster-planting and the protection of natural grounds, but it may in time need revision in order to provide for the more general inauguration of artificial cultivation. It is essential, however, that those to whom planting privileges are granted should be fully protected in their rights.

SPONGES.

The methods employed in the sponge fishery of Florida seriously affect the permanency of the industry, and it is believed that the interests of all concerned would be greatly promoted if changes were made in the present laws governing this fishery, such as the following:

To increase from 4 to 5 inches the minimum size of sponges which may be lawfully taken, and to enforce the law against the selling of undersized sponges; to permit the Florida Keys and Biscayne Bay grounds to be fished only during a specified part of any period of twelve months; to permit the Anclote and Rock Island grounds each to be fished only once in any period of twenty-four months, so arranging it, however, that the Anclote grounds may be worked one year and the Rock Island the next; to provide for the artificial cultivation of sponges in certain prescribed localities among the Florida Keys and Biscayne Bay by protecting those who wish to go into the business in the exclusive use of certain areas.

ESTABLISHMENT OF A BIOLOGICAL AND FISH-CULTURAL STATION.

Under the terms of the Senate resolution the Commissioner of Fisheries is directed "to report as to the advisability of establishing a station for investigation, experiment, and fish-culture at some suitable point on the coast." Many reasons make desirable the establishment of an experiment station at some point on the coast of Florida or the Gulf States. The number of important food-fishes on the Florida coast is greater than on any other coast section of the United States. Very little is known regarding the migrations, spawning habits, etc., of any of these numerous species, and nothing in the way of their artificial propagation has been attempted. From what is known of the nature of the eggs of the mullet, it is reasonably certain that a method for artificially hatching that species may be devised without special difficulty, yet the discovery and development of any such method remain to be made. Methods for the artificial propagation of several of the other valuable water products can also doubtless be developed.

The abundance on the Florida coast of other forms of animal life besides fishes, such as mollusks, crustaceans, and reptiles, is very great. Some of these are already of much importance, either as food or bait. A biological study of many of these forms would certainly prove of great commercial value as well as of scientific interest.

The field for experimentation with the various species of Florida sponges is practically a virgin one, whose cultivation promises economic results of vast importance. The careful development of a practical method by which sponges may be grown artificially, either from cuttings or from eggs, is worthy of the most serious attention. The means for extending and replenishing the natural sponge beds is a matter that should also receive consideration.

A station for the investigation of these and related questions might be advantageously established at some point on Biscayne Bay, at Key West, near Tarpon Springs, on Tampa Bay, or elsewhere on the Gulf coast. At the outset the most essential thing in connection with the establishment of such a station and the necessary studies would be the employment of a number of competent experts to carry on the investigations. In the beginning, at least, the equipment in the way of buildings, appliances, etc., need be neither extensive nor costly.

U. S COMMISSION OF FISH AND FISHERIES,

JOHN J. BRICE, Commissioner.

PUBLICATIONS

OF THE

UNITED STATES COMMISSION OF FISH AND FISHERIES AVAILABLE FOR DISTRIBUTION ON JUNE 30, 1897.

Extracted from U. S. Fish Commission Report for 1896. Appendix 7, Pages 343 to 356.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1897.

7.—PUBLICATIONS OF THE UNITED STATES COMMISSION OF FISH AND FISHERIES AVAILABLE FOR DISTRIBUTION ON JUNE 30, 1897.

The publications of the Commission consist of an annual report and annual bulletin, which are made up of separate papers treating of the different subjects germane to the work of the Commission, and a small edition of each of these papers is issued in pamphlet form for distribution to those who are specially interested in the subject-matter.

BOUND PUBLICATIONS.

Of the bound publications the earlier volumes are out of print, and all the copies allowed this office have been distributed. A few copies of the following volumes can be furnished:

ANNUAL REPORTS.

Designation.	For the year—	Published.	Pages.	Plates.
Part XV	1887	1891	LXIII+900	112
XVI	1888	1892	CXXVIII+902	90
XVII	1889-91	1894	664	67
XVIII	1892	1894	CCIV+528	47
XIX	1893	1895	484	35
XX	1894	1896	718	28
XXI	1895	1896	590	1

ANNUAL BULLETINS.

Designation.	For the year—	Published.	Pages.	Plates.
Vol. VIII	1888	1890	IX+494	74
IX	1889	1892	XI+504	166
X	1890	1893	VII+400	94
XI	1891	1894	VI+431	88
XII	1892	1894	VII+489	118
XIII	1893	1894	VII+462	41
XIV	1894	1895	V+406	25
XV	1895	1896	XI+475	83

PAMPHLET PUBLICATIONS.

Each pamphlet has a serial number, which appears on the left in the accompanying list. The missing numbers are out of print and can not be supplied.

Serial No.

3. Report on the condition of the sea fisheries of the south coast of New England in 1871 and 1872, by Spencer F. Baird. Report for 1871–72, I, pp. I–XLI, 1893.
4. Report of the Commissioner for 1872 and 1873.—A. Inquiry into the decrease of the food-fishes.—B. The propagation of food-fishes in the waters of the United States, by Spencer F. Baird. Report for 1872–73, II, pp. I–CII. 1874.
15. Report of the Commissioner for 1873–74 and 1874–75.—A. Inquiry into the decrease of the food-fishes.—B. The propagation of food-fishes in the waters of the United States, by Spencer F. Baird. Report for 1873–74 and 1874–75, III, pp. VII–LI. 1876.
17. Report of the Commissioner for 1875–76.—A. Inquiry into the decrease of food-fishes.—B. The propagation of food-fishes in the waters of the United States, by Spencer F. Baird. Report for 1875–76, IV, pp. 1*–50*. 1878.
21. Cheap fixtures for hatching of salmon, by Charles G. Atkins. Report for 1878, VI, pp. 945–966 (including 15 figs.). 1880.
25. Report of the Commissioner for 1877.—A. Inquiry into the decrease of food-fishes.—B. Propagation of food-fishes in the waters of the United States, by Spencer F. Baird. Report for 1877, V, pp. 1*–48*. 1879.
27. The carp and its culture in rivers and lakes, and its introduction into America, by Rudolph Hessel. Report for 1875–76, IV, pp. 865–900 (including 6 figs.). 1878.
28. Report of the Commissioner for 1878.—A. Inquiry into the decrease of food-fishes. B. Propagation of food-fishes in the waters of the United States, by Spencer F. Baird. Report for 1878, VI, pp. XV–LXIV. 1880.
31. The winter haddock fishery of New England, by G. Brown Goode and J. W. Collins. *Bulletin for* 1881, I, pp. 226–235. 1882.
32. Report on the marine Isopoda of New England and adjacent waters, by Oscar Harger. Report for 1878, VI, pp. 297–462, plates I–XIII. 1880.
37. Gill nets in the cod fishery; a description of the Norwegian cod nets, with directions for their use, and a history of their introduction into the United States, by J. W. Collins. Bulletin for 1881, I, pp. 1–17, plates I–XII. 1881.
40. Popular extracts from the investigation of the Commission for the scientific examination of the German Seas, by H. A. Meyer et al. Report for 1879, VII, pp. 525–557 (including 17 figs.). 1882.
41. List of dredging stations of the U. S. Fish Commission from 1871 to 1879, inclusive, with temperature and other observations, by Sanderson Smith and Richard Rathbun. Report for 1879, VII, pp. 559–601. 1882.
42. Report on the cephalopods of the northeastern coast of America, by A. E. Verrill. Report for 1879, VII, pp. 211–455, plates I–XLVI. 1882.
46. Report of the Commissioner for 1879.—A. Inquiry into the decrease of the food-fishes.—B. The propagation of food-fishes in the waters of the United States, by Spencer F. Baird. Report for 1879, VII, pp. XI–LI. 1882.
51. Materials for the history of the swordfishes, by G. Brown Goode. Report for 1880, VIII, pp. 287–294, plates I–XXIV. 1883.
60. The Spanish mackerel, *Cybium maculatum* (Mitch.) Ag.; its natural history and artificial propagation, with an account of the origin and development of the fishery, by R. E. Earll. Report for 1880, VIII, pp. 395–426, plates I–III. 1883.
62. Report of the Commissioner for 1880.—A. Inquiry into the decrease of food-fishes.—B. Propagation of food-fishes in the waters of the United States, by Spencer F. Baird. Report for 1880, VIII, pp. XVII–XLVI. 1893.
65. Report of the Commissioner for 1881, by Spencer F. Baird. Report for 1881, IX, pp. XIII–LXXI. 1884.
68. The Annelida *Chætopoda* from Provincetown and Wellfleet, Mass., by H. E. Webster and James E. Benedict. Report for 1881, IX, pp. 699–747, plates I–VIII. 1884.
70. Report on the construction and work in 1880 of the Fish Commission steamer *Fish Hawk*, by Z. L. Tanner. Report for 1881, IX, pp. 3–53, plates I–XVIII (including 3 figs.). 1884.
71. A contribution to the embryography of osseous fishes, with special reference to the development of the cod (*Gadus morrhua*), by John A. Ryder. Report for 1882, X, pp. 455–605 (including 11 figs.), plates I–XII. 1884.
73. Annual report on the electric lighting of the U. S. F. C. steamer *Albatross*, December 31, 1883, by G. W. Baird. Bulletin for 1884, IV, pp. 153–158 (including 8 figs.). 1884.
75. The status of the U. S. Fish Commission in 1884, by G. Brown Goode. Report for 1884, XII, pp. 1139–1184. 1886.
77. Report of the Commissioner for 1882, by Spencer F. Baird. Report for 1882, X, pp. XVII–XCII. 1884.
89. Suggestions to the keepers of the United States life-saving stations, light-houses and light-ships, and to other observers, relative to the best means of collecting and preserving specimens of whales and porpoises, by Frederick W. True. Report for 1883, XI, pp. 1157–1182 (including 5 figs.), plates I–XI. 1885.

Serial No.

90. The osteology of *Amia calva*, including certain special references to the skeleton of teleosteans, by R. W. Shufeldt. Report for 1883, XI, pp. 747-878, plates I-XIV. 1885.

92. The first decade of the U. S. Fish Commission; its plan of work and accomplished results, scientific and economical, by G. Brown Goode. Report for 1880, VIII, pp. 53-62, 1883; also in Bulletin for 1882, II, pp. 169-178. 1883.

94. A catalogue of the fishes known to inhabit the waters of North America north of the Tropic of Cancer, with notes on the species discovered in 1883 and 1884, by David S. Jordan. Report for 1885, XIII, pp. 789-973. 1887.

95. Report of the Commissioner for 1883, by Spencer F. Baird. Report for 1883, XI, pp. XVII-XCV. 1885.

96. Report on the work of the U. S. Fish Commission steamer *Albatross* for the year ending December 31, 1883, by Z. L. Tanner. Report for 1883, XI, pp. 117-236, plates I-III. 1885.

100. List of deep-water mollusca dredged by the U. S. Fish Commission steamer *Fish Hawk* in 1880, 1881, 1882, with their range in depth, by Katharine J. Bush. Report for 1883, XI, pp. 701-727. 1885.

103. Utilizing water by fish-culture, by Berthold Benecke. Report for 1883, XI, pp. 1101-1131, plates I-V. 1885.

104. An exposition of the principles of a rational system of oyster culture, together with an account of a new and practical method of obtaining oyster spat on a scale of commercial importance, by John A. Ryder. Report for 1885, XIII, pp. 381-423, plates I-IV. 1887.

106. On the development of osseous fishes, including marine and fresh-water forms, by John A. Ryder. Report for 1885, XIII, pp. 489-604 (including 7 figs.), plates I-XXX. 1887.

108. Report of the Commissioner for 1884, by Spencer F. Baird. Report for 1884, XII, pp. XIII-LXXI. 1886.

110. Report on the work of the U. S. Fish Commission steamer *Albatross* for the year ending December 31, 1884, by Z. L. Tanner. Report for 1884, XII, pp. 3-116, plates I-III. 1886.

111. Pond culture, by Carl Nicklas. Report for 1884, XII, pp. 467-655 (including 44 figs.). 1886.

113. Report on the medusae collected by the U. S. Fish Commission steamer *Albatross* in the region of the Gulf Stream, 1883-84, by J. Walter Fewkes. Report for 1884, XII, pp. 927-980, plates I-X. 1886.

114. On the origin of heterocercy and the evolution of the fins and fin rays of fishes, by John A. Ryder. Report for 1884, XII, pp. 981-1107 (including 8 figs.), plates I-XI. 1886.

115. Report of the Commissioner for 1885, by Spencer F. Baird. Report for 1885, XIII, pp. XIX-CXII. 1887.

120. On the development of the cetacea, together with a consideration of the probable homologies of the flukes of cetaceans and sirenians, by John A. Ryder. Report for 1885, XIII, pp. 427-488 (including 3 figs.), plates I-III. 1887.

124. List of the dredging stations of the U. S. Fish Commission, the U. S. Coast Survey, and the British steamer *Challenger*, in North American waters, from 1867 to 1887, together with those of the principal European government expeditions in the Atlantic and Arctic oceans, by Sanderson Smith. Report for 1886, XIV, pp. 871-1017, 6 charts, 3 diagrams. 1889.

127. A review of the *Sciænidæ* of America and Europe, by David S. Jordan and Carl H. Eigenmann. Report for 1886, XIV, pp. 343-451, plates I-IV. 1889.

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340. Notes on the food of four species of the cod family, by William C. Kendall. Report for 1896, XXII, pp. 177–186. 1897.
341. The fisheries of Indian River, Florida, by John J. Brice et al. Report for 1896, XXII, pp. 223–262, plates 22–60. 1897.
342. Report on the fish and fisheries of the coastal waters of Florida, by John J. Brice. Report for 1896, pp. 263–312. 1897.
343. Report of a survey of the oyster regions of St. Vincent Sound, Apalachicola Bay, and St. George Sound, Florida, by Franklin Swift. Report for 1896, pp. 187–221, plate 21. 1897.

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U. S. COMMISSION OF FISH AND FISHERIES,
JOHN J. BRICE, Commissioner.

RECORDS OF OBSERVATIONS

MADE ON BOARD THE

UNITED STATES FISH COMMISSION STEAMER ALBATROSS

DURING THE

YEAR ENDING JUNE 30, 1896.

Extracted from U. S. Fish Commission Report for 1896. Appendix 8, Pages 357 to 386.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1897.

8.—RECORDS OF OBSERVATIONS MADE ON BOARD THE UNITED STATES FISH COMMISSION STEAMER ALBATROSS DURING THE YEAR ENDING JUNE 30, 1896.

The operations of the steamer *Albatross* from July 1, 1895, to June 30, 1896, have already been discussed in the report of the Commissioner. At the beginning of the year the vessel was engaged in running a line of soundings across Bering Sea in the direction of the Commander Islands, Siberia, where she arrived on July 3. After a stop of three days at Nikolski Harbor, she started on the return trip to the Pribilof Islands, first making a slight detour toward the north in order to determine the position of the outer slope of the shore platform off Cape Oliutorsk, which appears to have been incorrectly located on the published charts. St. Paul Island was reached on July 9, and during the balance of the month, except while coaling at Unalaska, the vessel was occupied in connection with the investigations of the fur-seal rookeries on the Pribilofs. The greater part of August was spent in the pelagic sealing belt outside of the protected zone, making inquiries into the movements and distribution of the seals, while sounding, dredging, and physical observations were also extensively carried on.

Leaving Unalaska on August 30, the *Albatross* entered the Pacific Ocean, and proceeded to New Whatcom, Wash., where she arrived on September 18. Fishery investigations with special reference to the salmon were then taken up in the Puget Sound region and were continued until October 16, when the *Albatross* left for the south, reaching San Francisco on the 20th, and the Mare Island navy-yard on the 24th. General repairs and refitting detained the vessel at the latter place until near the end of January, 1896, after which, until April 12, she was stationed at San Diego, Cal., advantage being taken of this opportunity to make a physical and natural-history examination of San Diego Bay. On the return trip to San Francisco, Cortez and Tanner Banks were visited, but stormy weather prevented extensive operations in their vicinity, and stops were made at Santa Barbara and San Pedro.

From May 7 to 18 the *Albatross* was used in connection with the official speed trial of the battle-ship *Oregon*. On June 5 she left San Francisco and proceeded to Seattle, where arrangements were completed for a northern cruise during the summer of 1896, in conformity with an act of Congress providing for extensive scientific inquiries respecting the fur-seal. Departure was taken from that place on June 24, and at the close of the fiscal year the vessel was in the North Pacific Ocean, on the way to Unalaska.

The following tables constitute the official records of the sounding, dredging, and tow-net stations, and of physical and miscellaneous observations made during the several cruises of this year. They correspond in character and detail with those which have accompanied all former annual reports upon the operations of this vessel.

Record of animal life,

ON PASSAGE FROM ST. PAUL, PRIBILOF ISLANDS, TO NIKOLSKI

Date.	Meridian positions. Lat. N.	Long. E.	Mean temperature. Air, D. B.	Sea surf.	Fur-seals.	Whales.	Porpoises.	Auks.	Albatrosses.
	° ′ ″	° ′ ″	°	°					
1895. July 1	55 51 00	174 38 00	43	41	....	....	....	....	....
2	56 00 00	169 24 00	43	43	....	....	....	....	Few ......
3	Nikolski Anchorage, Bering Island.		45	43	Several ...	....	....	....	....

FROM NIKOLSKI ANCHORAGE, BERING ISLAND, KOMMANDORSKI GROUP, VIA

Date.	Lat. N.	Long. E.	Air, D. B.	Sea surf.	Fur-seals.	Whales.	Porpoises.	Auks.	Albatrosses.
July 5	55 23 00	165 42 00	43	44	Two	Several orca.	....	....	One........
6	57 16 00	169 41 00	44	43	....	One orca..	....	....	Few ......
7	58 22 00	174 27 00	45	42	....	....	....	....	Two ......
		West.							
7*a*	57 38 00	179 42 00	42	42	....	One........	....	....	Few ......
8	56 55 30	174 33 00	42	41	Two	....	Six	Many.....	Many.....
9*b*	56 57 00	170 17 00	42	40	Abundant	....	....	Many	Few ......
10	54 11 30	166 44 00	44	43	....	Two	....	....	Few ......

FROM ILIULIUK HARBOR, UNALASKA ISLAND,

Date.	Lat. N.	Long. E.	Air, D. B.	Sea surf.	Fur-seals.	Whales.	Porpoises.	Auks.	Albatrosses.
July 15	54 19 00	166 58 00	43	44	One.......	Many....	....	....	....
16	Village Cove, St. Paul Island.		45	40	Common..	....	....	Many......	....
*									

FROM ST. PAUL, PRIBILOF ISLANDS,

Date.	Lat. N.	Long. E.	Air, D. B.	Sea surf.	Fur-seals.	Whales.	Porpoises.	Auks.	Albatrosses.
July 30	56 42 00	170 08 00	46	41	Few	Many orca	....	....	....
31	54 15 00	166 51 00	52	45	....	....	....	Few	....

CRUISING IN BERING SEA BETWEEN DUTCH

Date.	Lat. N.	Long. E.	Air, D. B.	Sea surf.	Fur-seals.	Whales.	Porpoises.	Auks.	Albatrosses.
Aug. 4	54 02 00	167 05 00	45	45	....	One........	....	....	Few ......
5	55 06 00	169 08 00	45	45	Seven.....	Many.....	....	....	Few ......
6	55 26 00	170 19 00	45	45	Six	....	....	....	....
7	55 36 00	170 45 00	45	44	Sixteen ...	Several	....	....	....
8	55 53 00	171 40 30	46	44	Sixteen ...	Two	....	....	Few ......
9*c*	56 47 00	169 41 00	43	40	Few	....	....	Many.....	Few ......
10	56 15 00	172 35 00	44	43	Twelve ...	Three	....	....	....
11	55 23 00	170 31 00	45	45	Common..	Many.....	....	Many.....	One.......
12	54 54 00	168 59 00	45	45	....	....	....	....	....
13	55 13 00	167 40 00	45	45	....	Many.....	....	....	....
14	54 03 00	166 40 00	46	45	Seven	Two	....	....	....
18	54 16 00	166 58 00	48	46	....	Many.....	....	Few	....
19	54 17 00	168 54 00	45	44	Two	....	....	....	Few ......
20	55 16 00	168 04 00	46	46	Eight	....	....	....	....
21	55 41 00	168 34 00	47	46	Seven	Two	....	....	....
22	56 13 00	167 11 00	46	46	Three	....	....	....	Few ......
23*d*	East Anchorage, St. Paul Island.		46	43	Common..	....	....	Many.....	Few ......
24	55 31 00	168 05 30	48	46	Eleven ...	Two	....	Few	Few ......
25	Dutch Harbor, Unalaska.		46	45	....	....	....	....	Few ......

* July 17 to July 29, inclusive. Usual number of seals on and near rookeries, and usual abundance of auks, gulls, cormorants, guillemots, petrels, puffins, terns, etc.
a Crossed 180th meridian.
b Call at St. Paul Island.
c Call at St. George and St. Paul, Pribilofs.
d Call at St. Paul Island, Pribilofs.

drift, etc., observed at sea.

ANCHORAGE, BERING ISLAND, KOMMANDORSKI GROUP.

Cormorants.	Ducks.	Guillemots.	Gulls.	Petrels.	Puffins.	Terns.	Land birds.	Drift.	Kelp.
....	....	....	....	Many	....	....	....	Some ..	
....	....	Many...	Many...	Many...	Many...	....	One Arctic linnet.	....	
....	....	Many...	Many...	....	....	....	....	Some ..	

ST. PAUL, PRIBILOF ISLANDS, TO ILIULIUK HARBOR, UNALASKA ISLAND.

Cormorants.	Ducks.	Guillemots.	Gulls.	Petrels.	Puffins.	Terns.	Land birds.	Drift.	Kelp.
....	....	Many...	Many...	Many. .	Many...	....	....	....	
....	....	Many...	....	Many...	Many...	....	Three wrens.	....	
....	....	Several .	....	Several .	....	....	....	....	
....	....	....	Several .	Several .	....	....	....	....	
Few	....	Many...	Many...	Many...	Many...	Few	....	....	Little.
Several .	....	Many...	Many...	Many...	Many...	Few	....	....	Much.
....	....	Many...	Many...	Many...	Many...	....	....	....	Much.

TO ST. PAUL, PRIBILOF ISLANDS.

Cormorants.	Ducks.	Guillemots.	Gulls.	Petrels.	Puffins.	Terns.	Land birds.	Drift.	Kelp.
....	....	Many...	Few	Few	Many...	Many...	....	....	Much.
Many...	....	Many...	Many...	Many...	Many...	Many...	Several .	....	Some.

.TO DUTCH HARBOR, UNALASKA ISLAND.

Cormorants.	Ducks.	Guillemots.	Gulls.	Petrels.	Puffins.	Terns.	Land birds.	Drift.	Kelp.
....	....	Many...	....	Many...	....	....	....	....	Some.
....	....	Several .	Few	Many...	Few	....	....	....	Much.

HARBOR, UNALASKA, AND THE PRIBILOF ISLANDS.

Cormorants.	Ducks.	Guillemots.	Gulls.	Petrels.	Puffins.	Terns.	Land birds.	Drift.	Kelp.
....	....	Several .	Several .	Many...	Several .	....	....	....	
....	....	Several .	Several .	Many...	Several .	....	....	....	
....	....	Many....	....	Many...	....	....	....	....	
....	....	Many...	Several .	Many...	....	....	....	....	
....	....	Many...	Many...	Many...	Few	....	....	....	
Several .	....	Many...	Many...	Many...	Several .	Few	....	....	Much.
....	....	Many...	Many...	Many...	....	....	....	....	
Few	....	Many...	Many...	Many...	Many...	Few	....	....	Some.
....	....	....	....	Few	....	....	....	....	
....	....	Many...	Many...	Many...	....	....	....	....	
....	....	Many...	Many...	Many...	Several .	....	....	....	Much.
....	....	Many...	Many...	Many...	Many...	....	....	....	Much.
....	....	Many...	Many...	Many...	....	....	....	....	
....	....	Many...	Many...	Many...	....	....	....	....	
....	....	Many...	Many...	Many...	Few	....	....	....	
....	....	Many...	Many...	Many...	....	....	....	....	
Several .	Few	Many...	Many...	Many...	Many...	Few	....	....	Some.
....	....	Many...	Many...	Many...	Many...	....	....	....	Some.
Few	....	Many...	Many...	Many...	Many...	....	....	....	Much.

Record of animal life, drift,

FROM DUTCH HARBOR, UNALASKA,

Date.	Meridian positions. Lat. N.	Long. W.	Mean temperature. Air, D. B.	Sea, surf.	Fur-seals.	Whales.	Porpoises.	Auks.	Albatrosses.
1895.	° ′ ″	° ′ ″	°	°					
Aug. 30	54 09 00	166 13 00	52	46	....	Many.....	....	Few	Few ......
31	55 17 00	161 40 00	50	49	....	Many.....	....	....	Few ......

FROM PORTAGE BAY, ALASKA PENINSULA, TO SITKA,

Date.	Lat. N.	Long. W.	Air, D. B.	Sea, surf.	Fur-seals.	Whales.	Porpoises.	Auks.	Albatrosses.
Sept. 2	55 28 00	159 10 00	53	49	....	Several ...	....	....	Few ......
3	56 29 00	153 40 00	52	49	....	Many.....	....	Several ...	Several ...
4a	57 57 00	151 40 00	55	49	....	Many.....	....	....	Several ...
5	59 00 00	145 29 00	50	51	....	Two	....	Few	....
6b	59 46 00	139 54 00	51	48	Two......	....	Many..	....	....
7	58 55 00	138 37 00	53	52	....	One......	....	....	....
8	Sitka Harbor, southeast Alaska.		55	53	....	....	....	....	....

FROM SITKA, SOUTHEAST ALASKA, TO NEW WHATCOM,

Date.	Lat. N.	Long. W.	Air, D. B.	Sea, surf.	Fur-seals.	Whales.	Porpoises.	Auks.	Albatrosses.
Sept. 10	Sitka Harbor, southeast Alaska.		51	51	....	....	....	....	....
11c	56 23 00	133 07 00	55	48	....	....	....	....	....
12	55 33 00	132 09 00	59	51	....	....	....	....	....
13	53 57 00	130 11 00	51	49	....	....	....	....	....
14	52 37 00	128 31 00	51	49	....	....	....	....	....
15	52 04 00	127 59 00	53	51	....	....	....	....	....
16	50 33 00	126 49 00	52	50	....	....	Many..	....	....
17	49 49 00	124 57 00	55	52	....	....	....	....	....
18 *	New Whatcom, Wash.		56	55	....	....	....	....	....

FROM PORT TOWNSEND, WASHINGTON, TO SAU-

Date.	Lat. N.	Long. W.	Air, D. B.	Sea, surf.	Fur-seals.	Whales.	Porpoises.	Auks.	Albatrosses.
Oct. 16	48 14 00	123 19 00	49	48	....	....	....	....	....
17	46 25 00	124 58 00	55	54	....	....	....	....	Several ...
18	42 54 00	124 56 00	52	52	....	....	Many..	....	Several ...
19	40 01 00	124 14 00	54	54	....	Many.....	Many..	Two	Several ...
20	Sausalito Harbor, California.		56	56	....	....	....	....	Few ......

FROM SAN FRANCISCO TO

Date.	Lat. N.	Long. W.	Air, D. B.	Sea, surf.	Fur-seals.	Whales.	Porpoises.	Auks.	Albatrosses.
1896.									
Jan. 28	37 26 00	122 40 00	53	53	....	Three.....	....	....	Few ......
29	34 24 00	120 25 00	58	55	Several hair seals.	....	....	....	Few ......
30	San Diego Harbor, California.		61	57	....	....	....	....	....

FROM SAN DIEGO TO SANTA BARBARA,

Date.	Lat. N.	Long. W.	Air, D. B.	Sea, surf.	Fur-seals.	Whales.	Porpoises.	Auks.	Albatrosses.
Apr. 12	San Diego Harbor, California.		58	60	....	....	....	....	....
13	33 04 00	119 19 00	55	57	....	....	....	....	Few ......
†14	33 26 00	119 43 00	55	55	....	....	....	....	....
15	34 11 00	119 37 00	55	53	....	....	....	....	....

*From September 19 to October 15, in waters of Puget Sound and vicinity.
† Anchor, Smuggler's Cove, Santa Cruz Island.
a Call at St. Paul, Kadiak Island.
b Call at Yakutat Bay.
c Anchor Fort Wrangell, southeast Alaska. Anchor Mary Island, southeast Alaska. Anchor at Promise Island, British Columbia. Anchor at Klemtoo Anchorage, British Columbia. Anchor at Safety Cove, British Columbia. Anchor at Plumper Bay, British Columbia.

etc., observed at sea—Continued.

TO PORTAGE BAY, ALASKA PENINSULA.

Cormorants.	Ducks.	Guillemots.	Gulls.	Petrels.	Puffins.	Terns.	Land birds.	Drift.	Kelp.
		Many	Several	Many	Many		1 hawk		Some.
		Many	Many	Many	Many		Many		Much.

SOUTHEAST ALASKA, VIA KADIAK AND YAKUTAT.

Cormorants.	Ducks.	Guillemots.	Gulls.	Petrels.	Puffins.	Terns.	Land birds.	Drift.	Kelp.
		Many	Many	Many			Several		Much.
		Several	Many	Many	Several		Several hawks.		Little.
			Many	Many	Several		Several snipe.		
			Several	Several	Several				
Many	Many		Many				Many	Much ice.	Little.
Many	Few		Many	Few			Many	Little	Much.
Several	Several		Many	Few	Few	Several	Several	Much	Much.

BELLINGHAM BAY, WASHINGTON, VIA INLAND PASSAGES.

Cormorants.	Ducks.	Guillemots.	Gulls.	Petrels.	Puffins.	Terns.	Land birds.	Drift.	Kelp.
Several			Few					Little	Much.
Several	Many		Many			Several	Few	Much	Some.
Many	Few		Many			Few	Several	Little	Little.
Many		Few	Many				Many	Much	Much.
Several	Several		Many			Few		Little	Much.
Few	Few		Several				Several	Much	Much.
Several	Several		Many			Few		Much	Some.
Few	Few		Many					Much	Much.
			Several				Few	Much	Little.

SALITO, SAN FRANCISCO BAY, CALIFORNIA.

Cormorants.	Ducks.	Guillemots.	Gulls.	Petrels.	Puffins.	Terns.	Land birds.	Drift.	Kelp.
			Several					Little	Little.
			Many	Several			Two	Little	Much.
		Few	Many	Several					
			Several	Few					Little.
Few		Few	Several						

SAN DIEGO, CALIFORNIA.

Cormorants.	Ducks.	Guillemots.	Gulls.	Petrels.	Puffins.	Terns.	Land birds.	Drift.	Kelp.
		Several	Many	Several			Many pelicans.		
		Several	Many	Several					
Many			Several				Few pelicans.		Little.

CALIFORNIA, VIA SANTA CRUZ ISLAND.

Cormorants.	Ducks.	Guillemots.	Gulls.	Petrels.	Puffins.	Terns.	Land birds.	Drift.	Kelp.
Many			Several				Few pelicans.		Little.
			Several	Few					
			Few						Much.
			Several						Much.

Record of animal life, drift,

FROM SANTA BARBARA TO

Date.	Meridian positions. Lat. N.	Meridian positions. Long. W.	Mean temperature. Air, D. B.	Mean temperature. Sea, surf.	Fur seals.	Whales.	Porpoises.	Auks.	Albatrosses.
1895.	° ′ ″	° ′ ″	°	°					
Apr. 20	Santa Barbara, Cal.		50	51					
21	San Pedro, Cal.		56	55					
FROM SAN PEDRO TO									
Apr. 26	33 45 00	118 46 00	55	58					
27	35 29 00	121 06 00	55	55					Few
28	Sausalito Harbor, California.		54	53					
FROM SAN FRANCISCO TO									
May 8	San Francisco Harbor.		53	53					
9	35 17 00	121 13 00	56	52		Few			Few
FROM SANTA BARBARA TO SAN FRAN-									
May 15	34 33 00	120 40 00	59	53					
16	35 26 00	121 02 00	52	48					
17 *	San Francisco Harbor.		52	51					
FROM SAUSALITO, CALIFORNIA, TO SEATTLE,									
June 5	37 50 00	122 35 00	55	54	Several hair seals.				Several
6a	39 27 00	124 10 00	53	50					Several
7	42 21 00	124 43 00	56	52		Few			Several
8	45 27 15	124 25 45	56	55					Several
9	48 23 00	124 14 00	53	51		Many orca	Many		Few
10	Victoria Harbor, British Columbia.		63	52		One	Many		
FROM SEATTLE, WASHINGTON, TO DUTCH HARBOR									
June 24	47 53 10	122 29 30	56	53					
25b	49 28 47	124 25 15	60	55		Few orca	Few	One	
26c	51 05 00	128 26 00	55	51		Two			Several
27	52 00 00	133 37 00	52	50		Two orca			Many
28	52 54 00	139 04 00	48	48					Many
29	53 29 00	144 51 00	48	47	One				Many
30	53 45 00	151 18 00	47	46		One			Many

* May 17 to June 4, at anchor, Port Harford, Cal.

a Small blackfish.

etc., observed at sea—Continued.

SAN PEDRO, CALIFORNIA.

Cormorants.	Ducks.	Guillemots.	Gulls.	Petrels.	Puffins.	Terns.	Land birds.	Drift.	Kelp.
			Several	Few					Much.
			Few						Little.

SAUSALITO, CALIFORNIA.

			Several	Few					Little.
		Few	Several	Few					Little.
		Few	Several	Few					

SANTA BARBARA, CALIFORNIA.

		Few	Several	Few	Few				Little.
			Several	Few					Much.

CISCO, VIA PORT HARFORD, CALIFORNIA.

Few			Several	Few					Little.
Few			Several	Few					Little.
		Several	Several						Little.

WASHINGTON, VIA VICTORIA, BRITISH COLUMBIA.

		Several	Many	Several	Few				
			Many	Few	Few				
			Several	Several	Several				
			Several	Several	Many			Few large logs.	Little.
Many	Few	Several	Several	Several	Few			Much.	Much.
Few			Several					Much.	Much.

UNALASKA, VIA ALBERT BAY, BRITISH COLUMBIA.

								Little.	Much.
Several			Several					Much.	Much.
Several	Few		Many			Few			
Several	Several		Many	Several				Much.	Much.
			Few	Many	Few			Much.	Little.
				Many	Several			Much.	Much.
		Several		Many				Little wreckage.	Much.
		Few		Many					

b Few blackfish.

c Much salpæ. Call at Alert Bay.

Cruising and meteorological record.

Date.	Meridian positions.		Distance run per log.	Barometer.		Temperatures.						State of the weather.	Direction and force of wind.	State of the sea.
						Air.				Sea at surface.				
						Dry bulb.		Wet bulb.						
	Lat. N.	Long. E.		Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.			
1895.	° ′ ″	° ′ ″	*Knots.*			°	°	°	°	°	°			
July 1	55 51 00	174 38 00	151.0	29.84	29.68	49	37	45	37	43	40	Fair and pleasant; fog at times	S'd and W'd, 3	Smooth.
2	56 00 00	169 24 00	175.0	29.87	29.74	46	41	46	41	45	42	Overcast; misty 4 to 8 a. m	ENE., 1-4; NE., 4; N. by E., 5	Smooth to moderate.
3	Nikolski Anchorage, Bering Island.		152.4	29.97	29.83	50	41	49	41	43	43	Fair and pleasant	N. by E. 4; N. by W. 4; W. by N., 2; SSW., 1.	Moderate to smooth.
4	.....do			30.09	29.99	47	44	47	44	43	43	Fair to overcast and showery	SSW., 2; S. by W., 2; SSE., 4	Do.
5	55 23 00	165 42 00	23.2	30.26	30.09	47	40	47	40	46	43	Overcast, misty, and rainy	W., 1; ENE., 1-3; E. by S., 3	Smooth.
6	57 16 00	169 41 00	174.0	30.29	30.20	46	42	46	42	45	41	Overcast and cloudy	N'd and W'd, 1-2	Do.
7	58 22 00	174 27 00	166.5	30.19	30.09	48	42	48	42	44	41	Overcast; misty at times	W'd, 2-3	Do.
		Long. W.												
7	57 38 00	179 42 00	191.0	30.11	30.04	45	40	44	41	43	41	Overcast, misty, and foggy	NW., 3; WNW., 3	Do.
8	56 55 30	174 33 00	172.0	30.05	30.01	43	41	43	40	42	41	Overcast and foggy; misty at times	WNW., 3; N., 2	Do.
9	56 57 00	170 17 00	168.9	30.02	30.00	46	39	46	40	42	37	Overcast, foggy, and misty; thick	Variable, 1; SSE., 2; E'd, 3	Do.
10	54 11 30	166 44 00	205.0	29.91	29.56	48	40	48	41	46	41	Overcast, misty, and rainy; disagreeable.	E. by S., 3; ESE., 6	Smooth to moderate.
11	Iliuliuk Harbor, Unalaska.		29.1	29.74	29.53	50	47	50	47	46	45	Overcast, misty, and rainy	E., 2; squalls, 6; E'd, 2; calm	Moderate.
12	.....do			29.92	29.74	52	45	52	45	48	44	Fair and pleasant	N'ly, 1; NW., 2	Smooth.
13	.....do			30.24	29.94	50	44	49	44	46	44	.....do	N'd and E'd., 2-4	
14	.....do			30.39	30.24	48	40	49	40	48	42	.....do	Calm; variable, 1	
15	54 19 00	166 58 00	32.6	30.46	30.39	44	41	45	42	45	42	Overcast; fog and mist in morning	Calm; NNE., 1; ESE., 2	Smooth.
16	Village Cove, St. Paul Island.		203.0	30.49	30.45	47	43	47	43	43	37	Overcast and foggy	ESE., 2; S., 2; E., 2	Do.
17	.....do			30.49	30.46	45	42	45	42	39	37	Overcast and foggy; drizzle at times	E., 2; ESE., 2	Do.
18	North Anchorage, St. George Island.		41.5	30.51	30.46	51	42	50	43	43	38	Overcast, to fair midday, to misty	SSE., 2; SW., 1	Do.
19	.....do			30.57	30.51	50	46	50	46	43	41	Overcast; fair in midday; overcast	S'd and W'd, 1	Do.
20	Village Cove, St. Paul Island.		41.5	30.55	30.40	47	44	47	44	42	37	Overcast; misty at times	WSW., 2; SSW., 2; SE. to ENE., 1	Do.
21	.....do			30.39	30.09	46	43	46	43	38	37	Overcast, foggy, and misty	ENE., 2-3	Do.
22	.....do			30.08	29.98	45	43	45	43	38	37	Overcast and rainy; thick	ENE., 3-2	Do.
23	.....do			30.08	30.03	48	43	48	44	39	37	Foggy; very thick	E'd, 1	Do.
24	.....do			30.13	30.08	53	44	53	44	43	37	Foggy; pretty clear 1 to 4 p. m	Calm; E'd, 1	Do.
25	.....do			30.08	29.79	45	43	45	43	38	37	Overcast and boisterous; rain in squalls.	S'd and E'd, 4; squalls, 6	Increasing.

	26	.....do			30.08	29.94	46	43	46	43	39	37	Overcast and cloudy, fog at times	SSE., 1-3	Smooth; heavy swell.
	27	.....do			30.08	29.87	44	41	44	42	39	37	Overcast; fog, mist, and rain; very thick.	S'd and E'd, 3-2	H'vy ground swell.
	28	Lukannon Bay, St. Paul Island.		6.5	29.81	29.23	43	41	43	41	38	37	Overcast and foggy; steady rain	ENE., 3; SE., 2; S'd, 2; NNW., 2	Swell from southward.
	29	.....do			29.86	29.23	45	43	45	43	38	37	Overcast and stormy; steady mist and rain.	N. by W. and NNW., 4; squalls, 6	Mod'ate, with gr'd swell.
	30	56 42 00	170 08 00	33.8	30.07	29.89	50	40	50	40	45	37	Overcast and foggy	NNW., 4; squalls, 6; NNW., 3-2	Moderate; irregular.
	31	54 15 00	166 51 00	185.0	30.07	29.94	60	43	60	43	47	44	Foggy; very thick	N'd, 2; variable, 1	Smooth.
Aug.	1	Dutch Harbor, Unalaska.		21.3	29.98	29.95	51	48	51	48	48	47	Overcast, foggy, and misty to clearing.	E'd, 2	
	2	.....do			29.98	29.90	51	47	51	47	49	47	Fair and pleasant first part; then raining.	E'd, 1-2	
	3	.....do			30.14	29.95	50	45	50	46	49	46	Fair and pleasant	N'd and E'd, 1; local squalls, 4	
	4	54 02 00	167 05 00	37.0	30.23	30.14	47	43	47	43	46	45	Fair to overcast, with mist and rain	Variable, 1; W'd, 3	Smooth.
	5	55 06 00	169 08 00	96.0	30.21	29.96	46	44	46	44	46	44	Overcast, misty, and rainy	S'd, 3-4	Increasing.
	6	55 26 00	170 19 00	45.0	29.92	29.47	46	45	46	45	45	44	Boisterous; misty and rainy	ESE., 6; S., 6; W., 6-7	Moderate.
	7	55 36 00	170 45 00	17.5	29.86	29.59	45	44	45	44	45	42	Boisterous; overcast and misty	W'd, 4; squalls, 5	Do.
	8	55 53 00	171 40 30	35.5	29.91	29.86	48	43	48	43	45	43	Overcast and cloudy	W'd, 5	Do.
	9	56 47 00	169 41 00	113.2	30.17	29.91	45	40	45	40	43	38	Boisterous to moderating; fog and mist.	W'd, 4; squalls, 6 at times	Do.
	10	56 15 00	172 35 00	92.0	30.21	30.16	46	41	46	41	45	40	Overcast; mist and drizzle from 6 to 12 p. m.	WSW., 3	Smooth to gentle.
	11	55 23 00	170 31 00	87.0	30.18	30.05	46	44	46	45	45	44	Pleasant generally; showers at times.	SW. by W., 3; WNW., 2	Smooth.
	12	54 54 00	168 59 00	61.0	30.32	30.06	47	44	47	44	45	44	Overcast; fog and mist 4 to 12 p. m.	W'd, 2	Do.
	13	55 13 00	167 40 00	47.0	30.34	30.24	47	43	47	43	45	44	Overcast; driving fog and mist 3 to 12 p. m.	SW., 4-5	
	14	54 03 00	166 40 00	76.0	30.37	30.26	48	44	48	44	46	44	Overcast and misty to clearing	SW., 4; SSW., 2	Moderate.
	15	Dutch Harbor, Unalaska.		13.6	30.37	30.23	54	46	54	46	48	45	Overcast to fair and pleasant	SSW., 1; variable, 1	
	16	.....do			30.18	30.04	53	45	53	45	47	46	Boisterous; overcast and misty	S'd and E'd, 3; squalls, 7; SE., 2	
	17	.....do			30.07	30.01	56	49	56	49	50	47	Overcast; rain and mist at times	SE., 1; variable, 1; SSE., 2; squalls, 3	
	18	54 16 00	166 58 00	31.4	29.98	29.79	52	45	52	45	47	44	Rainy and misty; disagreeable	SSE., 2; squalls, 4; SW., 3	Light.
	19	54 17 00	168 54 00	67.0	29.86	29.72	47	44	47	44	45	42	.....do	SW., 2-3	Smooth.
	20	55 16 00	168 04 00	65.0	29.80	29.68	47	45	47	45	47	45	Overcast; foggy and misty	SW., 1; NW., 2	Do.
	21	55 41 00	168 34 00	31.0	29.98	29.81	49	46	49	46	47	45	Overcast; misty greater part	N'd and W'd, 3-2	Do.
	22	56 13 00	167 11 00	56.0	30.05	29.98	48	45	48	45	47	46	Overcast; misty until 8 a. m	NNW., 3; S'd, 3; S. by W., 3	Irregular.
	23	East Anchorage, St. Paul Island.		142.7	30.03	29.92	47	45	47	45	46	41	Thick; much fog and rain	SSW., 3; S'd, 1	Smooth.
	24	55 31 00	168 05 30	121.0	30.03	29.94	50	46	50	46	47	44	Rainy and misty; fair midday; mist and fog.	NNE., 2-4	Do.
	25	Dutch Harbor, Unalaska.		156.4	29.98	29.93	47	45	47	45	46	44	Stormy; driving mist noon to midnight.	NNE. and N., 6; squalls, 10	Increasing.
	26	.....do			29.93	29.88	47	45	47	45	46	44	Stormy, moderating to pleasant	N'd, 6-8; NW., 3; NW., 1	
	27	.....do			29.93	29.86	46	44	46	44	46	44	Fair and pleasant	Calm; NE., 1; calm	
	28	.....do			29.88	29.84	50	41	50	41	47	44	.....do	Calm; N'd and E'd, 1; calm	
	29	.....do			29.84	29.71	54	47	53	47	47	46	Overcast; showers at times	SE., 3-5; NE., 2-3	
	30	54 09 00	166 13 00	22.3	30.26	29.86	58	46	58	46	48	45	Fair and pleasant	SW., 2; NW., 1	Smooth.
	31	55 17 00	161 40 00	194.1	30.56	30.27	54	47	54	47	51	47	.....do	NW'ly, 3-5	Do.

Cruising and meteorological record—Continued.

Date.	Meridian positions. Lat. N.	Meridian positions. Long. W.	Distance run per log.	Barometer. Max.	Barometer. Min.	Temperatures. Air. Dry bulb. Max.	Dry bulb. Min.	Wet bulb. Max.	Wet bulb. Min.	Sea at surface. Max.	Sea at surface. Min.	State of the weather.	Direction and force of wind.	State of the sea.
1895.	° ′ ″	° ′ ″	*Knots.*			°	°	°	°	°	°			
Sept. 1	Portage Bay, Alaska Peninsula.		48.4	30.56	30.44	53	47	53	47	49	47	Cloudy, but generally pleasant	NNW., 3-5; WNW., 2-4; NNW., 2-4.	
2	55 28 00	159 16 00	58.1	30.44	30.33	60	46	60	46	52	45	Fair and pleasant	NW., 3; squalls, 6-7; local, 2-3; NW., 3-5.	Smooth.
3	56 29 00	153 40 00	198.0	30.31	30.03	56	48	56	48	50	48	....do	N'd and W'd, 4-2	Do.
4	57 57 00	151 40 00	138.3	30.03	29.93	63	47	63	47	50	47	....do	N'd and W'd, 2-4	Do.
5	59 00 00	145 29 00	204.0	30.16	29.93	54	45	54	45	53	50	Cloudy; frequent passing showers	NE., 3; squalls, 6; E., 4; squalls, 6-8.	Moderate.
6	59 46 00	139 54 00	186.7	30.22	30.14	56	46	56	46	52	43	Showery to fair and pleasant	ENE., 3; squalls, 5-7; variable, 1	Smooth.
7	58 55 00	138 37 00	111.6	30.15	29.91	62	44	62	44	54	48	Clear and pleasant	N'd and W'd., 1-2	Do.
8	Sitka Harbor, SE. Alaska.		193.5	29.94	29.89	65	46	65	46	55	50	....do	NW., 3; variable, 1; N., 1	Do.
9	....do			29.93	29.83	59	41	57	41	54	50	....do	Local, 1	
10	....do			30.08	29.89	59	43	58	43	54	48	....do	Calm; W'd, 1	
11	56 23 00	133 07 00	162.4	30.19	30.11	64	47	64	47	52	44	....do	N'd, 1	Smooth.
12	55 33 00	132 09 00	94.5	30.19	29.84	72	44	71	44	55	47	....do	N'd and E'd, 1-2	Do.
13	53 57 00	130 11 00	130.8	29.98	29.92	54	48	54	48	52	48	Fair to overcast and misty	SE'd, 3-2	Do.
14	52 37 00	128 31 00	123.9	30.06	29.96	52	50	52	50	50	48	Overcast and rainy	SE'd, 2; squalls, 4; SE., 2	Do.
15	52 04 00	127 59 00	53.0	30.06	29.85	56	51	56	50	52	50	....do	N'd, 1; calm	Do.
16	50 33 00	126 49 00	116.6	30.20	29.90	55	49	55	50	52	48	Overcast and misty to clearing	E., 1-3; calm	Do.
17	49 49 00	124 57 00	111.7	30.25	30.10	57	52	57	52	55	49	Fair and pleasant; smoky	Calm; ESE., 2-4; E., 2-1	Do.
18	New Whatcom, Wash.		146.6	30.09	29.70	59	54	58	54	57	53	....do	Variable, 1; S'd, 2-3; SE., 3-6	Do.
19	....do			29.99	29.68	66	46	61	46	56	52	Cloudy; occasional showers	Local squalls, 4-6; ESE., 2-1	
20	....do			30.36	29.99	70	44	70	44	55	49	Clear and pleasant	N'd, 2-1	
21	....do			30.48	30.39	54	41	54	41	51	49	Fair and pleasant to overcast and rainy.	Calm; S., 2-1; calm	
22	48 42 30	122 44 30	15.3	30.39	30.10	54	48	54	49	51	49	Overcast and rainy	NE., 2; ENE., 1; SE., 2-4	Smooth.
23	48 59 30	122 58 00	30.4	30.09	29.91	55	53	56	54	51	51	Clear and pleasant	SSW., 2	Do.
24	48 38 30	122 44 00	34.8	30.27	29.99	57	50	56	50	51	48	Misty and smoky to clear and pleasant.	SSW., 1	Do.
25	New Whatcom, Wash.		55.2	30.40	30.27	58	48	58	49	56	48	Fair to overcast and drizzly	NNE., 1; calm; NNE., 1	
26	....do			30.40	30.19	55	45	55	45	54	50	Clear and pleasant	NNW., 1-3-1	
27	....do			30.39	30.26	64	49	64	50	54	50	....do	NNW., 1-3-2	
28	....do			30.30	30.04	64	47	61	47	53	50	....do	Calm; variable, 1; calm	
29	....do			30.11	30.00	60	48	60	48	54	48	Fair and pleasant	Calm	

	30	Fairhaven, Wash.		25.9	30.07	29.96	58	49	58	49	54	48	....do	Calm; SSW., 1	Smooth.
Oct.	1	Seattle Harbor, Wash.		45.9	30.09	29.95	61	50	61	51	54	48	Pleasant, generally; showers at times.	N'd, 1; S'd and E'd, 3-1	Do.
	2	....do			30.39	30.11	59	53	59	53	55	52	Fair and pleasant; haze and smoke	Variable, 1; SW., 2	Do.
	3	48 04 30	122 26 00	66.8	30.49	30.31	56	46	56	46	54	51	....do	S'd and W'd, 1-2	Do.
	4	Port Ludlow, Wash.		32.2	30.33	30.03	60	43	58	43	52	48	....do	SW., 1; N'd and W'd., 1	Do.
	5	Port Townsend, Wash.		16.3	30.13	30.06	60	49	60	49	54	49	....do	Calm; N., 1; WSW., 2; calm	Do.
	6	Port Angeles, Wash.		35.9	30.26	30.13	64	46	64	46	50	48	....do	Calm; W'd, 1	Do.
	7	Victoria Harbor, British Columbia.		19.3	30.26	30.04	53	46	53	46	48	47	Very foggy	Calm; S'd, 1, and E'd, 1; calm	Do.
	8	....do			30.14	29.95	54	47	54	46	49	47	Fog and rain first part; then clearing.	Calm; SE., 2-3	Do.
	9	Fidalgo City, Wash.		68.5	30.38	30.15	62	53	62	53	51	48	Cloudy and smoky, but generally pleasant.	WSW., 2-4; SSW., 3-2; calm	Do.
	10	48 42 00	122 32 00	21.1	30.42	30.33	62	53	62	52	56	49	Commenced rain, clearing to pleasant	ESE., 1; NNE., 1-2	Do.
	11	New Whatcom, Wash.		2.8	30.33	30.12	55	50	55	50	54	52	*Drizzling rain and fog; thick*	Variable, 1	Do.
	12	....do			30.17	30.09	55	52	55	52	53	52	Cloudy; fog and smoke about horizon	Variable, 1	
	13	....do			30.36	30.15	57	48	57	49	54	51	Clear and pleasant generally	Calm; WSW., 3-2; calm	
	14	....do			30.40	30.24	55	47	55	47	55	51	....do	Calm; N., 1	
	15	....do			30.27	30.12	58	45	56	45	54	48	Fair and pleasant generally	NNE., 1; SW., 2; calm	Smooth.
	16	48 14 00	123 19 00	78.3	30.24	30.09	51	47	51	47	50	47	....do	Variable, 1; WSW., 3-2	Do.
	17	46 45 00	124 58 00	198.1	30.24	30.08	58	51	58	51	57	50	....do	WNW., 2; NNW., 4	Do.
	18	42 54 00	124 56 00	221.1	30.08	29.98	55	49	55	49	56	50	Foggy and misty	NE., 3; variable, 2-1	Do.
	19	40 01 00	124 14 00	200.3	30.14	30.07	56	51	56	51	56	52	Cloudy, with fog and mist at times	S'd, 1; NW., 3-4	Do.
	20	Sausalito Harbor, California.		196.0	30.12	30.05	58	54	58	54	58	54	Cloudy and misty; clearing latter part.	NW., 4-2; local, 1	Do.
	21	....do			30.13	30.07	59	56	59	56	58	57	Fair and pleasant generally	Calm; S'd and W'd, 2	
	22	....do			30.17	30.09	66	55	66	55	58	56	Clear and pleasant	Calm; SW., 2-1; squalls, 4-5	
	23	....do			30.24	30.14	62	55	62	55	58	56	Fair and pleasant generally	Calm; local, 2; calm	
	24	37 59 00	122 26 00	9.8	30.28	30.10	75	55	75	55	64	55	....do	Calm; variable, 1-2; S., 1	Smooth.
	25	Navy-yard, Mare Island.		15.2	30.21	30.00	75	54	75	54	62	58	Clear and pleasant	Calm; E., 1; NE., 2-1; calm	
	26	....do			30.08	29.90	78	54	78	54	64	59	....do	Calm; SE., 1; NW., 1; SW., 1	
	27	....do			30.14	30.02	61	53	61	53	61	59	Fair and pleasant	S'd and W'd, 1; WNW., 2	
	28	....do			30.17	30.08	60	51	60	51	60	58	....do	WNW., 1-2; SW., 2; W., 3-2	
	29	....do			30.20	30.13	58	52	58	52	59	56	....do	W'd., 2	
	30	....do			30.23	30.12	59	51	59	51	58	57	....do	W'd, 3; SW. by S., 1-2	
	31	....do			30.28	30.18	63	52	63	52	60	57	Clear and pleasant	S'd and W'd, 2-1; calm; SE., 1	
Nov.	1	....do			30.24	30.02	65	50	65	50	60	57	....do	Calm; SW., 1-2	
	2	....do			30.07	29.81	59	53	59	53	58	57	Fair and pleasant	S'd and W'd, 2-3	
	3	....do			29.90	29.77	52	46	52	46	58	54	Cloudy to overcast and rainy	NW., 4; SW., 1; NNE., 1-2	
	4	....do			30.10	29.92	55	45	55	45	59	56	Clear and pleasant	Calm; S'd and W'd, 1-2	
	5	....do			30.12	29.99	51	46	51	46	56	54	Overcast and rainy	WSW., 1; SSE., 2; ENE., 3; NE., 4-6; NNE., 2.	
	6	....do			30.18	30.09	64	48	62	48	57	54	Clear and pleasant	Calm; E., 1; SW., 1; calm	
	7	....do			30.27	30.13	65	48	65	48	57	54	....do	Calm; ESE., 1-2; calm	
	8	....do			30.25	30.07	83	47	77	47	57	54	....do	Calm; ESE., 1; SE., 2; calm	
	9	....do			30.19	30.07	79	49	76	49	57	54	....do	Calm; E., 1; SE., 2; calm	

Cruising and meteorological record—Continued.

Date.	Meridian positions. Lat. N.	Meridian positions. Long. W.	Distance run per log.	Barometer. Max.	Barometer. Min.	Temperatures. Air. Dry bulb. Max.	Dry bulb. Min.	Wet bulb. Max.	Wet bulb. Min.	Sea at surface. Max.	Sea at surface. Min.	State of the weather.	Direction and force of wind.	State of the sea.
1895.	° ′ ″	° ′ ″	*Knots.*			°	°	°	°	°	°			
Nov. 10	Navy-yard, Mare Island, Cal.		....	30.10	29.96	57	49	57	49	56	54	Fair and pleasant	Variable, 1; and calms	
11	....do		....	30.08	29.96	67	51	64	51	57	53	....do	Calm; SW. and WSW., 1-3-1	
12	....do		....	30.34	30.08	58	48	58	48	55	54	....do	W., 2-4; WNW., 2-1	
13	....do		....	30.54	30.35	58	45	58	45	55	52	Clear and pleasant	Calm; W'd, 1; calm	
14	....do		....	30.57	30.42	65	50	65	48	56	54	....do	Calm; variable, 1; calm	
15	....do		....	30.45	30.29	68	55	68	55	57	54	....do	E., 1-3; ESE., 2; S. by E., 1-2	
16	....do		....	30.28	30.07	72	56	72	56	56	55	....do	E'd, 2-4; calm	
17	....do		....	30.16	30.04	72	54	69	54	57	54	....do	E., 3; SE., 3; calm	
18	....do		....	30.18	30.01	72	50	72	50	57	52	....do	Calm; SE., 2-1; calm	
19	....do		....	30.10	29.99	74	54	72	54	56	53	....do	Calm; ENE., 3; ESE., 3-2; E., 1	
20	....do		....	30.14	29.92	81	51	78	51	58	55	....do	Calm; E., 1; SE., 2; calm S., 2	
21	....do		....	29.99	29.70	60	49	60	50	56	53	....do	W., 2; SW., 3; variable, 1-2; NW., 2	
22	....do		....	29.99	29.70	56	49	54	48	54	53	....do	NW., 2-4; squalls, 5-6; N., 3-2	
23	....do		....	30.15	30.00	83	46	76	46	55	51	....do	N'd, 2-4-1; calm	
24	....do		....	30.26	30.15	63	41	58	41	53	50	....do	Calm; S., 2; SW., 1; calm	
25	....do		....	30.35	30.24	52	45	52	45	52	49	Fair and pleasant	Calm; N'd and W'd, 1; variable, 1; calm.	
26	....do		....	30.28	30.15	53	41	53	41	51	49	....do	Calm; variable, 1	
27	....do		....	30.25	30.14	52	48	52	48	51	50	Overcast and rainy, to clearing	SE., 2; NE., 2-1; ESE., 1	
28	....do		....	30.25	30.06	54	48	54	48	51	50	Overcast, raining latter part	ESE., 2-3; calm	
29	....do		....	30.37	30.12	56	47	56	47	51	50	Fair and pleasant	W., 3; WSW., 3-1	
30	....do		....	30.44	30.36	58	50	58	50	52	50	....do	WNW., 1; calm; WSW., 1; SW., 1	
Dec. 1	....do		....	30.46	30.36	59	50	59	50	53	51	Fair and pleasant; cloudy	Calm; SW., 2-1; S., 2-1; calm	
2	....do		....	30.44	30.33	55	48	55	48	52	50	....do	Calm; NNW., 1; E., 1	
3	....do		....	30.31	30.21	55	45	55	46	52	49	....do	Calm, ENE., 2-3	
4	....do		....	30.24	30.15	51	45	51	45	51	50	Fair, generally; fog first part	E'd, 3-2	
5	....do		....	30.17	30.12	58	45	58	45	50	49	Overcast and rainy	E. by S., 3-1; SSE., 2	
6	....do		....	30.28	30.17	67	51	63	51	53	50	Overcast and rainy, to clearing	SW., 1; calm	
7	....do		....	30.30	30.18	75	49	70	49	56	49	Foggy, to clear and pleasant	Calm; variable, 1; calm	
8	....do		....	30.34	30.22	72	45	69	45	54	49	Clear and pleasant	Calm; E. by S., 3-1	
9	....do		....	30.43	30.36	52	43	52	43	51	48	Foggy, to clear and pleasant	SE., 2-3; E., 4; ENE., 2-3	
10	....do		....	30.41	30.31	52	44	51	44	50	49	Fair and pleasant	E'd, 3-2	
11	....do		....	30.40	30.32	48	44	48	44	49	47	....do	E. and N., 3-5; ENE., 3; E., 3-2	
12	....do		....	30.38	30.24	47	42	47	42	49	47	Overcast, to fair and pleasant	ENE., 3; ESE., 3; E., 2-1	

13	do		30.33	30.19	54	44	54	44	49	48	do	ENE., 2-1; calm	
14	do		30.20	29.96	54	41	53	41	50	48	Clear and pleasant	Calm; SE., 1; S. by W., 2; squalls, 5.	
15	do		30.00	29.75	52	43	52	43	49	48	Overcast and showery, to clearing	SSW., 3; squalls, 6-7; WSW., 3-5 WNW., 3	
16	do		30.14	29.98	48	43	48	43	48	48	Pleasant, generally; showers in p. m.	Variable, 1; SSW., 2-3; calm	
17	do		30.37	30.15	52	41	52	41	Dry dock.		Pleasant, generally; showers in a. m.	Calm; W. by S., 2-1; calm	
18	do		30.44	30.36	51	43	51	43	do		Clear to overcast, and rainy	ESE., 1-2; E., 2; NE., 1	
19	do		30.38	29.92	55	46	55	46	do		Overcast and rainy	ENE., 1; E., 2; SE., 2-4	
20	do		30.04	29.77	54	48	54	48	do		Overcast and rainy; fair interval midday	SE., 4; squalls, 7; SW., 6-2; W'd, 3; SE., 2-3.	
21	do		30.11	30.01	48	40	48	40	do		Overcast and rainy, to clearing	Calm; NE., 2-3; calm	
22	do		30.38	30.06	53	36	53	36	do		Clear and pleasant	Calm	
23	do		30.43	30.00	53	38	53	38	do		Clear; rainy in afternoon; clearing again.	Calm; S., 2-1; variable, 1	
24	do		30.48	30.00	53	40	53	40	do		Clear and pleasant	Calm; WNW., 2-1	
25	do		30.46	30.34	55	43	55	43	do		do	Calm; E., 2; ESE., 1; E., 1	
26	do		30.50	30.38	57	40	57	40	do		do	Calm	
27	do		30.52	30.37	56	42	56	42	do		do	Calm; E., 2; variable, 1	
28	do		30.54	30.37	54	45	52	45	do		Clear, but boisterous	NNW., 3; squalls, 6-7; NNW., 2	
29	do		30.65	30.52	55	37	54	37	do		Clear and pleasant	N'd and E'd, 3-1	
30	do		30.65	30.48	53	37	53	37	do		do	Calm; variable, 1.	
31	do		30.61	30.42	56	36	56	36	do		do	Calm; ESE., 2-1; NE. by E., 1; calm.	
1896. Jan. 1	Navy-yard, Mare Island, Cal.		30.49	30.33	53	42	53	42	Dry dock.		Fair and pleasant; fog first part	Calm	
2	do		30.47	30.32	54	44	54	44	do		do	Calm; E. by S., 2; calm	
3	do		30.44	30.29	57	39	57	39	47	44	do	Calm; E. by S., 2-1; calm	
4	do		30.37	30.26	63	39	63	39	46	43	Fair and pleasant	Variable, 1-2	
5	do		30.35	30.20	53	39	53	39	48	44	do	E'd, 2-1; calm	
6	do		30.37	30.24	64	40	63	40	49	43	Clear and pleasant	Calm; E'd, 1-2	
7	do		30.42	30.30	60	41	59	41	46	44	do	E'd, 2	
8	do		30.43	30.30	55	45	55	45	45	44	Fair and pleasant	E., 2-3; calm; E., 2	
9	do		30.29	30.12	55	45	54	44	46	44	do	Calm; E., 2	
10	do		30.15	29.98	55	46	55	46	47	45	do	ENE., 3; E., 2	
11	do		30.09	29.98	56	49	56	49	47	46	do	E. by N., 1; calm; SW., 1	
12	do		30.14	30.07	53	48	53	48	46	44	Overcast, foggy, and drizzly	SSW., 1; calm	
13	do		30.16	30.10	52	49	52	49	47	46	Overcast; drizzling rain	Calm; E. by S., 2-1	
14	do		30.17	29.95	59	51	59	51	47	46	Cloudy; drizzling mist at times	Calm; S., 1-2	
15	do		29.93	29.69	58	56	58	56	49	47	Overcast and rainy; boisterous	SE. and S. by E., 3; squalls, 5	
16	do		29.89	29.72	59	57	59	57	51	48	do	S. by E., 3; squalls, 5; SSE., 5; squalls, 8.	
17	do		30.04	29.84	61	56	61	56	54	50	do	South, 3-5; calm; ENE., 2; S. by E., 3-5.	
18	do		30.12	29.78	62	56	62	56	55	51	Rainy and boisterous, to clearing	SSE., 4; squalls, 6-8; SSW., 3-1	
19	do		30.13	29.88	59	55	59	55	54	52	Overcast and rainy	Calm; S'd and E'd, 2	
20	do		29.98	29.81	61	57	61	57	55	52	Overcast and rainy, to clearing	SSE., 4; squalls, 6-8; S. by E., 3; SSE., 2.	
21	do		30.26	29.97	60	48	60	48	54	52	Overcast; frequent showers	SSW., 2; WSW., 2	
22	San Francisco Harbor.	26.0	30.31	29.98	52	43	52	43	52	48	Pleasant, generally; drizzle latter part.	Calm; SE., 2	Smooth.
23	do		30.15	29.99	53	48	53	48	52	50	Boisterous and rainy, to clearing	W'd, 1-3	

Cruising and meteorological record—Continued.

Date.	Meridian positions. Lat. N.	Meridian positions. Long. W.	Distance run per log.	Barometer. Max.	Barometer. Min.	Temperatures. Air. Dry bulb. Max.	Temperatures. Air. Dry bulb. Min.	Temperatures. Air. Wet bulb. Max.	Temperatures. Air. Wet bulb. Min.	Temperatures. Sea at surface. Max.	Temperatures. Sea at surface. Min.	State of the weather.	Direction and force of wind.	State of the sea.
1896.	° ′ ″	° ′ ″	*Knots.*			°	°	°	°	°	°			
Jan. 24	San Francisco Harbor.		....	30.12	29.91	54	44	54	44	51	50	Fair and pleasant	Calm; ESE., 3; variable, 1	
25	.....do		....	30.08	29.86	59	50	59	50	54	51	Boisterous and rainy, to clearing	SE., 8, dropping to 2	
26	.....do		....	30.07	29.86	60	56	60	56	53	52	Overcast and unsettled; rain at times.	E'd, 2-3; S'd and E'd, 8; SE. by E., 3.	
27	.....do		....	29.90	29.70	58	53	58	53	53	52	Unsettled and cloudy; frequent showers.	SSE., 1; squalls from E. by N., 5; W'd, 1.	
28	37 26 00	122 40 00	36.0	30.04	29.90	54	52	54	52	54	52	Fair and pleasant	S'd, 3-2; calm; NW. by W., 3-5	Gentle.
29	34 24 00	120 25 00	233.1	30.02	29.81	63	53	62	52	56	54	Clear and pleasant	NW., 6-7-4	Moderate.
30	San Diego Harbor, Cal.		221.9	30.10	29.88	70	52	70	52	59	56	.....do	NNW., 4; local, 1	Smooth.
31	.....do		....	30.22	30.13	70	50	70	50	60	54	.....do	NW., 1-2	
Feb. 1	.....do		....	30.25	30.12	64	48	61	48	60	56	.....do	Calm; S. by W., 3; E. by N., 1	
2	.....do		....	30.17	30.09	58	51	58	50	57	55	Cloudy and showery	E., 1-3; SE., 3-2; SW. by W., 2; W., 2.	
3	.....do		....	30.18	30.04	59	49	59	49	58	54	Clear and pleasant	E., 1; ESE., 3; W., 3-2; calm	
4	.....do		....	30.23	30.10	57	47	57	46	57	55	.....do	E. by N., 2; calm; WNW., 3-2; N. by W., 1.	
5	.....do		....	30.22	30.06	58	45	58	45	57	54	.....do	NE., 1; calm; WNW., 2-1	
6	.....do		....	30.14	29.98	59	46	59	46	57	53	.....do	NE., 1; WNW., 3-2; calm	
7	.....do		....	30.34	30.14	62	47	62	47	56	53	.....do	Calm; W'd, 2-1; NE., 1	
8	.....do		....	30.37	30.24	58	44	58	44	55	54	.....do	Variable, 1; WNW., 2; calm	
9	.....do		....	30.27	30.08	62	47	62	47	57	53	.....do	Calm; WNW., 1-2; calm	
10	.....do		....	30.14	30.01	61	49	59	47	56	54	.....do	Calm; WNW., 1; calm	
11	.....do		....	30.07	29.98	59	52	58	50	55	55	.....do	Calm; W., 1; calm	
12	.....do		....	30.27	30.08	59	46	56	46	57	55	.....do	Variable, 1; NW., 2; calm	
13	.....do		....	30.31	30.19	63	48	58	42	58	54	.....do	Calm; WNW., 2-3; NE., 1	
14	.....do		....	30.22	30.10	60	52	57	48	56	54	.....do	NE., 1; calm; WNW., 2-1; calm	
15	.....do		....	30.16	30.03	62	50	56	49	56	55	.....do	Calm; WNW., 1-2; calm	
16	.....do		....	30.18	30.02	69	51	60	48	57	56	.....do	Calm; WNW., 2-3; calm	
17	.....do		....	30.10	29.97	69	55	63	51	60	56	.....do	Calm; NW., 2-3; calm	
18	.....do		....	30.15	30.00	70	56	63	53	59	56	.....do	Calm; WNW., 2-1	
19	.....do		....	30.07	29.98	70	57	64	52	60	56	.....do	Calm; SSW., 3-2; calm	
20	.....do		....	30.16	30.02	68	58	64	56	60	58	.....do	Calm; S. by W., 1-3; SSE., 2; calm	
21	.....do		....	30.21	30.10	63	54	62	52	60	58	.....do	ENE., 2-1; WNW., 2-1	

22	....do		30.22	30.10	61	54	59	52	60	57	....do	Calm; WNW., 2-3-1
23	....do		30.23	30.16	62	51	60	50	60	58	....do	NE., 1; NW., 2; WNW., 2; calm
24	....do		30.28	30.17	68	53	60	52	61	58	....do	Calm; WNW., 2; calm
25	....do		30.32	30.19	69	50	62	50	60	58	....do	Calm; WNW., 1-3; variable, 1
26	....do		30.25	30.06	65	53	61	51	61	58	....do	Calm; WNW., 1-2; calm; ESE., 1
27	....do		30.11	29.98	66	54	62	53	62	58	....do	Calm; WNW., 2-3; calm
28	....do		30.02	29.92	65	56	63	55	62	59	Cloudy; showers in a. m.	E'ly, 1; SSW., 2; calm
29	....do		30.00	29.92	64	55	61	51	62	59	Fair, generally; shower 6.30 p. m.	SW., 1-2; W., 3
Mar. 1	....do		30.04	29.98	55	51	52	45	59	57	Fair and pleasant	W. by S., 3; W., 4
2	....do		30.09	29.90	57	45	53	44	59	55	Cloudy to overcast and rainy	WNW., 3; ENE., 2; ESE., 3; S. by E., 5; squalls, 6-9.
3	....do		29.90	29.77	55	47	52	46	57	54	Overcast, stormy, and rainy	S'd and E'd, 3; squalls, 4-6; W., 3; squalls, 6-8.
4	....do		30.13	29.90	55	46	53	46	55	53	Cloudy; occasional showers	WSW., 2; squalls, 6-8
5	....do		30.22	30.13	57	45	55	44	56	53	Cloudy; showers in morning	Variable, 2; WSW., 2; calm
6	....do		30.32	30.21	59	46	56	45	56	54	Clear and pleasant	ENE., 1; S. by E., 2; WNW., 2
7	....do		30.30	30.13	59	45	55	45	56	54	....do	Variable, 1; WNW., 2-3; calm
8	....do		30.22	30.12	61	48	58	46	57	54	....do	ENE., 1; WNW., 2-1; calm
9	....do		30.15	30.00	61	52	58	50	58	55	....do	Calm; WNW., 2; calm
10	....do		30.21	30.09	67	51	61	49	58	55	....do	Calm; WNW., 3-2; calm; NE., 1
11	....do		30.22	30.09	62	51	59	49	58	56	....do	ENE., 1; calm; W. by N., 2; calm
12	....do		30.15	30.01	65	52	61	50	59	53	....do	Calm; WNW., 1-2; calm
13	....do		30.09	29.96	61	51	59	51	59	57	Fair and pleasant, generally; fog first part.	Calm; SSW., 2; ESE., 1
14	....do		30.13	29.99	64	56	62	54	59	57	Clear and pleasant	ESE., 3; S. by E., 2; SSW., 2-1; calm.
15	....do		30.18	30.12	63	52	59	51	59	57	....do	NE., 1; WNW., 2-3; NW., 3-2
16	....do		30.18	30.06	61	54	59	53	59	57	Cloudy; fog and mist latter part	WNW., 2-3-1; calm
17	....do		30.15	30.01	61	55	59	54	61	58	Fair and pleasant; fog first part	Calm; WNW., 2-3-1; calm
18	....do		30.17	30.05	71	54	66	53	62	58	Clear and pleasant	Calm; W. by N., 2; calm
19	....do		30.17	30.02	66	55	63	54	63	60	....do	Calm; WNW., 2-4-1; calm
20	....do		30.15	30.03	66	55	62	56	64	58	....do	Calm; WNW., 3-2; calm
21	....do		30.16	30.06	64	55	62	55	64	61	Fair and pleasant; fog first part	Calm; WNW., 1-2; calm
22	....do		30.21	30.10	71	59	68	57	66	62	Clear and pleasant	WNW., 1; NW., 2-3; WNW., 1
23	....do		30.19	30.07	72	61	67	59	66	62	....do	Calm; WNW., 1-3; calm
24	....do		30.09	29.91	77	62	70	60	66	62	....do	Calm; WNW., 1-2; calm
25	....do		30.04	29.92	74	58	70	58	66	62	....do	Calm; WNW., 2; calm
26	....do		30.02	29.90	70	60	68	59	66	61	Fair and pleasant; fog first part	Variable, 1-2; calm
27	....do		30.01	29.95	64	58	61	56	64	60	Fair and pleasant	Calm; WNW., 1; W., 2; WNW., 1
28	....do		30.01	29.89	60	57	59	56	62	58	Cloudy; frequent showers	ENE., 2; SE., 2; SSE., 3-5; variable, 2-1.
29	....do		30.10	30.01	64	55	63	55	62	58	Clear and pleasant	ESE., 1; SSW., 1; SW., 2; WNW., 1; calm.
30	....do		30.07	29.96	62	54	61	54	62	60	Fair and pleasant; fog first part	Calm; W. by N., 2; calm
31	....do		30.17	30.00	68	55	65	53	63	60	Clear and pleasant	Calm; WNW., 2; ENE., 1
Apr. 1	....do		30.19	30.04	68	54	64	52	63	61	....do	ENE., 2; calm; WNW., 2-3; ENE., 1.
2	....do		30.07	29.92	67	54	62	50	62	58	....do	WNW., 1-2; ENE., 1
3	....do		30.13	30.01	64	52	61	51	63	59	....do	Calm; WSW., 2-1; NE., 1
4	....do		30.23	30.10	62	53	58	51	63	60	....do	ENE., 1-2; WNW., 3-2; calm
5	....do		30.26	30.17	61	52	58	51	62	60	....do	Calm; WNW., 3-2
6	....do		30.25	30.17	62	56	58	54	63	61	....do	WNW., 2-3-1

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Date.	Meridian positions. Lat. N.	Meridian positions. Long. W.	Distance run per log.	Barometer. Max.	Barometer. Min.	Temperature. Air. Dry bulb. Max.	Dry bulb. Min.	Wet bulb. Max.	Wet bulb. Min.	Sea at surface. Max.	Sea at surface. Min.	State of the weather.	Direction and force of wind.	State of the sea.
1896.	° ′ ″	° ′ ″	Knots.			°	°	°	°	°	°			
Apr. 7	San Diego Harbor, Cal.		....	30.18	30.10	65	57	64	56	63	62	Clear and pleasant	WNW., 1; WSW., 2-1; calm	
8	.....do		....	30.11	30.00	68	54	64	54	65	62	.....do	NE., 2-1; SW., 1; WSW., 2; calm.	
9	.....do		....	30.08	30.01	66	56	63	52	65	61	Fair generally; showers, 10 to 12 p. m.	ESE., 2; SSW., 2; WSW., 2; WNW., 3.	
10	.....do		....	30.05	29.96	57	53	52	49	62	59	Cloudy and boisterous; showery	WNW., 4; squalls, 6-7; NE., 2	
11	.....do		....	30.13	30.01	63	49	58	45	62	58	Clear and pleasant	NE., 2-1; WSW., 2; calm	
12	.....do		....	30.14	30.07	64	52	60	50	62	58	.....do	Variable, 1; S'd and W'd, 2-3; calm	Smooth.
13	33 04 00	119 19 00	130.4	30.10	30.02	58	54	56	52	59	55	Fair, to overcast and boisterous	W. by N., 3; NW., 5; WNW., 6-9	Increasing to heavy.
14	33 26 00	119 43 00	117.5	30.07	29.91	56	51	55	46	55	53	Clear, but stormy and boisterous	WNW., 7-8; squalls, 9-10	Rough and irregular.
15	34 11 00	119 37 00	53.3	30.00	29.89	60	49	55	45	55	52	Clear but boisterous	W., 6-8; squalls, 8-9	Heavy.
16	Santa Barbara, Cal.		14.1	30.05	29.91	60	50	56	47	53	49	.....do	WNW., 3; squalls, 5-7	Moderate.
17	.....do		....	30.17	30.03	64	48	63	48	53	50	.....do	W'd, 3; calm; W'd, 3; squalls, 6	Do.
18	.....do		....	30.12	29.96	60	44	58	44	52	47	Cloudy and pleasant; light mist in a. m.	W'd, 1-2	Do.
19	.....do		....	30.13	29.93	55	45	55	44	52	50	Clear but boisterous	WSW., 4-8; squalls, 6-8; calm	Do.
20	.....do		....	30.23	30.13	56	44	55	44	53	50	Clear and pleasant	WSW., 1	Smooth.
21	San Pedro Harbor, Cal.		94.7	30.19	30.02	61	50	60	50	57	52	Fair, generally; rain latter part	Variable, 1; SW., 3; calm	Do.
22	.....do		....	30.11	30.02	67	51	64	50	59	54	Clear and pleasant	Calm; WSW., 2-3; calm	Do.
23	.....do		....	30.13	30.06	63	48	60	47	58	53	.....do	Calm; SSE., 2; SSW., 1	Do.
24	.....do		....	30.19	30.09	60	54	58	52	58	55	.....do	ESE., 1-3; calm	Do.
25	.....do		....	30.11	30.01	68	57	65	57	62	57	Fair and pleasant; light mist at times.	Calm; S'd, 2; calm	Do.
26	33 45 00	118 46 00	27.1	30.09	30.02	57	52	56	50	62	54	Cloudy and showery to clear and pleasant.	WSW., 2	Do.
27	35 29 00	121 06 00	187.4	30.33	30.01	58	51	54	50	58	52	Clear and pleasant	WNW., 3-4; squalls, 5	Moderate.
28	Sausalito Harbor, Cal.		175.1	30.37	30.25	58	51	56	50	55	51	.....do	W'd, 2; local squalls, 4	Smooth.
29	.....do		....	30.32	30.20	56	49	55	48	54	52	Overcast and boisterous; rain at times.	S'd and W'd, 2; squalls, 4-6; WSW., 2.	Do.
30	.....do		....	30.33	30.17	56	46	53	46	53	52	Clear and pleasant	WSW., 1-2; local squalls, 4	Do.

May	1	Sausalito Harbor, Cal.		....	30.20	30.11	58	51	57	51	56	52	Cloudy and unsettled; showers at times.	S'd and E'd, 1; local squalls, 4	Smooth.
	2	Navy-yard, Mare Island.		24.0	30.20	30.11	54	52	63	51	58	55	Fair and pleasant	SW., 1-2	Do.
	3	....do		....	30.12	30.07	64	55	62	54	58	56	Overcast; showers in a. m	SSW., 2-3; squalls, 4-5	Do.
	4	....do		....	30.08	29.98	64	51	62	49	59	57	Cloudy and boisterous	SW., 3; WSW., 3; squalls, 5	Do.
	5	....do		....	30.07	29.96	63	47	58	45	58	55	Fair and pleasant	W'd, 3; squalls, 4	Do.
	6	....do		....	30.06	29.93	72	46	70	45	59	56	Clear and pleasant	W'd, 1-2	Do.
	7	San Francisco Harbor.		28.0	30.08	30.00	58	49	54	49	57	54	....do	S'd and W'd, 3; squalls, 6-7	Do.
	8	....do		....	30.27	30.04	57	50	55	48	56	50	Fair, but boisterous	WSW., 4; squalls, 6-7; WNW., 3	Moderate.
	9	35 17 00	121 13 00	175.1	30.26	30.05	62	50	61	48	54	50	Clear and pleasant	WNW., 4-5	Long and irregular.
	10	Santa Barbara, Cal.		110.0	30.12	30.01	72	49	70	48	57	52	....do	E'd, 1	Smooth.
	11	34 23 00	119 47 00	3.4	30.18	30.08	61	52	58	51	54	48	....do	E'd, 1; WNW., 4-5	Moderate.
	12	34 24 00	120 14 00	44.6	30.19	30.09	61	53	59	51	53	48	Clear, but boisterous	W'd, 4; squalls, 5-7	Do.
	13	34 24 00	120 14 00	26.4	30.17	29.96	69	53	65	53	53	48	....do	....do	Do.
	14	34 24 00	120 14 00	26.8	29.98	29.74	69	58	61	51	60	49	Clear; boisterous in a. m.; pleasant in p. m.	W'd, 3; squalls, 5-6; variable, 2-1	Moderating.
	15	34 33 00	120 40 00	84.8	30.10	29.97	62	51	56	50	57	48	Clear and pleasant	W'd, 3; squalls, 6-7; calm	Rough.
	16	35 26 00	121 02 00	70.2	30.22	30.09	54	49	53	48	50	47	....do	Calm; WNW., 4; squalls, 6-7	Heavy head.
	17	San Francisco Harbor.		193.2	30.22	30.04	56	48	53	46	54	47	Clear, but boisterous	NW'd, 4-5; squalls, 6-7; WSW., 3-5	Do.
	18	....do		10.0	30.22	30.04	57	48	53	46	59	53	....do	S'd and W'd, 2-3; squalls, 4-5	Smooth.
	19	Navy-yard, Mare Island.		19.0	30.27	30.19	71	49	70	47	61	57	Clear and pleasant	SW., 2	Do.
	20	....do		....	30.21	30.09	63	50	60	49	60	48	....do	S'd and W'd, 2	Do.
	21	....do		....	30.09	30.01	61	56	61	55	60	59	Cloudy and showery	Calm; S'd, 2	Do.
	22	....do		....	30.20	30.09	65	54	62	53	61	58	Cloudy, to clear and pleasant	SW., 1; W., 2	Do.
	23	....do		....	30.24	30.12	63	54	61	53	62	54	Clear and pleasant	SW., 2; squalls, 4	Do.
	24	....do		....	30.20	30.05	83	54	76	53	66	57	....do	Calm; SW., 1; calm	Do.
	25	....do		....	30.11	29.92	90	58	82	58	68	62	....do	....do	Do.
	26	Sausalito Harbor, Cal.		21.0	29.99	29.84	87	64	76	62	65	57	....do	Calm; variable, 1-2	Do.
	27	....do		....	30.00	29.92	70	56	65	55	58	55	Cloudy, foggy, and boisterous	SW., 2; local squalls, 6-9	Do.
	28	....do		....	29.99	29.90	59	54	57	52	56	55	....do	SW., 2; local squalls, 6-8	Do.
	29	....do		....	30.11	29.91	60	54	58	53	58	54	Overcast, misty, and boisterous; thunder and lightning.	SW., 2; squalls, 4-5; S'd, 1	Do.
	30	....do		....	30.23	30.11	64	57	62	56	59	56	Overcast and misty, to clearing	SW'd, 1-2	Do.
	31	....do		....	30.14	29.97	64	54	60	53	59	56	Clear and pleasant	W'd, 1-2; SW., 1-2; calm	Do.
June	1	37 39 00	122 21 00	15.0	30.01	29.92	56	52	55	48	62	52	Fair and pleasant, to boisterous	Calm; SW., 3; squalls, 5-7	Moderate.
	2	Sausalito Harbor, Cal.		15.0	30.09	29.96	56	50	53	48	58	55	Misty and foggy in a. m.; then clear and pleasant.	SW., 4; squalls, 6; SW., 2	Do.
	3	....do		....	30.13	30.07	56	50	54	48	57	54	Fair and pleasant	SW., 2; SW'd, 3; squalls, 7; S'd, 2	Do.
	4	....do		....	30.07	30.00	73	55	71	53	60	56	Cloudy, but pleasant	Calm; S'd, 1; SW., 2-3; squalls, 5	Do.
	5	37 50 00	122 35 00	9.2	30.09	30.00	58	51	58	49	59	49	Fair, but boisterous	SW., 3; squalls, 6; WNW., 4-7	Heavy head.
	6	39 27 00	124 10 00	150.8	30.18	30.08	55	51	55	50	52	47	Clear, but boisterous	NW., 5; squalls, 6-7	Mod. head.
	7	42 21 00	124 43 00	190.1	30.17	30.13	60	52	59	52	55	49	Cloudy and foggy; clearing latter part.	Calm; S'd and E'd, veering to W. and S., 3.	W'ly swell.
	8	45 27 00	124 25 45	200.5	30.27	30.15	59	53	56	51	56	53	Cloudy; showers at times	W., 3-4, veering to SSW., 3	Do.
	9	48 23 00	124 14 00	203.6	30.31	30.18	56	50	52	47	53	49	Cloudy; frequent showers and mists	SSW., 3; local, 2; SW., 3-5	Do.

Cruising and meteorological record—Continued.

Date.	Meridian positions.		Distance run per log.	Barometer.		Temperatures.						State of the weather.	Direction and force of wind.	State of the sea.
						Air.				Sea at surface.				
						Dry bulb.		Wet bulb.						
	Lat. N.	Long. W.		Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.			
1896.	° ′ ″	° ′ ″	*Knots.*			°	°	°	°	°	°			
June 10	Victoria Harbor, B. C.		32.1	30.45	30.32	77	49	76	47	55	48	Cloudy to clearing; showers in a. m.	SW., 2; squalls, 4; calm; N'd, 1	Smooth.
11	Seattle Harbor, Wash.		63.3	30.31	29.96	64	49	62	49	58	49	Fair and pleasant	Variable, 1	Do.
12	.....do		....	30.26	30.12	62	50	60	48	57	49	Clear and pleasant	S'd squalls, 6; N'd and W'd, 1-2	Do.
13	.....do		....	30.20	30.08	67	49	64	48	60	52	.....do	Variable, 1; calm	Do.
14	.....do		....	30.27	30.13	67	50	65	50	59	51	.....do	Calm; variable, 1	Do.
15	.....do		....	30.31	30.23	65	50	63	50	59	50	.....do	Calm; NW'd, 1-2	Do.
16	.....do		....	30.32	30.09	69	52	67	50	62	52	.....do	Calm; N'd and W'd, 1-2	Do.
17	.....do		....	30.19	30.09	67	56	65	54	58	53	.....do	SSE., 1; NW., 1	Do.
18	48 03 10	122 38 15	30.6	30.10	30.01	64	56	60	55	63	53	.....do	Calm; NW., 2; S'd, 1	Do.
19	New Whatcom, Wash.		47.9	30.29	30.10	61	54	56	50	62	55	.....do	SSE., 1; SSW., 3; S'd, 1	Do.
20	.....do		....	30.33	30.17	66	52	64	50	65	57	.....do	Calm; WSW., 1-2; calm	Do.
21	48 01 40	122 37 00	44.7	30.29	30.13	67	52	64	52	62	50	.....do	Calm; S'd, 3; N'd and W'd, 2	Do.
22	Seattle Harbor, Wash.		28.1	30.38	30.22	65	54	63	53	62	56	.....do	S'd, 1; Variable, 1	Do.
23	.....do		....	30.30	30.20	65	57	63	56	61	56	.....do	N'd and W'd, 1-2	Do.
24	47 53 10	122 29 30	20.9	30.29	30.16	60	52	56	52	56	50	.....do	Calm; N'd and W'd, 1-2	Do.
25	49 28 47	124 25 15	177.1	30.20	29.96	68	53	62	52	60	48	.....do	N'd and W'd, 2-3; calm; W., 2	Do.
26	51 05 00	128 26 00	191.5	30.05	29.94	60	50	59	49	54	48	.....do	Calm; N'd and W'd, 3	Do.
27	52 00 00	133 37 00	212.8	30.12	29.98	54	49	53	49	51	49	Overcast, foggy, and misty	ESE., 4; SSE., 4; S'd, 3	Moderate.
28	52 54 00	139 04 00	215.9	30.04	29.82	51	46	50	46	50	47	Overcast and cloudy; misty first part.	S'd, 1-2; calm; N'd, 1	Smooth.
29	53 29 00	144 54 00	222.3	29.82	29.69	51	46	51	46	47	46	Overcast and misty	NE., 3	Long SW. swell.
30	53 45 00	151 18 00	227.3	29.90	29.67	48	47	47	46	47	46	.....do	NNE., 4-6	Moderate.
	124 days at sea and under way.		11,702.1											

Record of intermediate and surface tow-net stations of the steamer Albatross.

Date.	No. of station.	Position.		Temperature.		Time of day.	Depth of net.	Length of trial.	Net used.	Result.
		Lat. N.	Long. W.	Surface.	Depth.					
1895.		° '	° ' "				*Fathoms.*	*Minutes.*		
Aug. 5	46	55 06	169 08 00	46.0	38.2	1:17 p.m.	200	26	Intermediate	Abundance small crustacea, young shrimps, and sagitta.
		55 06	169 08 00			1:17 p.m.	Surface.	26	Surface	2 small fish and abundance of small crustacea.
7	47	55 36	170 45 00	44.0		11:28 a.m.	100	23	Intermediate	Numerous small crustacea and sagitta.
		55 36	170 45 00	44.0		11:28 a.m.	Surface.	23	Surface	Few small crustacea and sagitta.
	48	55 10	170 56 00	45.0	38.0	7:17 p.m.	150	27	Intermediate	Numerous small crustacea and sagitta and 4 small fish.
		55 11	170 56 00	45.0		7:17 p.m.	Surface.	27	Surface	Abundance of small crustacea and sagitta.
		55 11	171 13 00	45.0		10:00 p.m.	1	20	do	Abundance of small crustacea and siphonophore.
8	49	55 53	171 40 00	45.0	37.4	10:43 a.m.	200	58	Intermediate	Numerous small crustacea and sagitta.
		55 53	171 40 00	45.0		11:30 a.m.	10 feet.	16	Surface	Very few crustacea and sagitta.
	50	55 44	171 17 00	44.0	37.7	5:08 p.m.	100	20	Intermediate	2 small fish, abundance amphipod crustacea.
		55 44	171 17 00	44.0		5:15 p.m.	20 feet.	20	Surface	10 small fish, few crustacea and fish eggs.
10	51	56 15	172 35 00			1:40 p.m.	43	23	Intermediate	Abundance small crustacea of several species; numerous sagitta.
		56 15	172 35 00			1:40 p.m.	2	24	Surface	1 very small squid; few larval shells; abundance pelagic refuse.
	52	56 13	172 20 00	45.0		4:27 p.m.	50	21	Intermediate	Minute crustacea of several species; few sagitta.
		56 13	172 20 00	45.0		4:27 p.m.	Surface.	15	Surface	Quantity of small crustacea.
11	53	55 23	170 31 00			12:43 p.m.	48	23	Intermediate	1 young gadoid; few medusæ and annelida; 1 embryo ictopos; sagitta and crustacea.
		55 23	170 31 00			12:43 p.m.	Surface.	23	Surface	Quantity brownish pelagic refuse.
						2:47 p.m.	Surface.	25	do	Quantity of brownish spicules and pelagic refuse.
				45.0		10:00 p.m.	Surface.	20	do	Few small red medusæ; 1 large white medusa; many small crustacea and worms.
12	54	54 54	168 59 00	45.0	39.5	11:47 a.m.	25	30	Intermediate	Numerous small crustacea and sagitta.
		54 54	168 59 00	45.0		11:47 a.m.	Surface.	30	Surface	2 small fish; few medusæ, worms and crustacea.
						9:45 p.m.	Surface.	20	do	Few large brown medusæ; few smaller medusæ; 4 young cod; few small pelagic fishes; many small crustacea, etc.
13	55					12:53 p.m.	30	25	Intermediate	3 species small medusæ; several species minute crustacea; small cod; small invertebrates.
						12:53 p.m.	Surface.	25	Surface	Abundance brownish algæ and pelagic refuse; few larval squid.
						5:10 p.m.	Surface.	40	do	
18	56					5:00 p.m.	200	32	Intermediate	Few small medusæ, abundance sagitta, and minute crustacea.
						5:00 p.m.	Surface.	32	Surface	Quantity of larval shells, minute crustacea, and minute brownish algae.
19	57	54 17	168 53 30			12:00 m.	50	25	Intermediate	Abundance sagitta and minute crustacea; few larval squid.
		54 17	168 53 30			12:00 m.	Surface.	25	Surface	Small quantity sagitta and minute black crustacea; few small medusæ, larval crabs, and small pelagic fish.
	58						575	30	Intermediate	Few sagitta, crimson prawns, small medusæ, larval ophiurans; few ascidians; crustacea.
							Surface.	30	Surface	Quantity of larval shells, small crustacea, and medusæ.
						9:25 p.m.	Surface.	25	do	Hauled with electric light.
20	59					12:01 p.m.	200	20	Intermediate	Struck bottom; sagitta and minute pink crustacea; small ophiurans; 3 small fishes; worms.
						12:01 p.m.	Surface.	20	Surface	Few small crustacea.

Record of intermediate and surface tow-net stations of the steamer Albatross—Continued.

Date.	No. of station.	Position.		Temperature.		Time of day.	Depth of net.	Length of trial.	Net used.	Result.
		Lat. N.	Long. W.	Surface.	Depth.					
1895.		° ′	° ′ ″				*Fathoms.*	*Minutes.*		
Aug. 20	59	55 19	168 11 00	....	....	9:55 a. m.	Surface.	....	.....do	
		55 11	167 56 00	....	....	10:15 p. m.	Surface.	....	.....do	
	60	....	....	....	....	....	70	25	Intermediate.	Abundance of small crustacea and sagitta.
		....	....	....	....	....	Surface.	25	Surface	Similar to above.
		....	....	....	....	10:35 p. m.	Surface.	20	.....do	Many small medusæ and abundance of small crustacea.
21	61	....	....	....	....	9:20 p. m.	50	20	Intermediate .	Abundance minute pinkish crustacea of many species.
		....	....	....	....	9:20 p. m.	Surface.	20	Surface	Small quantity ova and larval squid; many larval crabs; few small pelagic fishes; brown algæ.
	62	....	....	....	....	....	30	20	Intermediate .	Abundance small crustacea and sagitta.
		....	....	....	....	....	Surface.	20	Surface	Few crustacea.
22	63	....	....	....	....	9:18 p. m.	20	25	Intermediate .	Few larval *Gadidæ* and squid; abundance of petropods with shells; few small medusæ.
		....	....	....	....	9:18 p. m.	Surface.	25	Surface	Usual sagitta and crustacea.

Record of dredging and trawling stations of the United States Fish Commission steamer Albatross.

Serial No.	Date.	Time.	Position.		Temperatures.			Depth.	Character of bottom.	Wind.		Drift.		Instrument used.	Remarks.
			Lat. N.	Long. W.	Air.	Surface.	Bottom.			Direction.	Force.	Direction.	Distance.		
	1895.		° ′ ″	° ′ ″	°	°	°	Fms.							
3601	Aug. 5	11.10 a. m.	55 06 00	169 08 00	46	46	35.8	1,044	gn. M. fne. S	S	3	SSE	1.0	L. B. T	Surface and intermediate nets.
3602	Aug. 10	9.43 p. m.	56 32 00	172 40 00	45	44	37.1	81	gn. M. S.	W. by S.	3	NNW	.8	do	Surface net.
3603	Aug. 11	11.38 a. m.	55 23 00	170 31 00	46	45	35.1	1,771	bn. oz.	SW. by S.	1	E. ¾ S.	.7	do	Surface and intermediate nets.
3604	Aug. 12	10.25 a. m.	54 54 00	168 59 00	46	45	35.2	1,401	gn. oz.	WNW.	2	SSW. ¾ W.	.8	do	Do.
3605	Aug. 13	12.44 p. m.	55 17 00	167 34 00	45	44	37.1	91	gn. M. S.	SW. by W	6	SE.	1.0	do	Do.
3606	do	5.12 p. m.	55 27 00	167 47 00	46	45	38.1	87	gn. M. fne. S.	SW. by S.	4–5	SE. by S.	.4	do	Do.
3607	Aug. 18	4.14 p. m.	54 11 30	167 25 00	46	45	35.9	987	gn. M. bk. lav. S.	SW. by S.	2	SE. by E.	.3	do	Do.
3608	Aug. 20	10.01 a. m.	55 19 00	168 11 00	46	45	37.8	276	gy. S.	WSW	1–2	N. ¼ W.	.6	do	Do.
3609	Aug. 21	9.12 a. m.	55 35 00	168 20 00	46	46	37.9	74	gn. M. S.	W. by N.	2	W. by S.	.7	do	Do.
3610	Aug. 22	8.11 a. m.	55 58 00	167 16 00	45	47	36.8	75	gn. M.	WNW.	3	W. by N.	.7	do	Do.
3611	do	5.18 p. m.	56 45 00	167 25 00	45	46	34.6	50	gn. M. S.	W. by S.	3	E. by S.	.6	do	Do.
3612	Sept. 30	8.30 a. m.	1′ west of Chuck-a-nut Island, Bellingham Bay, Wash.		56	52	....	11	gn. M.	N. by E.	2	NW. by N	.3	S. B. T	
	1896.														
3613	Mar. 31	9.35 a. m.	Channel 2¼′ S. by E. of National City wharf.		70	63	....	5	M. Sh.	Calm	0	....	....	Boat beam trawl.	San Diego Bay.
3614	do	10.25 a. m.	Channel 1¾′ S. by E. of National City wharf.		70	63	....	4½	do	do	0	....	....	do	Do.
3615	do	12.10 p. m.	Channel 1½′ S. by E. of National City wharf.		70	63	....	5	do	do	0	....	....	do	Do.
3616	do	1.05 p. m.	Channel ½′ SSE. of National City wharf.		72	63	....	5	do	do	0	....	....	do	Do.
3617	do	1.50 p. m.	Channel abreast of National City wharf.		72	63	....	5½	do	NW	1	....	....	do	Do.
3618	do	2.35 p. m.	Channel abreast of beacon No. 9.		72	63	....	4½	do	do	1	....	....	do	Do.
3619	do	3.03 p. m.	Channel 1½′ ESE. of beacon No. 8.		74	63	....	4	do	do	1	....	....	do	Do.
3620	do	3.50 p. m.	Channel ¾′ E. by S. of beacon No. 8.		74	63	....	6	do	do	1	....	....	do	Do.
3621	Apr. 1	10.12 a. m.	Channel ¾′ ENE. of *Point Loma* lighthouse.		72	61	....	6½	M. S.	do	0–1	....	....	do	Do.

Record of dredging and trawling stations of the United States Fish Commission steamer Albatross—Continued.

Serial No.	Date.	Time.	Position.		Temperatures.			Depth.	Character of bottom.	Wind.		Drift.		Instrument used.	Remarks.
			Lat. N.	Long. W.	Air.	Surface.	Bottom.			Direction.	Force.	Direction.	Distance.		
	1896.		° ′ ″	° ′ ″	°	°	°	*Fms.*							
3622	Apr. 1	10.45 a. m.	Channel abreast (east) of Ballast Point.		74	61	....	7	M. S	NW	1	....	......	Boat beam trawl.	San Diego Bay.
3623	....do ...	1.05 p. m.	Channel ½′ NW. by N. of Ballast Point.		73	63	....	6½	S	.....do	1	....	......	.....do	Do.
3624	....do ...	1.45 p. m.	Channel abreast of beacon No. 3.		70	63	....	5	M. S............	.....do	1	....	......	.....do	Do.
3625	....do ...	2.20 p. m.	Channel abreast of beacon No. 4.		72	63	....	6	M. S	NW	1	....	......	.....do	Do.
3626	....do ...	3.00 p. m.	Channel abreast of red beacon "Diamond."		72	63	....	7	.....do	.....do	1	....	......	.....do	Do.
3627	Apr. 13	2.37 p. m.	32 44 00	119 32 00	55	55	39.2	776	gn. M. S	W by N ..	5	....	......	S. B. T	West of Cortez and Tanner banks.
								Feet.							
3628	June 1	7.07 a. m.	37 45 15	122 17 07	53	57	....	18	Sft. gn. M........	S	3	....	......	Oyster dredge	Lower Bay of San Francisco.
3629	....do ...	7.53 a. m.	37 41 40	122 17 50	53	57	....	19½	.....do	SW........	3	....	......	.....do	Do.
3630	....do ...	9.15 a. m.	37 41 10	122 17 20	53	58	....	15	.....do	SSW	3	....	......	.....do	Do.
3631	....do ...	10.00 a. m.	37 41 55	122 19 50	53	58	....	25	gn. M........	SSW	3	....	......	.....do	Do.
3632	....do ...	11.05 a. m.	37 38 20	122 20 10	54	60	....	18	.....do	SW........	3	....	......	.....do	Do.
3633	....do ...	11.37 a. m.	37 39 00	122 20 15	55	62	....	18	.....do	SW........	3-4	....	......	.....do	Do.

Record of serial temperatures.

Date.	Time of day.	No. of station.	Position.		Depth.	Air, D.B.	Surface.	Bottom.	5 feet.	5 fms.	10 fms.	25 fms.	30 fms.	50 fms.	100 fms.	150 fms.	200 fms.	300 fms.	400 fms.	500 fms.	600 fms.	700 fms.	800 fms.	900 fms.	1,000 fms.
			Lat. N.	Long. W.																					
1895.			° ′ ″	° ′ ″	Fms.	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°
Aug. 4	9.41 p. m.	Hyd. 3589	54 00 30	169 20 30	1,003	45	45	35.5	46.0	45.3	45.0														
5	1.52 a. m.	Hyd. 3590	54 30 00	169 31 00	1,491	44	45	35.5	45.0	44.8	44.5														
5	5.56 a. m.	Hyd. 3591	54 59 00	169 41 00	1,676	46	45	35.0	45.0	45.0	42.8														
5	11.03 a. m.	Dr. 3601	55 06 00	169 08 00	1,044	46	46	35.8	46.0	45.5	44.3	40.1		38.1	37.1		38.2		37.5	37.6	37.1	36.2	36.7	35.7	
5	6.33 p. m.	Hyd. 3592	55 12 00	168 47 00	1,035	46	44	35.2	45.0	44.5	43.8														
6	12.12 a. m.	Hyd. 3593	55 34 00	169 22 00	1,315	46	45	34.7	45.0	44.8	44.0														
7	11.28 a. m.	Int. 47	55 36 00	170 45 00	....	45	44	......	44.0	44.0	43.3				37.4										
7	5.40 p. m.	Hyd. 3594	55 10 00	170 56 00	1,661	45	44	34.7	45.0	45.0	43.8	37.8		37.2	37.1		38.6	38.1	38.3	37.8	37.1	36.7	35.9	36.7	35.5
8	1.19 a. m.	Hyd. 3595	55 12 00	171 48 00	1,819	44	45	35.2	45.0	45.0	43.8														
8	6.44 a. m.	Hyd. 3596	55 32 00	172 17 00	1,901	43	43	35.5	45.0	44.5	43.8														
8	10.55 a. m.	Int. 49	55 53 00	171 40 00	....	44	45	......	45.0	44.3	44.0						37.4								
8	5.15 p. m.	Int. 50	55 44 00	171 17 00	....	44	45	......	45.0	44.5	43.8				37.7										
10	11.01 a. m.	Hyd. 3597	56 15 00	172 35 00	1,267	46	45	36.0	45.0	45.0	44.3	41.4		37.0	36.2		38.2	37.6	38.0	36.8	36.7		36.1	35.8	36.0
10	4.30 p. m.	Int. 52	56 13 00	172 20 00	....	46	45	......	45.0	44.5	43.8														
10	8.15 p. m.	Hyd. 3598	56 28 00	172 39 00	296	45	44	38.1	45.0	44.0	43.3														
10	8.40 p. m.	Hyd. 3599	56 29 00	172 39 00	200	45	45	38.1	45.0	44.0	43.3														
10	9.00 p. m.	Hyd. 3600	56 30 00	172 40 00	156	45	45	37.1	45.0	43.8	43.5														
10	9.20 p. m.	Hyd. 3601	56 31 00	172 40 00	110	45	44	37.1	45.0	44.0	43.3														
10	9.45 p. m.	Dr. 3602	56 32 00	172 40 00	81	45	44	37.1	45.0	43.8	43.5														
11	11.40 a. m.	Dr. 3603	55 23 00	170 31 00	1,771	46	45	35.1	45.0	44.3	44.0	38.1		38.4	36.0		38.3	38.4	38.1	37.5	37.2	35.9	36.1	35.6	35.3
11	4.25 p. m.	....	55 10 00	170 25 00	....	45	45	......	44.0	43.8	44.5														
11	10.00 p. m.	....	54 56 00	170 16 00	....	46	45	......	45.0	44.0	43.8														
12	12.45 a. m.	Hyd. 3603	54 39 00	170 19 00	1,025	46	44	35.3	45.0	44.0	43.3														
12	4.50 a. m.	Hyd. 3604	54 46 00	169 29 00	1,355	45	45	35.2	45.0	44.8	44 0														
12	11.00 a. m.	Dr. 3604	54 54 00	168 59 00	1,401	46	45	35.2	45.0	45.0	43.8	39.5		37.2	38.0		38.2	37.6	38.3	37.1	37.0	36.3	36.2	35.5	35.6
12	11.45 p. m.	Hyd. 3605	55 01 00	168 33 00	1,162	44	45	35.1	45.0	45.0	44.0														
13	2.00 a. m.	Hyd. 3606	54 54 00	168 13 00	1,132	44	44	35.5	45.0	44.0	43.8														
13	4 20 a. m.	Hyd. 3607	54 41 00	168 01 00	823	44	45	37.1	45.0	44.0	43.8														
13	6.55 a. m.	Hyd. 3608	54 41 00	168 25 00	1,122	44	45	35.3	45 0	44.0	43.8														
13	11.05 a. m.	Hyd. 3609	55 09 00	167 40 00	189	45	45	37.5	45.0	44.0	43.8														
13	12.45 p. m.	Dr. 3605	55 17 00	167 34 00	91	45	44	37.1	45.0	44.0	43.3		41.4												
13	5.15 p. m.	Dr. 3606	55 27 00	167 47 00	87	46	45	38.1	45.0	43.5	42.8														
13	8.30 p. m.	Hyd. 3611	55 32 00	168 11 00	83	45	45	38.9	44.0	43.8	43.0														
13	10.50 p. m.	Hyd. 3612	55 42 00	168 32 00	76	45	45	38.3	45.0	43.8	44.0														
18	11.40 a. m.	Hyd. 3613	54 14 00	166 54 30	778	52	46	36.3	45.0	44.0	43.3														
18	1.40 p. m.	Hyd. 3614	54 25 00	167 13 00	334	50	46	38.1	45.0	44.8	44.0														
18	4.15 p. m.	Dr. 3607	54 11 30	167 25 00	987	46	45	35.9	45.0	44.3	43.5	40.1		40.0	38.9		37.3	38.1	38.1	38.1	37.4	36.4	36.1	36.0	
18	11.00 p. m.	Hyd. 3615	54 25 00	167 38 00	486	45	46	37.1	45.0	44.3	44.0														
19	1.25 a. m.	Hyd. 3616	54 11 30	167 50 00	1,048	44	42	35.2	44.0	43.3	42.0														
19	3.40 a. m.	Hyd. 3617	54 24 00	168 02 00	538	44	42	37.1	44.0	43.0	41.8														
19	6.05 a. m.	Hyd. 3618	54 10 00	168 14 00	1,075	44	42	35.5	42.0	42.3	41.5														

Record of serial temperatures—Continued.

Date.	Time of day.	No. of station.	Position.		Depth.	Air, D.B.	Surface.	Bottom.	5 feet.	5 fms.	10 fms.	25 fms.	30 fms.	50 fms.	100 fms.	150 fms.	200 fms.	300 fms.	400 fms.	500 fms.	600 fms.	700 fms.	800 fms.	900 fms.	1,000 fms.
			Lat. N.	Long. W.																					
1895.			° ′ ″	° ′ ″	*Fms.*	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°
Aug. 19	8.35 a. m.	Hyd. 3619	54 06 00	168 37 00	1,231	45	43	35.3	43.0	42.8	42.5														
19	11.00 a. m.	Hyd. 3620	54 17 00	168 53 30	1,014	45	43	35.6	44.0	44.0	43.3	43.6		37.5	37.3		38.2	38.1	38.2	38.4	36.7	36.8	35.8	36.3	35.6
19	3.30 p. m.	Hyd. 3621	54 39 00	168 52 30	975	47	44	35.5	45.0	44.0	43.8														
19	8.20 p. m.	Hyd. 3622	54 53 00	169 19 00	1,471	46	45	35.1	45.0	43.8	44.0														
20	1.20 a. m.	Hyd. 3623	55 11 00	168 30 30	944	47	45	35.9	45.0	43.8	44.0														
20	4.05 a. m.	Hyd. 3624	55 32 00	168 36 00	273	48	47	38.1	45.0	43.8	43.5														
20	6.55 a. m.	Hyd. 3625	55 19 30	168 09 00	229	46	45	38.1	45.0	44.3	44.5														
20	8.15 a. m.	Hyd. 3626	55 19 30	168 10 00	244	46	45	38.1	45.0	43.8	43.0	38.8		39.6	37.7	37.6	37.7								
20	10.00 a. m.	Dr. 3608	55 19 00	168 11 00	276	46	45	37.8	44.0	43.0	42.8														
20	12.05 p. m.	Hyd. 3627	55 17 00	168 01 00	219	46	45	38.0	45.0	44.5	43.8	39.3		38.2	38.0	37.5	37.9								
20	10.20 p. m.	Hyd. 3629	55 11 00	167 56 00	367	46	45	37.8	45.0	44.0	43.8														
21	1.30 a. m.	Hyd. 3630	55 04 00	167 24 00	99	47	45	37.6	45.0	44.0	43.8														
21	3.35 a. m.	Hyd. 3631	55 19 00	167 27 00	78	47	47	36.5	45.0	43.8	44.0														
21	5.55 a. m.	Hyd. 3632	55 30 00	167 51 00	74	46	46	37.6	46.0	44.8	43.0														
21	9.10 a. m.	Dr. 3609	55 35 00	168 20 00	74	46	46	37.9	46.0	45.0	43.8														
21	11.55 a. m.	Hyd. 3633	55 41 00	168 34 00	77	46	46	37.8	46.0	45.0	43.8														
21	12.40 p. m.	Hyd. 3634	55 43 00	168 42 00	89	46	45	38.4	46.0	45.0	43.8														
21	1 10 p. m.	Hyd. 3635	55 44 00	168 47 00	141	46	45	37.8	45.0	44.0	42.8														
21	1.35 p. m.	Hyd. 3636	55 43 00	168 44 00	108	47	45	38.0	45.0	44.0	43.3														
21	5.35 p. m.	Hyd. 3637	55 27 00	168 01 30	104	47	46	36.8	45.0	45.0	43.8														
22	2.45 p. m.	Hyd. 3638	55 42 00	166 09 00	68	47	46	37.5	46.0	45.0	44.8														
22	8.10 p. m.	Dr. 3610	55 58 00	167 16 00	75	45	47	36.8	46.0	45.0	43.3														
22	5.15 p. m.	Dr 3611	56 45 00	167 25 00	50	45	46	34.6	46.0	45.0	43.8														
24	6.15 a. m.	Hyd. 3640	56 02 00	169 06 30	77	47	45	37.9	45.0	44.5	41.0														
24	5.45 p. m.	Hyd. 3641	54 57 30	167 14 00	137	48	47	37.7	47.0	45.8	43.0														
24	6.45 p. m.	Hyd. 3642	54 56 00	167 02 30	116	47	46	37.3	46.0	44.8	44.0														
24	7.20 p. m.	Hyd. 3643	54 55 30	166 57 30	113	46	46	37.3	46.0	43.8	43.0														
24	7.55 p. m.	Hyd. 3644	54 57 00	166 53 00	93	46	46	37.8	46.0	45.0	43.3														
24	9.00 p. m.	Hyd. 3645	54 52 00	166 43 30	113	46	46	37.5	45.0	43.8	43.0														
25	12.45 a. m.	Hyd. 3649	54 41 00	166 15 30	171	47	45	37.7	45.0	43.8	43.5														
25	2.00 a. m.	Hyd. 3650	54 32 00	166 09 00	264	47	45	37.8	45.0	44.0	43.8														
1896.																									
April 13	10.45 a. m.	Hyd. 3652	33 06 00	119 17 00	892	58	56	39.1	54.6	56.0	56.0														
13	2.30 p. m.	Dr. 3627	32 44 00	119 32 00	776	55	55	39.2	55.0	55.0	54.6														
13	6.25 p. m.	Hyd. 3653	32 38 00	119 36 00	180	55	55	45.4	54.0	55.0	54.3														
13	8.00 p. m.	Hyd. 3654	32 30 00	119 43 00	659	55	55	38.6	54.0	55.0	54.6														
13	11.05 p. m.	Hyd. 3655	32 34 00	119 55 00	891	55	55	38.2	54.0	55.0	54.6														

Record of ocean temperatures and specific gravities.

Date.	Time of day.	Station.	Lat. N.	Long. E.	Depth.	Temperature by attached thermometer.	Temperature of air.	Temp. of specimen at time sp. grav. was taken.	Specific gravity.	Specific gravity reduced to 15° C.
			° ′ ″	° ′ ″		°	°	°		
1895. July 1	6 a. m		55 48 00	175 50 00	Surface.	40	30	68	1.0244	1.024716
1	12 m		55 51 00	174 38 00	do	42	43	68	1.0244	1.024716
1	6 p. m		55 52 00	173 35 00	do	43	45	68	1.0244	1.024716
1	12 p. m		55 55 00	172 11 00	do	42	41	68	1.0246	1.024016
2	6 a. m		55 58 00	170 50 00	do	43	42	68	1.0246	1.024916
2	12 m		56 00 00	169 24 00	do	45	46	68	1.0244	1.024716
2	6 p. m		55 58 00	168 55 00	do	43	43	68	1.0244	1.024716
2	12 p. m		55 45 00	166 30 00	do	43	42	67	1.0242	1.024367
3	6 a. m		55 20 00	165 40 00	do	43	42	67	1.0242	1.024307
3	12 m	Nikolski, Bering Island			do	43	40	67	1.0242	1.024367
5	12 m		55 23 00	165 42 00	do	44	45	67	1.0240	1.024167
5	6 p. m		55 45 00	166 38 00	do	44	44	67	1.0242	1.024367
5	12 p. m		56 15 00	167 30 00	do	44	40	67	1.0244	1.024567
6	6 a. m		56 38 00	168 28 00	do	44	43	67	1.0244	1.024567
6	12 m		57 16 00	169 41 00	do	44	45	67	1.0244	1.024567
6	6 p. m		57 25 00	170 40 00	do	42	45	67	1.0244	1.024567
6	12 p. m		57 45 00	171 38 00	do	42	42	66	1.0240	1.024020
7	6 a. m		58 05 00	173 02 00	do	41	42	66	1.0240	1.024020
7	12 m		58 22 00	174 27 00	do	42	45	65	1.0242	1.024070
7	6 p. m		58 15 00	175 50 00	do	43	45	65	1.0240	1.023870
7	12 p. m		57 55 00	177 35 00	do	43	44	65	1.0236	1.023470
				Long. W.						
7	6 a. m		57 40 00	179 05 00	do	42	42	65	1.0238	1.023670
7	12 m		57 38 00	179 42 00	do	42	44	65	1.0238	1.023670
7	6 p. m		57 20 00	178 18 00	do	41	41	65	1.0236	1.023470
7	12 p. m		57 12 00	176 50 00	do	42	40	65	1.0240	1.023870
8	6 a. m		57 05 00	175 30 00	do	41	41	65	1.0240	1.023870
8	12 m		56 55 00	174 38 00	do	42	42	65	1.0238	1.023670
8	6 p. m		57 05 00	174 10 00	do	41	41	65	1.0234	1.023270
8	12 p. m		57 03 00	172 45 00	do	41	41	66	1.0234	1.023270
9	6 a. m		56 58 00	171 48 00	do	40	40	65	1.0232	1.023070
9	12 m		56 57 00	170 17 00	do	37	47	65	1.0232	1.023070
9	6 p. m		56 15 00	169 00 00	do	43	42	65	1.0234	1.023270
9	12 p. m		55 18 00	168 15 00	do	42	42	65	1.0242	1.024070
10	6 a. m		54 48 00	107 30 00	do	41	42	65	1.0242	1.024070
10	12 m		54 11 00	166 44 00	do	42	44	65	1.0244	1.024270
11	12 m	Unalaska Village			do	45	50	65	1.0194	1.019270
15	12 m		54 19 00	166 58 00	do	45	44	65	1.0242	1.024070
15	6 p. m		54 42 00	167 45 00	do	42	43	65	1.0242	1.024070
15	12 p. m		55 34 00	168 40 00	do	43	42	65	1.0240	1.023870
16	6 a. m		56 18 00	169 37 00	do	42	44	65	1.0234	1.023270
16	12 m	St. Paul Island			do	44	44	65	1.0232	1.023070
18	12 m	St. George Island			do	43	48	65	1.0230	1.022270
30	12 m		56 42 00	170 08 00	do	42	40	65	1.0232	1.023070
Aug. 5	1 p. m		55 06 00	169 08 00	do	46	46	60	1.0248	1.023980
5	1 p. m		55 06 00	169 08 00	25	40^{1}	46	60	1.0250	1.024180
5	1 p. m		55 06 00	169 08 00	50	38^{1}	46	60	1.0252	1.024380
5	1 p. m		55 06 00	169 08 00	100	37^{1}	46	60	1.0252	1.024380
5	1 p. m		55 06 00	169 08 00	200	38^{2}	46	60	1.0254	1.024580
5	1 p. m		55 06 00	169 08 00	300	.....	46	60	1.0256	1.024780
5	1 p. m		55 06 00	169 08 00	400	37^{5}	46	60	1.0260	1.025180
5	1 p. m		55 06 00	169 08 00	500	37^{6}	46	60	1.0262	1.025380
5	1 p. m		55 06 00	169 08 00	600	37^{1}	46	60	1.0262	1.025380
5	1 p. m		55 06 00	169 08 00	700	36^{2}	46	60	1.0264	1.025580
5	1 p. m		55 06 00	169 08 00	800	36^{7}	46	60	1.0264	1.025580
5	1 p. m		55 06 00	169 08 00	900	35^{7}	46	60	1.0264	1.025580
5	1 p. m		55 06 00	169 08 00	1,000	.....	46	60	1.0266	1.025780
7	8 a. m		55 10 00	170 56 00	Surface.	44	45	58	1.0252	1.024140
7	8 a. m		55 10 00	170 56 00	25	37^{8}	45	58	1.0252	1.024140
7	8 a. m		55 10 00	170 56 00	50	37^{2}	45	58	1.0254	1.024340
7	8 a. m		55 10 00	170 56 00	100	37^{2}	45	58	1.0254	1.024340
7	8 a. m		55 10 00	170 56 00	200	38^{6}	45	58	1.0256	1.024540
7	8 a. m		55 10 00	170 56 00	300	38^{1}	45	58	1.0256	1.024540
7	8 a. m		55 10 00	170 56 00	400	38^{3}	45	58	1.0258	1.024740
7	8 a. m		55 10 00	170 56 00	500	37^{8}	45	58	1.0260	1.024940
7	8 a. m		55 10 00	170 56 00	600	37^{1}	45	58	1.0262	1.025140
7	8 a. m		55 10 00	170 56 00	700	36^{7}	45	58	1.0264	1.025340
7	8 a. m		55 10 00	170 56 00	800	35^{9}	45	58	1.0264	1.025340
7	8 a. m		55 10 00	170 56 00	900	36^{7}	45	58	1.0264	1.025340
7	8 a. m		55 10 00	170 56 00	1,000	35^{5}	45	58	1.0266	1.025540
10	10.05 a. m		56 15 00	172 35 00	Surface.	45	46	60	1.0248	1.023980
10	10.05 a. m		56 15 00	172 35 00	25	41	46	60	1.0250	1.024180
10	10.05 a. m		56 15 00	172 35 00	50	37	46	60	1.0252	1.024380

Record of ocean temperatures and specific gravities—Continued.

Date.	Time of day.	Station.	Lat. N.	Long. W.	Depth.	Temperature by attached thermometer.	Temperature of air.	Temp. of specimen at time sp. grav. was taken.	Specific gravity.	Specific gravity reduced to 15° C.
1895.			° ′ ″	° ′ ″		°	°	°		
Aug. 10	10.05 a. m.		56 15 00	172 35 00	100	36^{2}	46	60	1.0252	1.024380
10	10.05 a. m.		56 15 00	172 35 00	200	38^{2}	46	60	1.0254	1.024580
10	10.05 a. m.		56 15 00	172 35 00	300	37^{6}	46	60	1.0256	1.024780
10	10.05 a. m.		56 15 00	172 35 00	400	38	46	60	1.0256	1.024780
10	10.05 a. m.		56 15 00	172 35 00	500	36^{8}	46	60	1.0258	1.024980
10	10.05 a. m.		56 15 00	172 35 00	600	36^{7}	46	60	1.0258	1.024980
10	10.05 a. m.		56 15 00	172 35 00	700	......	46	60	1.0258	1.024980
10	10.05 a. m.		56 15 00	172 35 00	800	36^{1}	46	60	1.0260	1.025180
10	10.05 a. m.		56 15 00	172 35 00	900	35^{8}	46	60	1.0262	1.025380
10	10.05 a. m.		56 15 00	172 35 00	1,000	36	46	60	1.0264	1.025580
11	11.20 a. m.		55 23 00	170 31 00	Surface.	45	46	60	1.0246	1.023780
11	11.20 a. m.		55 23 00	170 31 00	25	38^{1}	46	60	1.0250	1.024180
11	11.20 a. m.		55 23 00	170 31 00	50	38^{4}	46	60	1.0250	1.024180
11	11.20 a. m.		55 23 00	170 31 00	100	36	46	60	1.0252	1.024380
11	11.20 a. m.		55 23 00	170 31 00	200	38^{3}	46	60	1.0254	1.024580
11	11.20 a. m.		55 23 00	170 31 00	300	38^{4}	46	60	1.0254	1.024580
11	11.20 a. m.		55 23 00	170 31 00	400	38^{1}	46	60	1.0256	1.024780
11	11.20 a. m.		55 23 00	170 31 00	500	37^{5}	46	60	1.0256	1.024780
11	11.20 a. m.		55 23 00	170 31 00	600	37^{2}	46	60	1.0256	1.024780
11	11.20 a. m.		55 23 00	170 31 00	700	35^{9}	46	60	1.0258	1.024980
11	11.20 a. m.		55 23 00	170 31 00	800	36^{1}	46	60	1.0262	1.025380
11	11.20 a. m.		55 23 00	170 31 00	900	35^{6}	46	60	1.0262	1.025380
11	11.20 a. m.		55 23 00	170 31 00	1,000	35^{3}	46	60	1.0264	1.025580
12	10.06 a. m.		54 54 00	168 59 00	Surface.	45	46	60	1.0250	1.024180
12	10.06 a. m.		54 54 00	168 59 00	25	39^{5}	46	60	1.0250	1.024180
12	10.06 a. m.		54 54 00	168 59 00	50	37^{2}	46	60	1.0250	1.024180
12	10.06 a. m.		54 54 00	168 59 00	100	38^{1}	46	60	1.0252	1.024380
12	10.06 a. m.		54 54 00	168 59 00	200	38^{2}	46	60	1.0252	1.024380
12	10.06 a. m.		54 54 00	168 59 00	300	37^{6}	46	60	1.0256	1.024780
12	10.06 a. m.		54 54 00	168 59 00	400	38^{3}	46	60	1.0256	1.024780
12	10.06 a. m.		54 54 00	168 59 00	500	37^{1}	46	60	1.0258	1.024980
12	10.06 a. m.		54 54 00	168 59 00	600	37	46	60	1.0258	1.024980
12	10.06 a. m.		54 54 00	168 59 00	700	36^{8}	46	60	1.0258	1.024980
12	10.06 a. m.		54 54 00	168 59 00	800	36^{2}	46	60	1.0260	1.025180
12	10.06 a. m.		54 54 00	168 59 00	900	35^{5}	46	60	1.0262	1.025380
12	10.06 a. m.		54 54 00	168 59 00	1,000	35^{6}	46	60	1.0264	1.025580
18	4.01 p. m.		55 11 00	167 25 00	Surface.	45	46	60	1.0246	1.023780
18	4.01 p. m.		55 11 00	167 25 00	25	40^{5}	46	60	1.0248	1.023980
18	4.01 p. m.		55 11 00	167 25 00	50	39^{9}	46	60	1.0248	1.023980
18	4.01 p. m.		55 11 00	167 25 00	100	38^{7}	46	60	1.0250	1.024180
18	4.01 p. m.		55 11 00	167 25 00	200	37^{6}	46	60	1.0250	1.024180
18	4.01 p. m.		55 11 00	167 25 00	300	38	46	60	1.0254	1.024580
18	4.01 p. m.		55 11 00	167 25 00	400	38	46	60	1.0254	1.024580
18	4.01 p. m.		55 11 00	167 25 00	500	38	46	60	1.0256	1.024780
18	4.01 p. m.		55 11 00	167 25 00	600	37^{4}	46	60	1.0256	1.024780
18	4.01 p. m.		55 11 00	167 25 00	700	36^{4}	46	60	1.0260	1.025180
18	4.01 p. m.		55 11 00	167 25 00	800	36	46	60	1.0262	1.025380
18	4.01 p. m.		55 11 00	167 25 00	900	36	46	60	1.0262	1.025380
19	10.50 a. m.		54 17 00	168 53 00	Surface.	43	45	58	1.0250	1.024760
19	10.50 a. m.		54 17 00	168 53 00	25	43^{6}	45	58	1.0250	1.024760
19	10.50 a. m.		54 17 00	168 53 00	50	37^{9}	45	58	1.0252	1.024960
19	10.50 a. m.		54 17 00	168 53 00	100	37^{2}	45	58	1.0254	1.025160
19	10.50 a. m.		54 17 00	168 53 00	200	38^{1}	45	58	1.0254	1.025160
19	10.50 a. m.		54 17 00	168 53 00	300	38	45	58	1.0256	1.025360
19	10.50 a. m.		54 17 00	168 53 00	400	38	45	58	1.0260	1.025760
19	10.50 a. m.		54 17 00	168 53 00	500	38^{4}	45	58	1.0260	1.025760
19	10.50 a. m.		54 17 00	168 53 00	600	37	45	58	1.0260	1.025760
19	10.50 a. m.		54 17 00	168 53 00	700	36^{8}	45	58	1.0260	1.025760
19	10.50 a. m.		54 17 00	168 53 00	800	36	45	59	1.0260	1.025880
19	10.50 a. m.		54 17 00	168 53 00	900	36^{3}	45	59	1.0262	1.026080
19	10.50 a. m.		54 17 00	168 53 00	1,000	35^{5}	45	59	1.0264	1.026280
20	8.14 a. m.		55 19 00	168 10 00	Surface.	45	46	60	1.0246	1.023780
20	8.14 a. m.		55 19 00	168 10 00	25	39	46	60	1.0246	1.023780
20	8.14 a. m.		55 19 00	168 10 00	50	39^{5}	46	60	1.0248	1.023980
20	8.14 a. m.		55 19 00	168 10 00	100	38	46	60	1.0250	1.024180
20	8.14 a. m.		55 19 00	168 10 00	150	37^{5}	46	60	1.0252	1.024380
20	8.14 a. m.		55 19 00	168 10 00	200	38	46	60	1.0254	1.024580
20	12.03 p. m.		55 17 00	168 01 00	Surface.	45	46	60	1.0246	1.023780
20	12.03 p. m.		55 17 00	168 01 00	25	39^{1}	46	60	1.0248	1.023980
20	12.03 p. m.		55 17 00	168 01 00	50	38^{1}	46	60	1.0250	1.024180
20	12.03 p. m.		55 17 00	168 01 00	100	38	46	60	1.0254	1.024580
20	12.03 p. m.		55 17 00	168 01 00	150	37^{8}	46	60	1.0254	1.024580
20	12.03 p. m.		55 17 00	168 01 00	200	38^{1}	46	60	1.0256	1.024780

Record of ocean temperatures and specific gravities—Continued.

Date.	Time of day.	Station.	Lat. N.	Long. W.	Depth.	Temperature by attached thermometer.	Temperature of air.	Temp. of specimen at time sp. grav. was taken.	Specific gravity.	Specific gravity reduced to 15° C.
			° ′ ″	° ′ ″		°	°	°		
1895.										
Sept. 19	12 m	Bellingham Bay			Surface	53	50	62	1.0220	1.021450
22	6 p. m	Blaine			do	51	54	62	1.0210	1.020450
23	12 m	Point Roberts			do	51	54	62	1.0170	1.016450
24	10 a. m	Lummi Island			do	48	52	62	1.0220	1.021450
24	6 p. m	Friday Harbor			do	49	55	62	1.0220	1.021450
Oct. 3	10 a. m	Utsalady			do	53	52	62	1.0194	1.018850
3	8 p. m	Port Ludlow			do	51	49	62	1.0228	1.022250
5	8 p. m	Port Angeles			do	49	52	62	1.0240	1.023450
8	4 p. m	San Juan Island			do	49	52	62	1.0228	1.022250
9	1 p. m	Deception Pass			do	55	55	62	1.0220	1.021450
1896.										
May 21	*a* 2.30 p. m.	Navy-yard, Mare Island			do	60	61	68	1.0000	1.000316
21	*b* 4 p. m	do			do	60	59	68	1.0004	1.000716
21	*b* 5 p. m	do			do	60	59	68	1.0004	1.000716
21	*b* 7 p. m	do			do	60	57	68	1.0006	1.000916
21	*c* 9 p. m	do			do	60	57	68	1.0012	1.001516
23	*c* 10 a. m	Entrance to San Leandro Bay			do	63	66	63	1.0132	1.012791
23	*d* 11 a. m	do			do	63	66	63	1.0126	1.012191
23	*d* 12 m	do			do	63	66	63	1.0124	1.011991
23	*d* 1 p. m	do			do	64	65	64	1.0122	1.011928
23	*a* 2 p. m	do			do	62	60	63	1.0118	1.011391
23	*b* 3 p. m	do			do	64	60	64	1.0120	1.011728
23	*b* 4 p. m	do			do	64	58	61	1.0122	1.011928
23	*b* 5 p. m	do			do	64	58	64	1.0126	1.012328
23	*b* 6 p. m	do			do	64	56	64	1.0130	1.012828
24	*b* 9 a. m	do			do	64	68	64	1.0128	1.012428
24	*b* 10 a. m	do			do	65	69	65	1.0128	1.012670
24	*b* 11 a. m	do			do	65	69	65	1.0128	1.012670
24	*c* 12 m	do			do	66	72	66	1.0130	1.013020
24	*d* 1 p. m	do			do	68	74	68	1.0124	1.012716
24	*d* 2 p. m	do			do	68	74	68	1.0122	1.012516
24	*d* 3 p. m	do			do	72	76	72	1.0114	1.012344
24	*a* 4 p. m	do			do	72	73	72	1.0112	1.012144
24	*b* 5 p. m	do			do	71	73	71	1.0116	1.012386
24	*b* 6 p. m	do			do	71	73	71	1.0118	1.012586
26	*e* 12 m	Dunbarton Point			do	68	84	68	1.0128	1.013116
26	*c* 1 p. m	do			do	70	84	70	1.0134	1.014030
26	*f* 2 p. m	do			do	70	86	70	1.0134	1.014030
26	*f* 3 p. m	do			do	68	86	68	1.0134	1.013716
26	*f* 4 p. m	do			do	68	86	68	1.0132	1.013516
26	*f* 5 p. m	do			do	68	82	68	1.0128	1.013116
26	*a* 6 p. m	do			do	66	80	66	1.0126	1.012620
26	*c* 7 p. m	do			do	66	74	66	1.0126	1.012620
26	*e* 8 p. m	do			do	66	72	66	1.0126	1.012620
27	*a* 7.30 a. m	do			do	66	67	66	1.0126	1.012620
27	*b* 9 a. m	do			do	68	68	68	1.0126	1.012916
27	*b* 10 a. m	do			do	68	68	68	1.0128	1.013116
27	*b* 11 a. m	do			do	68	68	68	1.0128	1.013116
27	*b* 12 m	do			do	70	74	70	1.0130	1.013630
27	*b* 1 p. m	do			do	70	72	70	1.0132	1.013830
27	*c* 2 p. m	do			do	68	74	68	1.0134	1.013716
27	*f* 3 p. m	do			do	67	74	67	1.0134	1.013567
27	*f* 4 p. m	do			do	66	74	66	1.0134	1.013420
27	*f* 5 p. m	do			do	66	74	66	1.0132	1.013220
27	*f* 6 p. m	do			do	66	70	66	1.0129	1.012920
27	*a* 7 p. m	do			do	66	65	66	1.0126	1.012620
27	*b* 8 p. m	do			do	66	63	66	1.0126	1.012620
28	*f* 8 a. m	do			do	66	64	66	1.0130	1.0 3020
28	*a* 9 a. m	do			do	66	64	66	1.0130	1.013020
28	*b* 10 a. m	do			do	66	68	66	1.0132	1.013220
28	*b* 11 a. m	do			do	66	72	66	1.0134	1.013420
28	*b* 12 a. m	do			do	67	74	67	1.0134	1.013567
28	*b* 1 p. m	do			do	68	74	68	1.0134	1.013716
28	*b* 2 p. m	do			do	68	74	68	1.0134	1.013716
28	*c* 3 p. m	do			do	68	76	68	1.0134	1.013716
28	*e* 4 p. m	do			do	68	76	68	1.0134	1.013716
June 26	12 m		51 05 00	128 26 00	do	53	50	50	1.0232	1.022260
26	6 p. m		51 22 00	129 48 00	do	54	50	59	1.0244	1.023400
26	12 p. m		51 35 00	131 05 00	do	51	54	59	1.0244	1.023400
27	6 a. m		51 46 00	132 21 00	do	51	53	59	1.0246	1.023660

a Low water. *b* Tide flooding. *c* High water.
d Tide ebbing. *e* Flood tide. *f* Ebb tide.

Record of ocean temperatures and specific gravities—Continued.

Date.	Time of day.	Station.	Lat. N.	Long. W.	Depth.	Temperature by attached thermometer.	Temperature of air.	Temp. of specimen at time sp. grav. was taken.	Specific gravity.	Specific gravity reduced to 15° C.
1895.			° ′ ″	° ′ ″		°	°	°		
June 27	12 m	....	52 00 00	133 37 00	Surface	50	52	59	1.0246	1.023660
27	6 p. m	....	52 15 00	134 48 00	....do	49	50	59	1.0246	1.023660
27	12 p. m	....	52 27 00	136 18 00	....do	49	49	59	1.0248	1.023860
28	6 a. m	....	52 41 00	137 35 00	....do	48	48	59	1.0248	1.023860
28	12 m	....	52 54 00	139 04 00	....do	50	51	59	1.0248	1.023860
28	6 p. m	....	53 03 00	140 28 00	....do	48	49	59	1.0250	1.024060
28	12 p. m	....	53 12 00	141 52 00	....do	47	46	59	1.0250	1.024060
29	6 a. m	....	53 18 00	143 25 00	....do	47	46	59	1.0250	1.024060
29	12 m	....	53 29 00	144 54 00	....do	47	49	59	1.0252	1.024260
29	6 p. m	....	53 31 00	146 15 00	....do	47	50	59	1.0252	1.024260
29	12 p. m	....	53 35 00	148 09 00	....do	46	47	59	1.0252	1.024260
30	6 a. m	....	53 45 00	149 52 00	....do	46	47	59	1.0252	1.024260
30	12 m	....	53 45 00	151 18 00	....do	46	47	59	1.0252	1.024260
30	6 p. m	....	53 47 00	152 40 00	....do	46	47	59	1.0252	1.024260
30	12 p. m	....	53 48 00	154 45 00	....do	46	47	59	1.0252	1.024260

Record of hydrographic soundings by the United States Fish Commission steamer Albatross for the fiscal year ending June 30, 1896.

BERING SEA BETWEEN PRIBILOF AND COMMANDER ISLANDS.

Date.	Serial number.	Time of day.	Position.		Depth.	Character of bottom.	Temperatures.		
			Lat. N.	Long. E.			Air.	Sea.	
							D. B.	Surf.	Bottom.
1895.			° ′ ″	° ′ ″	Fms.				
July 1	Hy. 3548	7.05 a. m.	55 52 00	177 25 00	2,120	br. M. oz	38	40	35.1
1	Hy. 3549	4.35 p. m.	55 53 00	173 53 00	2,111	.....do	45	43	35.2
2	Hy. 3550	2.37 a. m.	55 59 00	171 57 00	2,086	.....do	42	44	35.1
2	Hy. 3551	10.30 a. m.	56 00 00	169 46 00	2,154	.....do	45	44	35.1
2	Hy. 3552	4.58 p. m.	56 00 00	168 16 00	2,153	br. M	43	43	35.1
2	Hy. 3553	11.07 p. m.	55 58 00	166 43 00	2,119	gy. S. M	42	43	35.1
3	Hy. 3554	2.22 a. m.	55 43 00	166 15 00	2,090	.....do	42	43	35.1
3	Hy. 3555	5.14 a. m.	55 25 00	165 46 00	70	.....do	41	43	34.3
3	Hy. 3556	6.34 a. m.	55 16 00	165 32 30	20	crs. S. rky	42	43	....
3	Hy. 3557	7.10 a. m.	55 12 00	165 38 00	35	gy. S	42	43	....
3	Hy. 3558	7.31 a. m.	55 11 00	165 40 00	37	.....do	42	43	....
3	Hy. 3559	8.04 a. m.	55 11 20	165 46 20	15	rky	42	43	....
5	Hy. 3560	12.22 p. m.	55 25 30	165 48 00	144	fne. gy. S	45	44	35.1
5	Hy. 3561	12.49 p. m.	55 27 00	165 49 00	66	rky	45	44	34.6
5	Hy. 3562	1.17 p. m.	55 28 30	165 51 30	341	gy. S. M	45	44	38.1
5	Hy. 3563	2.20 p. m.	55 32 00	165 56 30	1,087	G	45	45	35.1
6	Hy. 3564	1.13 a. m.	56 25 00	167 52 00	2,137	gn. oz	43	45	35.0
6	Hy. 3565	7.51 a. m.	56 56 00	169 06 00	1,860	bl. M. oz	43	44	35.0
6	Hy. 3566	12.00 m.	57 16 00	169 41 00	972	.....do	45	44	36.0
6	Hy. 3567	2.29 p. m.	57 29 00	170 09 00	410	gy. S. M	46	44	....
6	Hy. 3568	4.15 p. m.	57 35 00	170 24 00	537	br. oz. G	45	43	38.1
6	Hy. 3569	6.01 p. m.	57 41 00	170 39 00	609	br. oz. S	45	42	38.0
6	Hy. 3570	7.22 p. m.	57 47 00	170 54 00	540	gn. oz. G	44	42	37.0
6	Hy. 3571	8.44 p. m.	57 53 00	171 09 00	696	gn. M. oz	43	42	36.5
7	Hy. 3572	12.32 a. m.	58 13 00	171 51 00	1,469	.....do	42	42	35.0
7	Hy. 3573	5.05 a. m.	58 30 00	172 47 00	1,898	hrd	42	41	35.0
7	Hy. 3574	10.55 a. m.	58 23 00	174 17 00	1,978	bl. M. oz	45	42	38.7
7	Hy. 3575	5.05 p. m.	58 12 00	175 49 00	2,041	br. M. oz	48	48	36.0
7	Hy. 3576	11.08 p. m.	58 01 00	177 21 00	2,068	.....do	44	42	19.0
7	Hy. 3577	5.15 a. m.	57 49 00	178 50 00	2,080	.....do	42	42	35.0
				Long. W.					
7	Hy. 3578	11.20 a. m.	57 38 00	179 42 00	2,084	.....do	44	42	....
7	Hy. 3579	2.26 p. m.	57 34 00	179 16 00	2,076	gn. M	43	41	35.0
7	Hy. 3580	4.52 p. m.	57 30 00	178 50 00	2,059	.....do	43	41	35.0
7	Hy. 3581	7.40 p. m.	57 23 00	178 17 00	2,059	.....do	41	41	35.2
8	Hy. 3582	12.47 a. m.	57 13 00	177 07 00	1,994	.....do	41	41	35.1
8	Hy. 3583	5.40 a. m.	57 03 00	176 00 00	1,803	gn. M. fne. S	41	41	35.0
8	Hy. 3584	10.26 a. m.	56 54 00	174 50 00	1,825	(no specimen)	42	42	36.0
8	Hy. 3585	....	....	....	....	....	....	....	....

Record of hydrographic soundings, etc.—Continued.

BERING SEA BETWEEN PRIBILOF AND ALEUTIAN ISLANDS.

Date.	Serial number.	Time of day.	Position.		Depth.	Character of bottom.	Temperatures.		
							Air.	Sea.	
			Lat. N.	Long. W.			D. B.	Surf.	Bottom.
1895.			° ′ ″	° ′ ″	Fms.				
Aug. 4	Hy. 3586	7.15 a. m.	53 59 00	166 29 00	76	gn. M. S	46	46	39.2
4	Hy. 3587	7.43 a. m.	54 01 30	166 30 30	98	fne. gy. S. bk. Sp.	48	43	38.8
4	Hy. 3588	8.05 a. m.	54 03 30	166 31 30	93	gy. S. G	46	45	....
4	Hy. 3589	9.41 p. m.	54 00 30	169 20 30	1,003	gn. M. bk. S	45	45	35.5
5	Hy. 3590	1.52 a. m.	54 30 00	169 31 00	1,491	gn. M	44	45	35.5
5	Hy. 3591	5.56 a. m.	54 59 00	169 41 00	1,676	gn. M. fne. S	46	45	35.0
5	Dr. 3601	11.10 a. m.	55 06 00	169 08 00	1,044	....do	46	46	35.8
5	Hy. 3592	6.33 p. m.	55 12 00	168 47 00	1,035	br. oz	46	44	35.2
6	Hy. 3593	12.12 a. m.	55 34 00	169 22 00	1,815	....do	46	45	34.7
7	Hy. 3594	5.30 p. m.	55 10 00	170 56 00	1,664	....do	45	44	34.7
8	Hy. 3595	1.10 a. m.	55 12 00	171 48 00	1,819	....do	44	45	35.2
8	Hy. 3596	6.44 a. m.	55 32 00	172 17 00	1,901	....do	43	43	35.5
10	Hy. 3597	10.18 a. m.	56 15 00	172 35 00	1,267	gn. M. S	46	45	36.0
10	Hy. 3598	8.15 p. m.	56 28 00	172 39 00	296	....do	45	44	38.1
10	Hy. 3599	8.37 p. m.	56 29 00	172 39 00	200	....do	45	45	38.1
10	Hy. 3600	8.54 p. m.	56 30 00	172 40 00	156	....do	45	45	37.1
10	Hy. 3601	9.20 p. m.	56 31 00	172 40 00	110	....do	45	44	37.1
10	Dr. 3602	9.43 p. m.	56 32 00	172 40 00	81	....do	45	44	37.1
11	Hy. 3602	4.47 a. m.	55 53 00	171 42 00	1,496	....do	45	44	35.1
11	Dr. 3603	11.38 a. m.	55 23 00	170 31 00	1,771	br. oz	46	45	35.1
12	Hy. 3603	12.45 a. m.	54 39 00	170 19 00	1,025	gn. oz	46	44	35.3
12	Hy. 3604	4.49 a. m.	54 46 00	169 29 00	1,355	....do	45	45	35.2
12	Dr. 3604	10.25 a. m.	54 54 00	168 59 00	1,401	gn. oz	46	45	35.2
12	Hy. 3605	11.45 p. m.	55 01 00	168 33 00	1,162	gn. M. S	44	45	35.1
13	Hy. 3606	2.00 a. m.	54 54 00	168 13 00	1,132	....do	44	44	35.5
13	Hy. 3607	4.20 a. m.	54 41 00	168 01 00	823	....do	44	45	37.1
13	Hy. 3608	6.54 a. m.	54 41 00	168 25 00	1,122	....do	44	46	35.3
13	Hy. 3609	11.05 a. m.	55 09 00	167 40 00	189	....do	45	45	37.5
13	Dr. 3605	12.44 p. m.	55 17 00	167 34 00	91	....do	45	44	37.1
13	Hy. 3610	4.22 p. m.	55 32 00	167 50 00	110	fne. gy. S	46	44	38.1
13	Dr. 3606	6.12 p. m.	55 27 00	167 47 00	87	gn. M. fne. S	46	45	38.1
13	Hy. 3611	8.29 p. m.	55 32 00	168 11 00	83	fne. gy. S. bk. Sp.	45	45	38.9
13	Hy. 3612	10.49 p. m.	55 42 00	168 32 00	76	bn. M. fne. S	45	45	38.8
18	Hy. 3613	11.36 a. m.	54 14 00	166 54 30	778	gn. M. bk. S	52	46	36.3
18	Hy. 3614	1.37 p. m.	54 25 00	167 13 00	834	gn. M. S	50	46	38.1
18	Dr. 3607	4.14 p. m.	54 11 30	167 25 00	987	gn. M. bk. lav. S.	46	45	35.9
18	Hy. 3615	10.58 p. m.	54 25 00	167 38 00	486	gn. M. S	45	46	37.1
19	Hy. 3616	1.23 a. m.	54 11 30	167 50 00	1,048	....do	44	42	35.2
19	Hy. 3617	3.38 a. m.	54 24 00	168 02 00	538	....do	44	42	37.1
19	Hy. 3618	6.02 a. m.	54 10 00	168 14 00	1,075	gn. M. bk. S	44	42	35.5
19	Hy. 3619	8.38 a. m.	54 06 00	168 37 00	1,231	gn. M. S	45	43	35.3
19	Hy. 3620	11.02 a. m.	54 17 00	168 53 30	1,014	gn. M. bk. S	45	43	35.6
19	Hy. 3621	3.33 p. m.	54 39 00	168 52 30	975	gn. M. S	47	44	35.5
19	Hy. 3622	8.24 p. m.	54 53 00	169 19 00	1,471	....do	46	45	35.1
20	Hy. 3623	1.21 a. m.	55 11 00	168 30 30	944	gn. M	47	45	35.9
20	Hy. 3624	4.07 a. m.	55 32 00	168 36 00	273	gn. M. S	48	47	38.1
20	Hy. 3625	6.57 a. m.	55 19 30	168 09 00	229	gn. M. fne. S	46	45	38.1
20	Hy. 3626	8.18 a. m.	55 19 30	168 10 00	244	gy. S	46	45	38.1
20	Dr. 3608	10.01 a. m.	55 19 00	168 11 00	276	....do	46	45	37.8
20	Hy. 3627	12.05 p. m.	55 17 00	168 01 00	219	fne. gy. S	46	45	38.0
20	Hy. 3628	6.07 p. m.	55 23 00	167 48 00	90	fne. gy. S. bk. Sp.	47	47	37.8
20	Hy. 3629	10.23 p. m.	55 11 00	167 56 00	367	gn. M. S	46	45	37.8
21	Hy. 3630	1.20 a. m.	55 04 00	167 24 00	99	bk. S	47	45	37.6
21	Hy. 3631	3.37 a. m.	55 19 00	167 27 00	78	fne. bk. S	47	47	36.5
21	Hy. 3632	5.57 a. m.	55 30 00	167 51 00	74	gn. M. S	46	46	37.6
21	Dr. 3609	9.12 a. m.	55 35 00	168 20 00	74	....do	46	46	37.9
21	Hy. 3633	11.55 a. m.	55 41 00	168 34 00	77	....do	46	46	37.8
21	Hy. 3634	12.41 p. m.	55 43 00	168 42 00	89	gy. S. M	46	45	38.4
21	Hy. 3635	1.13 p. m.	55 44 00	168 47 00	141	gy. S	46	45	37.8
21	Hy. 3636	1.39 p. m.	55 43 00	168 44 00	108	fne. gy. S	47	45	38.0
21	Hy. 3637	5.35 p. m.	55 27 00	168 01 30	104	....do	47	46	36.8
22	Hy. 3638	2.45 a. m.	55 42 00	166 09 00	68	gn. M	47	46	37.5
22	Dr. 3610	8.11 a. m.	55 58 00	167 16 00	75	....do	45	47	36.8
22	Hy. 3639	2.31 p. m.	56 31 00	166 59 00	57	gn. M. S	48	47	35.3
22	Dr. 3611	5.18 p. m.	56 45 00	167 25 00	50	....do	45	46	34.6
24	Hy. 3640	6.15 a. m.	56 02 00	169 06 30	77	....do	47	45	37.9
24	Hy. 3641	5.45 p. m.	54 57 30	167 14 00	137	....do	48	47	37.7
24	Hy. 3642	6.47 p. m.	54 56 00	167 02 30	116	....do	47	46	37.3
24	Hy. 3643	7.20 p. m.	54 55 30	166 57 30	113	....do	46	46	37.3
24	Hy. 3644	7.54 p. m.	54 57 00	166 53 00	93	....do	46	46	37.8
24	Hy. 3645	8.58 p. m.	54 52 00	166 43 30	118	gn. M	46	46	37.5
24	Hy. 3646	9.48 p. m.	54 54 00	166 35 30	90	gn. M. S	47	46	37.5
24	Hy. 3647	10.48 p. m.	54 49 30	166 26 30	106	....do	46	46	37.3
24	Hy. 3648	11.22 p. m.	54 50 30	166 21 30	95	....do	47	46	37.8
25	Hy. 3649	12.46 a. m.	54 41 00	166 15 30	171	rky	47	45	37.7
25	Hy. 3650	2.05 a. m.	54 32 00	166 09 00	264	....do	47	45	37.8
	Hy. 3651	....	....	....	....	....	....	....	....

Record of hydrographic soundings, etc.—Continued.

BELLINGHAM BAY, STATE OF WASHINGTON.

Date.	Serial number.	Time of day.	Position. Lat. N.	Position. Long. W.	Depth.	Character of bottom.	Temperatures. Air. D. B.	Temperatures. Sea. Surf.	Temperatures. Sea. Bottom.
			° ′ ″	° ′ ″	*Fms.*				
1895. Sept. 30	Dr. 3612	8.30 a.m.	1′ west Chuck-a-nut Island.		11	gn. M	56	52	....

SAN DIEGO BAY, CALIFORNIA, IN CHANNELS. *a*

Date.	Serial number.	Time of day.	Position.		Depth.	Character of bottom.	Air. D. B.	Sea. Surf.	Sea. Bottom.
1896. Mar. 31	Dr. 3613	9.35 a.m.	2½′ S. by E. of National City Wharf.		5	M. Sh	70	63	....
31	Dr. 3614	10.25 a.m.	1¾′ S. by E. of National City Wharf.		4½	....do	70	63	....
31	Dr. 3615	12.10 p.m.	1¾′ S. by E. of National City Wharf.		5	....do	70	63	....
31	Dr. 3616	1.05 p.m.	½′ SSE. of National City Wharf.		5	....do	72	63	....
31	Dr. 3617	1.50 p.m.	Abreast of National City Wharf.		5½	....do	72	63	....
31	Dr. 3618	2.35 p.m.	Abreast of Beacon No. 9.		4½	....do	72	63	....
31	Dr. 3619	3.03 p.m.	1½′ ESE. of Beacon No. 8.		4	....do	74	63	....
31	Dr. 3620	3.50 p.m.	¾′ E. by S. of Beacon No. 8.		6	....do	74	63	....
Apr. 1	Dr. 3621	10.12 a.m.	¾′ ENE. of Point Loma light-house.		6½	M. S	72	61	....
1	Dr. 3622	10.45 a.m.	Abreast (east) of Ballast Point.		7	....do	74	61	....
1	Dr. 3623	1.05 p.m.	½′ NW. by N. of Ballast Point.		6½	S	73	63	....
1	Dr. 3624	1.45 p.m.	Abreast of Beacon No. 3.		5	M. S	70	63	....
1	Dr. 3625	2.20 p.m.	Abreast of Beacon No. 4.		6	....do	72	63	....
1	Dr. 3626	3.00 p.m.	Abreast of Red "Diamond" Beacon.		7	....do	72	63	....

a Boat trawl.

OFF SOUTHERN CALIFORNIA COAST: WEST OF CORTEZ AND TANNER BANKS.

Date.	Serial number.	Time of day.	Lat. N.	Long. W.	Depth.	Character of bottom.	Air. D. B.	Sea. Surf.	Sea. Bottom.
Apr. 13	Hy. 3652	10.51 a.m.	33 06 00	119 17 00	892	fne. S. M	58	56	39.1
13	Dr. 3627	2.37 p.m.	32 44 00	119 32 00	776	gn. M. S	55	55	39.2
13	Hy. 3653	6.24 p.m.	32 38 00	119 36 00	180	fne. gy. S	55	55	45.4
13	Hy. 3654	8.02 p.m.	32 30 00	119 43 00	659	crs. gy. S	55	55	38.6
13	Hy. 3655	11.24 p.m.	32 34 00	119 55 00	891	....do	55	55	38.2

LOWER BAY OF SAN FRANCISCO.

Date.	Serial number.	Time of day.	Lat. N.	Long. W.	Depth.	Character of bottom.	Air. D. B.	Sea. Surf.	Sea. Bottom.
					Feet.				
June 1	Dr. 3628	7.07 a.m.	37 45 15	122 17 07	18	sft. gn. M	53	57	....
1	Dr. 3629	7.53 a.m.	37 41 40	122 17 50	19½	....do	53	57	....
1	Dr. 3630	9.15 a.m.	37 41 10	122 17 20	15	....do	53	58	....
1	Dr. 3631	10.00 a.m.	37 41 55	122 19 50	25	gn. M	53	58	....
1	Dr. 3632	11.05 a.m.	37 38 20	122 20 10	18	....do	54	60	....
1	Dr. 3633	11.37 a.m.	37 39 00	122 20 15	18	....do	55	62	....

U. S COMMISSION OF FISH AND FISHERIES

JOHN J. BRICE, Commissioner.

OBSERVATIONS

UPON THE

HERRING AND HERRING FISHERIES OF THE NORTHEAST COAST, WITH SPECIAL REFERENCE TO THE VICINITY OF PASSAMAQUODDY BAY.

BY

H. F. MOORE, PH. D.,

Assistant, United States Fish Commission.

Extracted from U. S. Fish Commission Report for 1896. Appendix 9, Pages 387 to 442, Plates 60 to 62.

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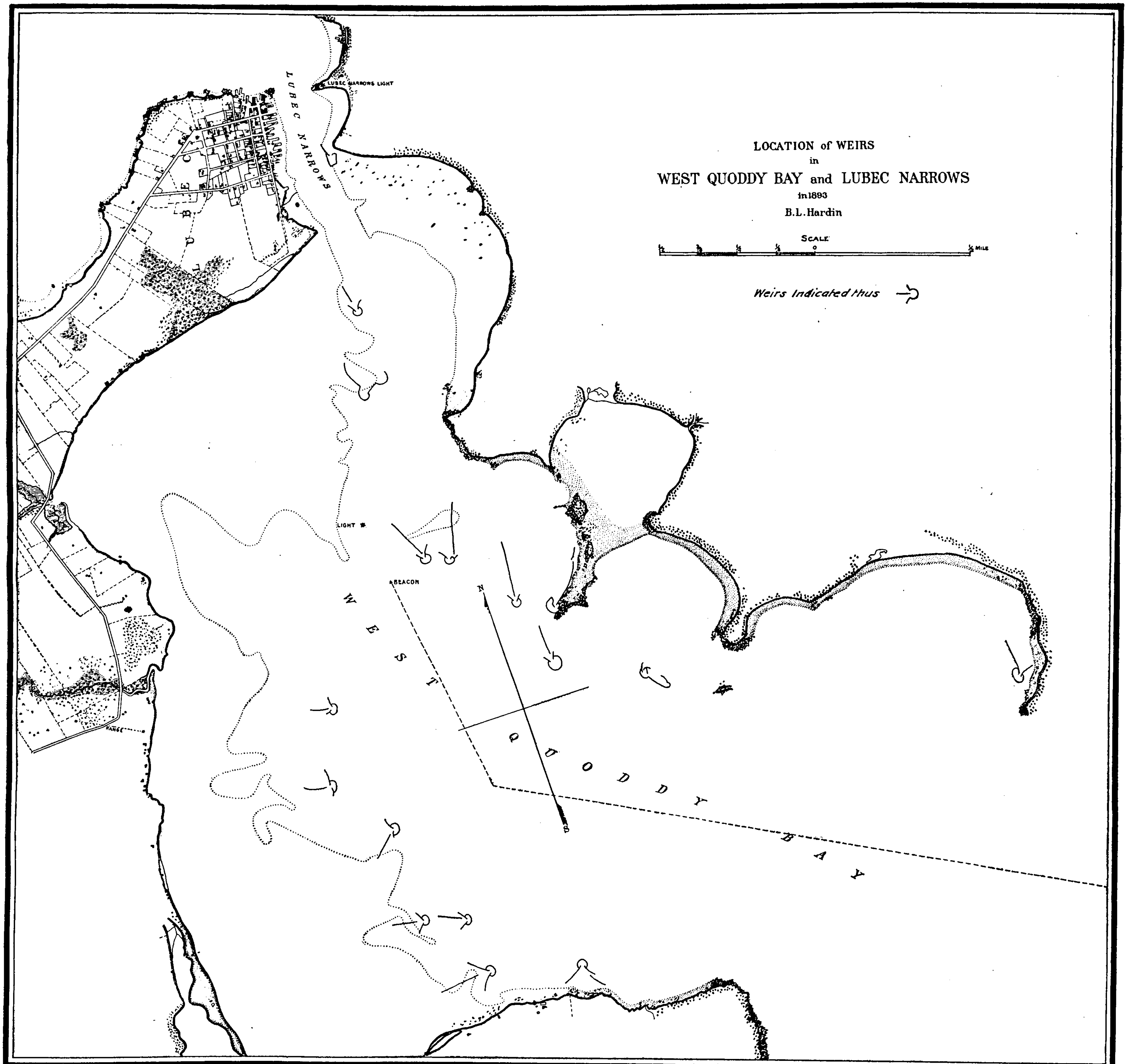
1897.


LOCATION of WEIRS
in
WEST QUODDY BAY and LUBEC NARROWS
in 1893
B.L. Hardin
SCALE
MILE
Weirs indicated thus
LUBEC NARROWS LIGHT
LUBEC NARROWS
LUBEC
LIGHT
BEACON
RANGE
N
S
WEST QUODDY BAY

9.—OBSERVATIONS ON THE HERRING AND HERRING FISHERIES OF THE NORTHEAST COAST, WITH SPECIAL REFERENCE TO THE VICINITY OF PASSAMAQUODDY BAY.

By H. F. Moore,
Assistant, U. S. Fish Commission.

The observations upon which this paper is based were made while the writer was engaged in investigations in behalf of the joint commission, named by the United States and Canada, to inquire into the fisheries of the waters contiguous to the boundary of the two countries. The studies were carried on during the summers of 1893 and 1895, and extended from Portland, Maine, to St. John, New Brunswick, with special reference to waters on and near the boundary line between Maine and New Brunswick.

For the purposes of the present report it is deemed desirable to consider as a whole all of the region lying between West Quoddy Head, Maine, and Point Lepreau, New Brunswick, including Grand Manan and the St. Croix River as far as Robbinston. The region thus outlined is a natural one from both a geographical and an economic standpoint. The shore line is one of extreme irregularity, the indentation produced by the Passamaquoddy system being the dominant feature.

Passamaquoddy Bay is separated from the Bay of Fundy by a chain of islands, the largest of these being Campobello and Deer islands, and the most important Moose Island, on which the city of Eastport is situated. The numerous small islands lying east and northeast of Deer Island are collectively known as the Western Isles. On its western side Passamaquoddy Bay receives the waters of the St. Croix River, which is a tidal stream as far as Calais and St. Stephens. South and west of Eastport it connects with the intricate ramifications of Cobscook Bay and its numerous arms and tributaries which reach into Maine for a distance of from 10 to 15 miles, to the towns of Pembroke, Dennysville, and Whiting.

The entrance to Passamaquoddy Bay is by two passages, one through Lubec Narrows, between the western end of Campobello and the town of Lubec, and thence by the Western Passage between Deer Island and the Maine shore; the other, Letite Passage, is through the archipelago east of Deer Island. Vessels plying between Eastport and Lubec and points west use Lubec Narrows when the tide is favorable, but as the currents flow with great velocity at certain stages of the tide it is often necessary for them to run around the eastern end of Campobello and enter through Head Harbor Passage, between Campobello and Deer

Island. This route is the one invariably followed by vessels plying in either direction between St. John and Eastport.

Immediately east of the mouth of Passamaquoddy Bay there is a complex series of bays, coves, and channels, separated by headlands and islands, forming Letite and L'Etang harbors, with their approaches. This region and Beaver Harbor, a few miles further east, are important localities in the weir fishery for sardine-herring, and the place last mentioned was a leading center for the now extinct winter herring fishery. Between Beaver Harbor and Point Lepreau are several bays and coves in which weirs are located, but the fishery is not important except in times of scarcity in the region nearer Eastport.

Grand Manan is a large island about 16 miles long and with a maximum width of 7 miles. It belongs to the province of New Brunswick, and lies in the Bay of Fundy, about 7 miles from the southwestern end of Campobello. Its northwestern shore—that facing the mainland—presents an almost unbroken rampart of cliffs about 18 miles long, and in places reaching a height of 400 feet. The only important interruption in this rocky wall is at Dark Harbor, a subtriangular inlet about half a mile wide and almost as long. Over a considerable portion of the area of this basin there is a depth of water of from 35 to 40 feet at low tide.

Except for a narrow opening near the west end, the mouth of the harbor is closed by a natural bar of riprap; the tide rises about 15 feet, and, as the basin fills almost entirely through the opening above mentioned, the currents run in and out with great velocity. Advantage is taken of this fact to utilize the harbor as a huge fish-pond, an arrangement of stakes at the inlet making the entrance of the fish easy and their exit difficult, and as a consequence herring can be taken at almost any season in the weir located on the southwest shore, but as they are often held in the pond for a long time and subjected to a scarcity of food they are frequently in a very poor condition.

The southeast side of Grand Manan is low, and a fringe of small settlements and scattered dwellings skirts its entire length, giving abode to a population almost entirely dependent upon the fisheries. Off this shore lie innumerable islands, rocks, and reefs, inducing intricate and rapid tidal currents, famous in the herring fishery of the region.

Another group of small islands, known as The Wolves, lies about 10 miles northeast of Grand Manan and about 8 miles from the mouth of Beaver Harbor. They are almost uninhabited, but temporary stations upon them are sometimes occupied by fishermen.

One of the most striking features of the Bay of Fundy is the great rise and fall of tides, in the region above sketched the height varying from about 15 to 22 feet. This vast semidiurnal flow of the waters, taken in connection with the intricacy of the channels, produces swift and complex currents, innumerable eddies, and several whirlpools, not without danger to small crafts such as are here in common use in the fisheries.

The international boundary line passes down the St. Croix River and thence through the Western Passage, Friars Roads, Lubec Narrows, and West Quoddy Bay. It is rarely over a mile from the main shore of the United States, and it therefore follows that most of the waters here considered fall within the limits of New Brunswick. Notwithstanding this, however, the interests of the citizens of the United States are of great importance, owing to the fact that the manufacture of sardines from small herring is conducted almost entirely on United States soil, giving employment to many persons of both sexes.

The largest and most important town is Eastport, on Moose Island, a city of above 5,000 inhabitants, having regular steamboat communication with a number of points, and great expectations of some day becoming a railroad town. Lubec is next in importance, other towns being Robbinston and St. Andrews, on the St. Croix River, and Pembroke, Dennysville, and Whiting upon several arms of Cobscook Bay.

GENERAL DISTRIBUTION.

The herring, *Clupea harengus*, is one of the most abundant fishes inhabiting the North Atlantic Ocean. Although it apparently never enters the Mediterranean, it is found sparingly upon the coasts of Europe as far south as the Strait of Gibraltar. From the Bay of Biscay northward it increases in abundance, reaching its maximum in the waters adjoining the coasts of Scotland, Norway and Sweden. It extends its range eastward along the shores of the Arctic Ocean at least as far as Siberia, and in the White Sea it occurs in sufficient numbers to make it the object of regular fisheries in the spring and fall. Commercially the herring is of greatest importance in the North Sea and contiguous waters, where the fishery has been for many years of vast importance to the nations of northern Europe.

During the last two decades the Norwegians and others have developed a herring fishery of some importance upon the coast of Iceland. In Greenland the herring also occurs, but it gives rise to no fishery of value, though it is probable that it is there as abundant as upon the shores of Iceland, where the native population neglected the important product at their doors until their attention was directed to it by the fishermen of Europe less than thirty years ago.

Upon the Atlantic coast of North America the herring ranges as far south as Cape Hatteras, being occasionally caught in the Chesapeake and off the outer shores of Virginia, Maryland, and New Jersey. It never occurs in great abundance south of Block Island, and the principal fisheries are north of Cape Cod. Newfoundland is the northernmost portion of North America in which the herring fishery is persistently and extensively followed, and there are likewise more or less extensive fisheries at the Magdalene Islands and at other places on the Gulf of St. Lawrence, while from the Bay of Fundy to Cape Cod the fishing-grounds are practically continuous. The herring fishery upon the shores of North America is entirely a shore fishery. With the exception of a few occasionally taken for bait by the line fishermen on the banks, our herring are all caught in the immediate vicinity of the shore, and it was regarded as an undesirable innovation when, in the later years of the winter herring-fishery, the fishermen were compelled to set their nets 6 or 8 miles from land.

The lack of an offshore fishery on our coasts is due not to the absence of the fish, but to the fact that the shore fisheries are amply able to supply the somewhat limited demand. Bodies of herring are frequently seen far out at sea by vessels engaged in other branches of the fishery, and large hauls are sometimes accidentally made by mackerelmen in their purse seines. The herring fishery has never assumed the importance here which has long characterized it in Europe, although in abundance the species is probably not inferior.

HISTORY AND GENERAL CHARACTER OF THE FISHERIES.

The herring fisheries in the Passamaquoddy region are carried on by means of brush weirs, gill nets, and torching. The latter method is the one of most ancient usage and was practically the only method employed prior to 1820, when weirs were introduced. This method of catching the fish is said to be effectual only after the weather has grown cool, and in the neighborhood of Lubec it usually begins during the "September darks"—that is, about the time of new moon during the month of September. Formerly a torch of birch bark was used, but with increasing scarcity of that material and the appearance of kerosene in the markets as a cheap illuminant the latter was substituted. A mass of cotton or similar material is wound about a stick several feet in length and, when saturated with kerosene and ignited, makes a rude but cheap and serviceable torch. This is fixed to the bow of a boat, which is rapidly rowed through the water by several fishermen, while another, provided with a large dip net, is stationed in the bow. The fish rise toward the light in numbers as long as the speed of the boat is maintained, but when the motion ceases they sink back into the depths. They are usually simply bailed into the boat as they rise, and sometimes large quantities are taken in this way. At other times the torch is used in connection with the weirs, the fish being tolled in by their blind pursuit of the light, which is then extinguished, and the operation repeated as often as may be necessary. This method is adopted when the fish for some reason remain in the deeper water beyond the weirs, and is said to be profitable when sardine-herring are scarce and in demand.

Torching in its simpler form is still somewhat extensively followed in the vicinity of Lubec, and before the introduction of pounds into this region was the principal source of supply for smoking-herring. Through the instrumentality of the weir fishermen it has been prohibited by the law of New Brunswick, the objections urged against it being that it tends to break up and scatter the schools, and that dropping oil upon the surface of the water tends to drive the fastidious herring from its haunts.

Gill nets are the most recently adopted of the appliances used by the herring fishermen of Passamaquoddy, being introduced about 1829. Those employed in the limited fishery for Quoddy River herring have a mesh of about 3 inches in extension, but for the winter and spawn runs a smaller mesh has always been used. They are always set at some distance below the surface, the depth to which they are sunk being regulated by the length of the bridles by which they are suspended from the buoys. The nets are anchored at one or both ends, according to circumstances, the former being the method usually pursued near Eastport, where the operation is usually known as drifting. The quantity of fish caught is sometimes sufficient to sink the buoys, and in order that such nets may not be lost it is customary to have a buoy attached to the anchor by a line long enough to reach to the bottom. This is especially necessary during the spawning run, when the schools are often very dense and the catches are correspondingly large. Further details are given in the chapters relating to the Quoddy River and winter herring fisheries.*

The brush weir is an ancient form of fish-trap, invented independently by many peoples of widely separated habitats and of various scales of civilization. There is ample evidence that simple forms of the device were used by the aboriginal inhabitants of the United States prior to the coming of the white man, but it seems to have been unknown, or at least unused, by the settlers on the border between Maine and New Brunswick prior to about 1820.

Concerning the introduction and the early history of this fishery the following account is given in The Fishery Industries of the United States: †

The typical brush weir introduced from Nova Scotia.—According to Mr. D. I. Odell, of Eastport, and Mr. Jacob McGregor, of Lubec, the fishermen of the United States owe their knowledge of the brush weir in its present form to Nova Scotia, where it was in use before the beginning of the present century. According to these parties the date of its introduction into the United States was about 1820, when two or three small ones were built near the western end of Campobello Island and along the shores of North Lubec for the capture of different species. These were not sufficiently successful to warrant their extended use and after one or two seasons' fishing they were abandoned. The first large weir exclusively for herring is said to have been built in 1828, by Mr. John McGregor and his son Jacob, at North Lubec. Mr. McGregor was a native of Digby, Nova Scotia, and had become thoroughly familiar with the brush weir as employed in the fisheries of that region before his removal to the United States several years earlier. Thus far during his stay in Lubec he had been engaged in the smoking of herring, depending wholly upon torching for his supply; but he soon found that the movements of the herring were very similar to those of the school that visited Digby, where the weir was successfully used. He therefore decided, on account of the labor and exposure in torching and the comparatively small quantity of fish taken, to build a brush weir for the capture of the fish. Accordingly he selected Rogers Island as a suitable location and proceeded at once to construct his weir. It was built in shoal water and was much smaller

* For a more detailed account of nets and methods refer to The Fishery Industries of the United States, section V, vol. I.

† Section V, vol. I, pp. 499 and 500.

than the weirs of the present day. It proved very successful in the capture of herring, and other parties soon built weirs of similar size for the same purpose.

Growth of the weir fishery.—From this small beginning the weir fishing gradually spread to the adjoining section, and Campobello, Grand Manan, and the various settlements along the American shore soon had extensive weir fisheries. In 1835 the weir was introduced into the fisheries of Grand Manan Island by Lubec parties. In 1836 the first one was built in West Quoddy Bay, which soon came to be the principal fishing-ground on the American shore; and within fifteen years from that date there were 30 weirs between Lubec and West Quoddy Head, a distance of 3 or 4 miles at most.

In 1849, according to Mr. M. H. Perley, there were 27 weirs at Grand Manan, 21 at Campobello Island, and 7 on the West Isles. We find no printed record of the number on the American shore at that time, but the older fishermen of the region informed us that there were about 45 in the town of Lubec, with 20 additional at Eastport and along the Maine shore between Lubec and Calais. This would give 65 for the American shore and 55 on the English islands, making a total of 120 at that time.

These weirs were all small, and were of the pattern afterwards known as "half tide" or "hedge weirs," being so constructed that the fish could enter them when the tide was past half flood, but from which they could not escape during the later stages of ebb tide, being often left high and dry at low water. Such weirs are still employed in some places, but rarely in Passamaquoddy. They were afterwards improved by the addition of a leader or its equivalent, and were built larger and in deeper water.*

In 1880 there were 142 weirs in the Canadian waters of the region with which we are immediately concerned, located as follows:

St. Croix district	6
Inner Bay, Passamaquoddy	10
Lepreaux, Beaver Harbor, and Letite	16
Deer Island (estimate)	40
Campobello	29
Grand Manan	41
Total	142

In the same year weirs were located in United States waters as follows:

Outer shore of Lubec	4
United States shore of West Quoddy Bay	10
Canadian shore of West Quoddy Bay (owned in Lubec)	7
North Lubec	10
Eastport and small islands in vicinity	17
West shore of St. Croix River, between Robbinston and Eastport	12
Above Robbinston	6
Total	66

Those on the Canadian side of West Quoddy Bay were probably also included in the Canadian record, and allowing for this duplication we may conclude that in 1880 there were about 200 weirs in the waters between West Quoddy Head and Point Lepreau, including Grand Manan. This was at a period when the sardine business had already assumed considerable importance and gave evidence of a greater growth to come. In 1881 the number of weirs in Canadian waters had increased to 240,

*For information concerning the construction of the weirs the reader is referred to pp. 501-504 of the work already cited.

and in 1887 there were 264. In the following year, 1888, the competition for licenses was exceedingly keen, and 327 were issued, a number which has never been exceeded. This year's experience disabused men's minds of the visions of profit which they had heretofore held, and nearly 100 licenses were permitted to lapse in the succeeding year (1889).

In Maine the growth of the weir fishery appears to have been less precipitate, but there is no accurate information upon the subject, as there was no enumeration of the weirs between the years 1880 and 1893. In that year Dr. B. L. Hardin made a painstaking survey of the region, excepting Grand Manan and the vicinity of Point Lepreau, carefully plotting the weirs from angles obtained with a sextant. A reproduction of his chart is published herewith, and will be of great value as a basis for comparison for future studies of the fishery.

In 1893 there were 285 in the entire district with which this report is immediately concerned, 239 of these being under license of Canada and 46 in the United States or owned by United States fishermen.

The Canadian weirs were located as follows:

St. Croix district	5
St. Andrews district (Inner Bay)	35
Lepreau and Beaver Harbor	78
West Isles (including Deer Island)	74
Campobello	23
Grand Manan	24
Total	239

Those upon the United States side had the following distribution:

Outer shore of Lubec (United States side Lubec Narrows)	4
United States shore of West Quoddy Bay	7
North Lubec, Seward Neck, and Johnson Cove	5
Morrison Cove	1
Eastport	3
Between Eastport and Robbinston	9
Pemmamaquan River and East Bay	17
	46
Neglected or abandoned, Eastport	4
Neglected or abandoned, between Eastport and Robbinston	2
Total	52

Comparing these tables with those for 1880, it will be seen that between the years 1880, when the sardine business began its most active development, and 1893, there was an increase of about 50 per cent in the total number of weirs in the region. This increase was entirely upon the Canadian side, the United States waters suffering a decrease in this fishery, at least so far as the amount of apparatus is concerned. This falling off affected principally the immediate vicinity of Eastport, where the greatest activity prevailed at an earlier date. Above Robbinston there were no weirs in 1893 as compared with 6 in 1880. Lubec Narrows about held its own, and Pemmamaquan River and East Bay, where there were none or but a very few small weirs in 1880, had become the scene of the largest weir fishery in the United States waters of Passamaquoddy in 1893, this rapid growth being induced, not by any change in the known habits or distribution of the fish, but by the demand produced by the establishment of sardine canneries in the vicinity.

The changes in the distribution of the weirs on the Canadian side within the period mentioned were characterized by a heavy reduction in the number at Grand Manan, which, being more remote from Eastport and separated therefrom by open and more or less stormy waters, is not affected by the demand for sardine-herring, the delivery of which brooks no delay or uncertainty. The weir fishery at that place is dependent almost entirely upon the smoked and pickled herring trade and the supply of bait. The increase which has been noted in Canadian waters took place almost entirely in St. Andrews Bay, the West Isles, and in the vicinity of L'Etang; that is, in the sheltered waters more remote from Eastport. It is generally claimed that this eastward movement of the center of the industry was conditioned by a change in the distribution of the small herring. This is no doubt true to some extent, but that the fishery would have shown this tendency to extend even without this temporary change in the movements of the herring, is not to be doubted. Should the distribution of the herring remain as general as for several years past, there will inevitably result a tendency to curtail the amount of apparatus used in waters more distant from the factories, as weirs in such places will not pay when the boats engaged in transportation can procure their fares in more accessible places. The number and distribution of the weirs are undergoing constant fluctuation. A good catch and a steady market in any given locality causes an increase in the following year, and a failure, either in the catch or the market, causes a corresponding decrease, owing to the discouragement of the fishermen, especially in Canadian waters, where it is necessary to procure a license.

DISTRIBUTION AND MOVEMENTS.

If we except the winter herring, which is discussed in a separate chapter, and the spawning runs in spring and fall, there is little evidence to show any definite or extensive migrations of herring in the vicinity of Passamaquoddy Bay. During summer and fall there are more or less extensive local movements of the schools, but they are not of such a character as justify the use of the term migration. They are apparently conditioned entirely by local circumstances, distribution of food, location of enemies, and meteorological conditions, the effects of which are obvious.

The schools of sardine-herring, and the larger individuals which are more or less associated with them during summer and fall, are constantly moving back and forth without apparent system. It appears, however, that the fish found in the waters inside of Campobello usually enter by Head Harbor Passage at the east end of the island. In many cases in 1893 and 1895, it was possible to trace the movements of these schools from the vicinity of L'Etang westward to Deer Island, Cobscook Bay, and the vicinity of Lubec, or northward to the several parts of St. Andrews Bay and the vicinity of Robbinston. Sometimes the schools work out through Lubec Narrows and are caught in West Quoddy Bay.

The small herring, and some of the larger ones, remain in the vicinity throughout the year, and the same statement will hold concerning sardine-herring on other parts of the coast of Maine. During winter they apparently keep in the deeper water, but occasionally catches have been made in the weirs during February. Schools of small fish are seen in the Bay of Fundy throughout the winter and bodies of larger ones sometimes occur in the vicinity of Grand Manan during the cold months, but they do not usually approach the shores and very few are said to enter Dark Harbor after November.

In spring the herring, especially the smaller ones, begin to approach the shores, but they are not caught in the weirs in abundance until July. Some of the fishermen state that prior to about 1883 considerable quantities were caught during March, but that since then the advent of the schools has grown gradually later until at the present time they are not expected until July. Concerning this we find the following in The Fishery Industries of the United States, compiled from information gathered about 1880:

> The fish taken in the early spring are usually quite small, and have little value for smoking or for bait; they are also in such poor condition that they yield but little oil, and it therefore seldom pays to press them. For these reasons, during the early years of the fishery, the weirs were seldom put in order before the 1st of June, and frequently few fish were taken prior to the beginning of September, when the fishing began in earnest and continued till the close of the year. Now, however, owing to the demand for small fish by the sardine canneries, the weirs are usually repaired in the early spring, and the fishermen tend them regularly from the 1st of April till the following January. (Fishery Industries, section V, vol. I, p. 502.)

The records of the catches of individual weirs in 1878 and 1879, published with the foregoing, show that comparatively few herring were taken before July or August, precisely as is now the case. The sardine-packers state that they do not care to begin work before July because of the irregular catch and that in the early days of the business, when operations began at an earlier date, the supply of fish was insufficient for all, and the resulting competition raised the prices to a level which was wholly unjustified, and which would be ruinous at the present price of the finished product. There is no difficulty in securing all the fish needed after July 1, and the comparative abundance and regularity of the catch then renders possible the steady and more economical operation of the factories.

The probability is, therefore, that the herring arrive at about the same time that they always did, that there is no recession of the date such as was noticed in the later years of the winter fishery, and that the weirs are not fished before July merely because there is no demand for the product, and not on account of any change in the habits or distribution of the fish. For the same reason the fishing season of the weirs does not last as late as formerly, when good catches were often made during December and January. At present the factories usually cease operations before December, but the fish remain later than that and could be caught if necessary, although probably not in such large quantities as earlier in the season.

I am informed that there was at one time, and there may be still, a distinct migration of herring from the Bay of Fundy shore of Nova Scotia across to Grand Manan. The schools, after spawning in the spring, ran over to the Ripplings early in July to avail themselves of the rich food supply which that locality affords. They were formerly followed across by the fishermen of Nova Scotia, a practice which has apparently fallen into abeyance. The evidence, however, makes it by no means certain that the schools in the two places are identical.

The appearance of the "Quoddy River herring" in Quoddy Roads appears to have been the result of a distinct though limited migration, but whence they came or whither they went can not be stated.

EFFECTS OF PHYSICAL PHENOMENA.

Tides.—The movements of herring on and off shore are largely influenced by the tides, this being true at least of such as come toward land for other purposes than for spawning. This statement applies particularly to the sardine herring of the Bay of Fundy, which approach the shores and run into the coves upon the flood tide, but drop off into deeper water when the tide is ebbing. The shoreward movement may be either to procure food for themselves or to avoid becoming food for their enemies, the reverse movement upon the ebbing tide being induced by the instinct of the herring to avoid stranding at low water, a fate which would often overtake it were it to remain in the shallow coves. As both the herring and its principal enemy, the squid, are more active at night, this shoreward movement is then more extensive.

This tidal movement of the herring is quite pronounced in the neighborhood of Eastport, where the difference between high and low water averages 18 feet, and the fact has been taken advantage of by the fishermen, who build weirs in such a manner as to permit the fish to enter the coves on the flood tide but to compel them to enter the weir on the ebb.

The fishermen state that when migrating the herrings take advantage of the currents and eddies to help them on their way, but that when feeding they swim counter to the stream, so that the food may be carried to them, or else lie in an undercurrent and catch the food as the surface current carries it over them. There is no doubt that the herring prefers strong currents and eddies, such as are found at the "Ripplings" off Grand Manan and at the passages between islands in and about Passamaquoddy Bay. They resort to them not because they like swift water *per se*, but on account of the larger amount of food which is found there. Free-swimming and floating organisms tend to collect in such places, each eddy becomes a larder kept filled by the supply carried in by the converging and conflicting currents, and the herrings there find a large amount of food requiring a minimum of effort in its capture.

In watching herring feeding at the surface I have never seen any evidence that they keep facing the current; they attack their prey from all sides. If this be drifting with the current then the fish also drift with the current; if it be stemming the tide the fish follow it up, their aim in either case being to *keep with their food supply.*

What effect, if any, the current has upon the movements of the herring to and from the spawning-grounds, in the Bay of Fundy, is difficult to say; probably it is slight.

The influence of the tides in disseminating impurities supposed to be inimical to the herring fisheries is considered in another connection.

Winds.—The winds affect the distribution of the herring in two ways—by influencing the distribution of food and by the action of the surf and heavy seas in driving them from the coasts and from the surface into the deeper waters. My own opportunities for judging of the effect of the winds upon the distribution of food organisms were slight and the testimony of the fishermen is very contradictory. When the wind has sufficient velocity to make a sea, there is very little life to be found at the surface, and waves of even moderate height render the use of the surface tow-net of but little avail in collecting. There is thus produced a vertical distribution of the herring food, which is doubtless more pronounced in summer than in winter, when surface life is usually less abundant, even in calm weather. It is the horizontal distribution, however, rather than the vertical, which has the greater influence on the fisheries; if the food be by any agency carried offshore or to another part of the coast the herrings, except those engaged in spawning, will surely follow. Owing to the comparative dearth of surface life in winter the influence of the wind in this respect is less than in summer, but even during the latter season I could not observe that it had much effect. As both the Thysanopoda and the Copepoda are found in summer, both at the surface and for a depth of at least several fathoms, it would appear that the winds have not so great an effect on the distribution of food as is generally supposed.

Strong winds have, for another reason, a considerable effect upon the herring, or at least upon the weir fishery. I repeatedly noticed the failure of this fishery during the prevalence of storms and for a day or two afterwards. The herring run into the deeper water, where they can remain undisturbed, and do not come ashore again until the waves have subsided. Heavy seas have the same effect upon the spawn herring in the shallower waters, and it appears that at such times the herring temporarily move off and presumably cast their spawn in deeper water. It is stated that at times quantities of herring, weakened by the act of spawning, are killed by the violence of the waves.

This whole question of the effect of winds upon the herring on our coasts will bear closer scrutiny.

Light.—It has long been recognized, both in this country and in Europe, that light has an important effect upon the movements of the herring and upon the facility with which they may be captured.

During the hours of bright sunlight the herring, with the exception of "brit," keep in the deeper waters and rarely come close to shore or approach the surface. Herring are caught in the vicinity of Eastport in drift nets near the surface, but such nets are never known to catch anything during the daytime. In this locality the water is quite clear, but in St. John Bay, in New Brunswick, it is more or less turbid and dark from the large amount of solid matter brought down by the great river St. John, and it is significant that the only case known to me of herring being caught during the daytime occurred some years ago in St. John Bay. It is, moreover, a fact recognized by the fishermen, and frequently observed by me, that relatively few fish, although they may be playing at the surface, can be caught by drifting upon moonlight nights, and the fishery is not usually prosecuted at such times. This is to be explained by the greater facility with which the fish see and avoid the nets, an explanation which appears the more probable when it is noted that fishing with gill nets is said to be usually poorer when the water "fires," that is when it is strongly phosphorescent, and the nets suspended in it are like a wall of flame, and of course conspicuous to the fish and easily avoided.

Light has about the same effect upon the weir fisheries, large catches being rarely made during the day tides or upon moonlight nights, except when the herring are driven and held in shallow waters by their enemies, as for instance at Magaguadavic in 1894, when they were held inshore by large bodies of squids, considerable quantities were taken in dip nets. The best fishing is usually to be had during dark nights when the high tide occurs between 1 and 7 o'clock in the morning, the time appearing to vary somewhat in different places; near L'Etang, for instance, the later tides are better and in St. Andrew Bay the earlier ones. When the tides occur in the morning during and near full moon the fishing is not so good, but should a cloudy night intervene there is frequently an improvement in the catch for that night or during the continuance of the cloudy weather.

Another curious fact connected with this subject is the apparent fascination which a moving light possesses for the herring. It has long been known that they will follow a light upon dark nights and this habit is taken advantage of by the fishermen in the process known as "torching." This method of catching the fish is elsewhere described. It is sometimes asserted that the rising moon serves to attract herring in a similar manner, but there appears to be little evidence to support the statement.

There is no information at hand concerning the effect of light upon spawning herring and upon the fishery for them.

Sound.—It is well known to fishermen and to all who have studied the subject that herring are affected by loud noises. I have frequently noticed that a sudden blow upon the thwarts of a boat will cause herring swimming at the surface to suddenly disappear, but they will soon reappear if the noise be not continued. My observations at St. Andrews indicate that such noises as the sounding of a ship's horn or the distant report of small arms are unnoticed by herring at the surface, but the heavy detonations of cannon, as one would naturally suppose, produce a greater effect, and at Bar Harbor the frequent firing of small cannons on the yachts scare the fish, although they do not seem to go very far and soon recover from their fright. The fishermen at Seal Cove, Grand Manan, say that when the Gannot Rock fog gun, 9 miles distant, is fired all the herring at the surface go down at once, and the same thing was noticed at Eastport some years ago when warships were stationed in those waters.

These facts, well established, have been offered in explanation of the failure of fisheries at different places, fog alarms and whistles having been supposed to exert a very bad effect upon the catches of the weirs. Mr. W. B. McLaughlin, the keeper of the light-house at the Southern Head of Grand Manan, an intelligent man, to whom I am much indebted for assistance, is a firm believer in the pernicious effect of loud noises upon the fisheries. In a conversation in 1893, he stated that a weir on Big Duck Island had been known for forty years as a very successful fishery. The owners, as a safeguard to their shipping, were desirous that the Government should place a fog-horn upon the island and, although advised not to do so, made successful application for its establishment. Soon after it was placed in operation the fishery began to fail and was eventually completely ruined. I afterwards heard of this case from others.

Mr. McLaughlin offers the same hypothesis in explanation of the failure of the weirs in West Quoddy Bay. He says that they began to fall off in their catch at about the time the fog-alarm was placed on Quoddy Head, and that the porpoises, which prey upon the herring, made off at about the same time. Indians engaged in porpoise fishing were unable to confirm this statement, and, moreover, the weirs referred to have within the last few years again begun to be profitable fisheries, a fact which can hardly be explained by stating that the fish have become "educated" to the point of recognizing the harmlessness of the whistle.

Many of the fishermen explain the failure of the weir fisheries at Lubec and Treats Island by the terror with which the steamboats have inspired the herring. It is said that the constant churning of the water and the blowing of whistles has driven the herring away, but I have found that the same causes do not produce the stated effect upon other weirs. Those in Friar Bay are exposed to these disturbances as much as or more than is Treats Island; the ferry boats plying between Eastport and Lubec pass many times a day within a few rods of one of these, yet good catches are frequently made, and the owner expresses himself as well satisfied with the season's yield. The effect of steamboats upon the herring are certainly overestimated, for I have seen them pass within a few rods of herring schooling at the surface, and have noticed no evidence of alarm, although those quite close to the boats disappeared, but came to the surface again as soon as the boat had passed.

Fresh and brackish water.—I have not noticed that the herring show much tendency to run into places into which fresh water is discharged. The fishermen say that in dry seasons they run into coves and mouths of streams in order "to get fresh water to drink." The summer of 1895 was one of extraordinary drought, yet the herring appeared to be everywhere, and by no means confined to places receiving the discharge of streams of fresh water. When they do go to such places it is probably to obtain food or escape enemies, and in spite of the fresh water rather than in search of it. Moreover, the discharge of the streams in the neighborhood of Eastport is so small, as compared with the tidal ebb and flow, that they must have very little effect indeed upon the salinity of the water. In the River Schlei, in Germany, they spawn in water which is practically fresh, and they occasionally run into fresh water in some of the rivers in Maine—in the Kennebec, for instance, which they have been known to ascend as far as Gardiner.

Impure water.—It is a common belief among the fishermen that the herring are affected to a great extent by impurities in the water; that offal and dead fish, the oil from factories, and the use of decaying bait in lobster traps, etc., will drive fish from grounds which they have been in the habit of frequenting for many years. That these statements, so strongly made, have some basis in fact is probable, but that the effects have been exaggerated is beyond doubt. The matter will be more fully discussed in the section treating of the alleged decrease in herring in the Passamaquoddy region.

Temperature.—The effect of temperature upon the incubation of the eggs is mentioned in the section upon spawning, where its probable effect upon the date of spawning is also considered. Sufficient data for the discussion of this subject as relating to our coasts have not been collected. It would require observations extending over a series of years and at different stations to form any satisfactory basis for conclusions, and these observations should embrace the temperature of the air and of the water at the surface and at the bottom, together with a close record of the catch and the distribution of the fish. It is useless to speculate upon the matter in the absence of the data, but, on the other hand, were they in our possession there is but little doubt that they would yield important results.

Rain, snow, and ice.—The effect of these phenomena is closely connected with the effects of light and temperature, and, as in the case of the latter, the proper data for their discussion are lacking so far, at least, as our shores are concerned. Gentle rains and, inferentially, snows have the same effects, apparently, as cloudy or foggy weather without precipitation. In studying these, and in fact all phenomena, it is necessary to bear in mind the distinction between the fish and the fisheries. It is possible to effect changes in the latter while the fishes are but little affected.

Food.—An examination of the mouth cavity of the herring will disclose a series of long bristle-like processes, the gillrakers, projecting from the anterior face of each gill-arch, like the teeth of a comb. When the mouth is opened widely the tips of the gillrakers stand apart, but when it is closed or partly closed they become more closely approximated and each series is pressed closely against the inner face of the series attached to the arch next in front. There is thus formed a beautifully fine and effective sieve, capable of retaining small bodies contained in the water taken in at the mouth and discharged through the gill-slits.

As would be naturally inferred from the structure of the pharyngeal apparatus just referred to, the food of the herring consists of small organisms, often of microscopic dimensions. It is entirely animal in nature, and in Europe, according to those who have investigated the matter, it consists of copepods, schizopods (shrimp-like forms), amphipods (sand-fleas and their allies), the embryos of gasteropods and lamellibranchs, and young fishes, often of its own kind.

In the examination of about 1,500 specimens at Eastport and vicinity in the summer and early autumn of 1893 but two kinds of food were found. One of these consisted of copepods ("red seed"), which appeared to constitute the sole food of the small herrings, the so-called brit, and a considerable portion of that of the larger individuals from 5½ inches upward. The principal food of the latter, however, were schizopod crustaceans of the genus *Thysanopoda*, known to the fishermen as "shrimp." In many cases the stomachs of the fish were densely gorged with them, and, whenever determinable, *Thysanopoda inermis* was the principal species eaten, as it is also the most common form in the Passamaquoddy region. During the summer and fall dense bodies of *Thysanopoda* are seen swimming about the wharves at Eastport and at other places in the vicinity, and they are also extremely abundant on "The Ripplings" at Grand Manan, which has long been famous as a herring fishery. Excepting the eyes and the phosphorescent spots beneath, which are bright red, the bodies of these shrimps are almost transparent, yet such is the density of the schools in which they congregate that a distinct reddish tinge is often imparted to the water. In the summer and early fall of 1895 they were especially abundant about the wharves at Eastport, and on one occasion, at least, they were left at low water several inches deep over a considerable area of one of the docks.

In summer and fall both shrimps and copepods are found near the surface where the herrings commonly take their food. The former are very active and frequently avoid the rush of the fish by vigorous strokes of their powerful caudal paddles which throw them several inches above the surface, often thus evading capture a score of times before they finally succumb to their pursuers. To capture such prey requires some address on the part of the herring; they frequently throw themselves almost clear of the surface and their splashings at such times, though not so great as those of a school of pollock, are audible at a considerable distance.

When feeding upon copepods the movements of the herring are less impetuous. They swim open-mouthed, often with their snouts at the surface, crossing and recrossing on their tracks and evidently straining out the minute crustaceans by means of their branchial sieves. As their food drifts the fish follow so that it often appears as if the whole school were carried along at the mercy of the tide. When feeding at the surface, whether upon shrimps or copepods, they are said to be "schooling," a phenomenon more common at night than during the day, and according to the fishermen more prevalent upon moonlight nights than during dark or cloudy ones.

After they have passed the stage known as "brit" (2 to 4 inches long) the herrings appear to feed principally at night, or if they do so to any considerable extent during bright daylight it is at such a depth that they escape observation. I have commonly observed them schooling at sunrise and an hour or two before sunset, but rarely at midday even when surface food was abundant. It is not uncommon, however, to observe brit disporting themselves at the surface at all hours of the day, and in the late summer and early fall of 1895 immense schools of these tender young could be seen daily in the Western Passage and adjacent waters.

At night it is often possible to note the movements of the fish at a depth of several fathoms, and at such times I have seen them swimming back and forth, apparently screening the water, their every movement traced by a phosphorescent gleam, evoked perhaps from the very organisms which they were consuming. As stated above, they are more often at the surface at night than during the day, their presence being made manifest to both eye and ear.

By watching a school of herring feeding upon *Thysanopoda*, it is very evident that they follow their prey by sight, and the fact that these schizopods possess phosphorescent spots may explain the apparent ability of the herring to catch them at night. When feeding upon such minute forms as copepods, it is probable that the herring uses its vision but little, as it appears to pay no attention to individuals, but merely to swim open-mouthed and take its food *en masse*.

The fishermen state that when both shrimps and copepods abound the former is preferred—a statement corroborated by my own observations. Frequently in the same school a few of the fish will contain copepods while the vast majority are gorged with shrimps, and sometimes they will all be found in the latter condition when the tow net demonstrates the presence of copepods in abundance. When brit and larger herring are caught in the same weir, the former—too small to take large food—are filled with copepods, while the latter contain shrimps alone. The fishermen state that shrimps are rarely seen during the winter, but the examination of specimens caught at that season at Grand Manan shows that even then they form an important item in the herring's diet, although my observations lead me to think that they are relatively less important than during the summer. In the winter the shrimps doubtless frequent the surface less than in summer, which of course explains why they are not observed by the fishermen.

The stomachs of by far the greater number of herring taken in the weirs are empty, this being no doubt due to the absence of food in the weirs, and the rapid digestion of that taken by the fish previous to their capture. When food is abundant in and around the weir the fish are difficult to hold, in eager pursuit of their prey, passing through openings which at other times would be unnoticed.

The remarkable abundance of herring in the vicinity of Passamaquoddy Bay is doubtless in direct relation to its rich supply of nutritious food. The presence of great spawning-beds in the vicinity is also favorable; but the location of these must also be largely conditioned by the lavish provision which nature has made for the support of the progeny in all stages of their career.

ENEMIES.

Upon the coast of Maine and New Brunswick, as elsewhere, the enemies of the herring are numerous and voracious, many of them being of great commercial importance. Most of the species of the cod family, at least the larger members, feed more or less extensively upon the herring and its eggs. Cod and haddock are frequently taken with their stomachs full of herring spawn, and at Cross Island, Maine, during September, 1893, they were found gorged with both the herring and its eggs. At the same place pollock, which had been following the herring in great schools, were found to contain an average of about 6 full-grown and ripe herring, together with quantities of spawn. Cod, haddock, and hake feed extensively on the spawn of herring at Grand Manan and doubtless sculpins, sea-ravens, flounders, and other bottom-feeding species secure their share of the harvest.

Dogfish and silver hake are a source of much annoyance and loss to the gill-net fishermen, the former being particulary destructive to the nets, biting the entangled herring in two and cutting and tearing the twine in their efforts to pull the fish from the meshes. They appear in great schools during August and soon drive all other fish from the vicinity, causing for a time an almost total cessation of fishing with lines and nets. Fortunately their stay is of short duration, lasting usually about two or three weeks. When no other fish are to be had, the fishermen sometimes catch the dogfish for its liver (which is converted into "cod-liver oil"), the remainder of the fish being often spread upon the soil for fertilizer. No use whatever appears to be made of the silver hake, as its flesh is said by the fishermen to be uncurable by ordinary methods.

The albacore, locally known as the horse-mackerel, feeds largely on herring, but is not sufficiently abundant to cause much destruction, although it sometimes interferes with the fishery by getting into the weirs and chasing the herring. This appears to be the species which some of the fishermen call the "shark." The mackerel is said to feed extensively upon young herring, but now rarely appears in the region embraced by this report.

The squid is probably the most destructive enemy preying upon half-grown herring in the vicinity of Eastport, where they frequently appear in immense numbers. These visitations are often a source of loss to the fishermen, not only on account of the great destruction wrought, but also because they prevent the herring from entering the weirs or even drive them out after they have entered, as when pursued by these foes they pass without hesitation through the numerous openings in the brush. Sometimes, according to the fishermen, the squids drive the fish toward the shore, and thus into the weirs, in such cases tending to increase the catch. They are also of importance to the line fisherman as bait, considerable quantities of them being used at times in the cod and other fisheries. An effort to utilize them as food for man was made at Eastport several years ago. They were canned after the manner of sardines in both oil and mustard, but the experiment was not a success, the product being tough and tasteless.

Porpoises and seals in the Bay of Fundy also feed largely, probably almost entirely, upon herring, but are not sufficiently numerous to cause great harm. They will drive fish away from the weirs, however, and one instance was cited in which a weir was eventually abandoned on account of the seals so continually driving the herring that they deserted the locality. Both porpoises and seals are hunted at Grand Manan and vicinity by small parties of Indians, the former for their oil and the latter for their skins, which are made up into rugs and moccasins and sold to tourists.

Finback whales feed upon herring, but, though occasionally seen in summer, do not appear in numbers before October. A letter from Mr. McLaughlin, dated December 30, says that "for ten days a large school of herring and whales has been off this station" (Southern Head, Grand Manan). The whales sometimes enter the weirs and are killed, but occasionally the result is disastrous to the weir, a fine one at Grand Manan being almost ruined by a whale in September, 1893.

Gulls and other sea fowl no doubt feed to some extent upon the herring, but the great flocks occasionally seen hovering over schools are probably attracted more by the herring food than by the herring themselves.

Another factor which should be considered in connection with a discussion of the herring's numerous enemies is the collateral effect upon that species of the disappearance of menhaden from the Bay of

Fundy. Formerly this species was extraordinarily abundant in that region, but a number of years ago it entirely disappeared and has never returned. During its occurrence it was an important item of diet to most if not all the foes of the herring, and, like the latter, it was fair game to everything that fed upon fish. The attention which was then divided between the two species is now directed wholly, or at least largely, to the herring, and its numbers must to some extent suffer in consequence. At the same time there must now be available for the herring itself a greater food supply, and it would appear that this disturbance of the faunal balance must be greater and more far-reaching in its effects than the pollutions of a few lobster pots or the injudicious use of gill nets here and there along the shore. In speaking thus I have reference to the general effect upon the number of herring at large as distinguished from a purely local effect upon the fishery. The latter would be more quickly noticed and the source of more immediate, because localized, loss.

The enemies of the herring are important factors in governing its local distribution. Except when under the overpowering influence of the reproductive instinct the herring will always give way before its foes if present in large numbers. Individually its only safety lies in flight, but its powers in that direction are so inferior to those of some of its speedy pursuers that were it not for other factors the species would soon perish from the waters. Its ancient lineage, however, shows that it is well able to maintain itself despite all perils.

SPAWNING, GROWTH, ETC.

In the spawning of the herring upon the west shore of the Atlantic two distinct periods may be recognized, one in spring and the other in summer and fall. The two seasons are separated by intervals during which comparatively few ripe fish are found, although it appears that some herring with mature ova may be caught during almost, if not quite, every month in the year.

No records are at hand which show that the herring spawns upon the coast of North America north of Newfoundland, but there can be scarcely any doubt that it does so. At Placentia Bay and other localities on the coast of Newfoundland spawning begins in May and lasts until July. In the Gulf of St. Lawrence there are important spawning-grounds at various places, and here also reproduction takes place in spring only, although the period appears to be of shorter duration than at Newfoundland.

From an early date the herring have been known to frequent the shores of the Magdalene Islands and Anticosti in immense numbers, and at one time the trade in these fish constituted a very important part of the business of Eastport, Me. During the latter part of April and early in May dense schools approach the islands and deposit their spawn upon the sands near the shore. The spawning season lasts about two or three weeks, according to those who were formerly engaged in the fisheries, and sometimes, after storms, almost incredible quantities of eggs are thrown upon the beaches. During certain seasons ice is said to have prevented the fish from spawning at the Magdalenes, and a fisherman stated that about 1878 the herring, for that reason, ran over to the vicinity of the Gut of Canso and spawned in a locality which they had not been known to use for that purpose before, and that they have since continued to resort to that place yearly. It has not been possible to verify this statement, but it is known that the herring spawned in large numbers upon some portions of the coast of Antigonish, as well as upon the west shore of the Gulf of St. Lawrence, long before the year mentioned.

In the Bay of Fundy both spring and fall spawning schools are found, and, in the main, the grounds resorted to by these two bodies of fish are geographically distinct.

From Briar Island, Nova Scotia, eastward to beyond Digby Gut, a school of herrings arrives about the middle of April and spawns upon the coast, and at Clam Cove, at least until quite recently, there was a limited fishery for spawn herrings during April and May.

I could not learn of any herrings spawning during these months on the coast of New Brunswick east of Beaver Harbor, but it is a matter of common knowledge that formerly large bodies of herring spawned from the latter part of April to the early part of June in the waters of St. Andrew Bay and vicinity. I was informed by an old fisherman at Robbinston, Me., that Oak Bay has been, as long as memory runs, an important spawning-ground in spring during the period mentioned; he stated that "in 1894 the schools were as dense as he had ever seen at the Magdalene Islands;" but even if this be true the actual number of fish must be incomparably smaller than at the Magdalenes, owing to the circumscribed area available. The same informant stated that for at least five years no bodies of spawning herring have been in St. Andrew Bay. Whatever may have been the size of the schools of ripe herring now and formerly occurring in the vicinity, no important fishery for them appears to have been established, and the estimates of their great abundance appear to have been based largely on the amount of spawn which was found adhering to the rodes of vessels anchored there. During the spring of 1895 the total catch of spawn herring in Oak Bay was, I am informed, about 60 hogsheads, a very small quantity, indeed, if the spawning school is as large as has been stated.

Probably the most important of the spawning-grounds of the summer and fall schools is at Grand Manan, but east of that place are several localities where the species has been known to spawn during the summer in limited numbers. The best known of these is Tynmouth Creek or Ten Mile Creek, as it is usually called, a few miles east of St. John, where, until about fifteen years ago, the herring arrived annually during June and cast their spawn during July and the beginning of August. About 1880 they suddenly disappeared and I believe have not returned since.

At Grand Manan there is a close season for herring from June 15 to September 15, the only instance in North America where this species is protected during the spawning season. The protected area includes all waters within 3 miles of shore and between an imaginary line from Red Head to Gannet Rock, and another passing due west from the Southern Cross, a well-known pinnacle rock about one-half mile from Southern Head Light. This area covers about 30 square miles, but the spawning-ground overlaps the boundaries on all sides, both alongshore and seaward. The bottom consists of rocks, gravel, sand, and shells, and during the spawning season is said to be literally covered with spawn from close ashore to far out beyond the 3-mile limit. The schools arrive on the ground in June and spawn from that time until late in the fall, although the heaviest run is during July, August, and early in September. Mr. McLaughlin, the fisheries overseer at Grand Manan, says that until September very few fish are found which are neither ripe nor nearly so, but after the beginning of September unripe fish are more common, these perhaps being those which have already spawned.

Westward from Grand Manan there may be said to be a continuous spawning-ground along the coast to Wood Island, and beyond that place spawning-grounds, more or less limited in extent, are found at intervals as far as Block Island. In the vicinity of Machias Bay the herring usually appear after the middle of July and remain until late in September. In 1893 they came early in August, and during the last week in September were still spawning in vast numbers around all the islands near Cutler and Machias Bay. At Moosabec Reach (Jonesport) in 1893 the dates were about as at Machias, and from the information attainable this appears to be the rule. At Boisbubert, according to Capt. J. W. Collins, they spawn during the latter part of July and beginning of August. If the season ends during August at this place it is exceptional, as at localities on each side the most active spawning occurs during the month of September. At Frenchman Bay the net herring arrive during June and remain until late in October, but the period of active spawning is from August 15 to October 1, although a few ripe fish are obtainable at any time during their stay. At Swan Island the spawn is cast from August 25 to October 1, and at Isle au Haut the season is about the same, although the schools arrive as unripe fish about July 25.

Until about 1880 spawning herring were unknown at Matinicus Island, but they now come regularly about September 1 and remain for three or four weeks. The fishermen from that place formerly resorted to Wood Island, but they now have a supply at their doors, although some of them, after the herring leave Matinicus, still go to Wood Island to take advantage of the later season. No herring are known to spawn at Monhegan Island, but upon the opposite shore, in Penobscot Bay and in Casco Bay, they arrive in September and remain until the end of October, although it is probable that few are spawning during the latter part of their stay. At Wood Island the fish arrive after the middle of September and spawn in great numbers. Fishermen from Friendship and other places follow the spawning herring along the coast from Mount Desert to Wood Island and even to Gloucester, Mass. The fish reach the eastern coast of Massachusetts about October 1 and spawn during that month, while at No-Man's-Land spawning begins about October 15 to 25 and lasts for three or four weeks. In this vicinity ripe females have been taken as late as November 30, but the males caught with them were all spent. Block Island appears to be above the southern limit of the spawning range of the herring and they are said to spawn there during November.

The places mentioned in the foregoing résumé of the spawning-grounds include only those where the herrings approach within a short distance of the shore. All along the coast of Maine are numerous outlying reefs and shoals, most of which are within a distance of 25 miles from the mainland. Upon many of these herrings are known to deposit their eggs, which are found adhering to rodes of vessels and boats engaged in the cod and haddock fisheries. In all probability many of these banks and ledges are not spawned upon yearly, but from their large extent and the frequency with which the spawn is thus accidentally found, it is a reasonable assumption that no small proportion of the herring upon our coasts are hatched upon these offshore grounds. It may be stated as a fact that from Grand Manan to Cape Cod the herring spawns wherever suitable bottom is found.

It will be noticed that with the exception of the Tynmouth Creek locality, and perhaps one or two others likewise of little importance, the summer and fall schools spawn to the westward of the mouth of the Bay of Fundy, and the spring schools uniformly spawn entirely east of this line. A thorough study of the physical conditions and climatic history of the North Atlantic coast would no doubt throw light on the reasons for this. It will be seen also that the date of beginning of the reproductive act gradually recedes as we pass westward along the coast. At Wood Island the season commences 2½ months later than at Grand Manan, though the fish are still spawning in abundance at the latter place at the time the season reaches its maximum at the former. Between the commencement of spawning at Grand Manan and its cessation at Block Island, there is a term of between four and five months, from July to the end of November or the beginning of December.

A comparison of the spawning seasons upon the two shores of the Atlantic is of interest. Huxley has stated that in Scotland no full herring are found in June or December, and that they are rare in May and early in July, as well as late in November and in the beginning of January. A spring spawning takes place in the latter part of January, and continues through February, March, and April, and an autumn spawning late in July is continued in August, September, October, and the early part of November. February and March are the great months of spring and August and September of autumn spawning.

On the coast of Norway the spawning season is about the same as in Scotland, but on the coast of Bohuslän the bulk of the spring spawning is in April, though to some extent it occurs also in March and May, thus more nearly corresponding to the season in the Bay of Fundy. The isothermal lines extend parallel to the coast of Norway and thence across the North Sea to Scotland, which means that the waters on the two coasts have practically the same temperature, while the spring fisheries of Bohuslän are no doubt influenced by the discharge of cold water from the Baltic, which is frozen during the winter. The later occurrence of our spring fisheries is probably connected with the lower temperature of the waters on our coast in early spring, owing to the influence of the Arctic current flowing southward between the coast and the Gulf Stream. The effect of this is to produce a sharp southerly deflection of both summer and winter isothermal lines, so that they reach the coast in a much lower latitude on the western than on the eastern shore of the Atlantic.

There are no records available which will show the temperatures upon the spring spawning-grounds, but it is probable that owing to the strong tidal circulation the temperature in Oak Bay does not differ much from that at Eastport, where ten years' observation shows that a mean bottom temperature of 40° F. is not reached before the middle of May. The minimum temperature for the year, about 31° F., was observed during March, the mean for that month being about 33.4° F. After March the temperature gradually rises until it reaches the maximum of 52.8° F. in September, the mean of ten years observation being 50.4° F.

The following table gives a record of the mean temperatures of the air and water at Eastport, Me., for ten-day periods from 1878 to 1887, inclusive. The observations were made by the Signal Service, United States Army, daily between the hours of 1 p. m. and 3 p. m.

Date.	Air.	Surface.	Bottom—depth 2 to 32 feet.	Date.	Air.	Surface.	Bottom—depth 2 to 32 feet.
1878–1887.	° F.	° F.	° F.	1878–1887.	° F.	° F.	° F.
Jan. 10	23.52	38.03	38.02	July 9	66.56	46.85	45.87
20	23.13	36.69	36.83	19	66.24	47.93	46.92
30	22.99	36.04	35.89	29	66.47	48.71	47.75
Feb. 9	23.28	34.57	34.40	Aug. 8	67.86	49.71	48.65
19	27.09	34.20	34.01	18	66.21	50.53	49.53
Mar. 1	26.52	33.47	33.34	28	65.25	50.97	50.12
11	28.71	33.39	33.12	Sept. 7	64.08	51.25	50.34
21	32.24	33.72	33.32	17	60.90	51.39	50.63
31	34.71	34.37	33.82	27	58.14	51.11	50.33
Apr. 10	38.04	35.28	34.58	Oct. 7	55.74	51.01	50.36
20	43.47	36.49	35.67	17	53.21	50.49	49.88
30	47.25	37.96	37.04	27	48.76	49.45	48.96
May 10	49.81	38.69	37.93	Nov. 6	44.28	48.23	47.80
20	51.92	40.03	39.31	16	42.68	46.99	46.59
30	54.38	41.01	40.19	26	36.10	45.52	45.35
June 9	57.42	42.40	41.34	Dec. 6	33.43	43.89	43.69
19	59.47	43.86	43.05	16	31.31	42.43	42.18
29	63.86	45.35	44.42	31	24.87	39.88	39.77

The extremes in the water temperatures during the ten years did not differ in any given ten-day period to a greater extent than 5°, and the difference was generally less than 3°.

Reference to page 406 will show that the spring spawning occurs in Oak Bay during a period when the surface temperature at Eastport ranges between $36\frac{1}{2}°$ F. and 42° F. It takes place, therefore, on a rising temperature. The surface and bottom temperatures keep pace with one another during their rise and fall, and seldom differ by more than 1° or 2° in the depth attainable from the wharves at Eastport, which varied from 2 to 30 feet.

An examination of the temperature of the water at the spawning season of the fall herrings at various places on the coast of the United States shows some interesting facts. Early in the investigation it was noticed that the spawning time receded in date westward and southward along the coast, and that the temperature of the water at any given time became progressively higher in the same directions. In most cases the temperature observations were not made immediately upon the spawning-grounds, but many of the stations were sufficiently near to make probable but a very slight error in regarding the temperatures as identical.

In order to examine more closely into the relations existing between the temperature of the water and the spawning time, a chart was prepared showing the mean temperature of five years at a number of stations during the first week of each of the last six months of the year, the temperatures of all stations at each period being connected by lines, as shown in plate 61. From the data before given the spawning season at each place was indicated by vertical lines connecting its approximate or average date of beginning and ending and at the same time graphically indicating the temperatures prevailing at the surface of the water during the herring's term of reproductive activity. By an inspection of the chart it will be seen at once that there is an apparently close relation between the surface temperature and the time of spawning. The real relationship is, of course, with the bottom temperatures in which the actual spawning takes place, but as these temperatures were available in but one or two places, and as the surface and bottom readings rise and fall *pari passu*, or nearly so, it was considered that the general effect of the temperature may be shown as well by the one series as by the other. A source of possible error arises from the fact that the readings were not made actually upon the spawning-grounds, and are reported from independent observations. The stations at which the meteorological observations were made, however, are so close to the observed spawning-grounds that there is probably but a small percentage of error from this source, and the bulk of the spawning at the place named may safely be considered as accomplished between the dates and temperatures indicated.

As shown in the chart, the spawning of the summer and fall schools of herring takes place at a temperature between 47° F. and 57° F., independently of the time at which this temperature occurs after July 1. West of Matinicus Island the temperature is within this range in spring as well as in fall, but so far as known no herring spawn in that

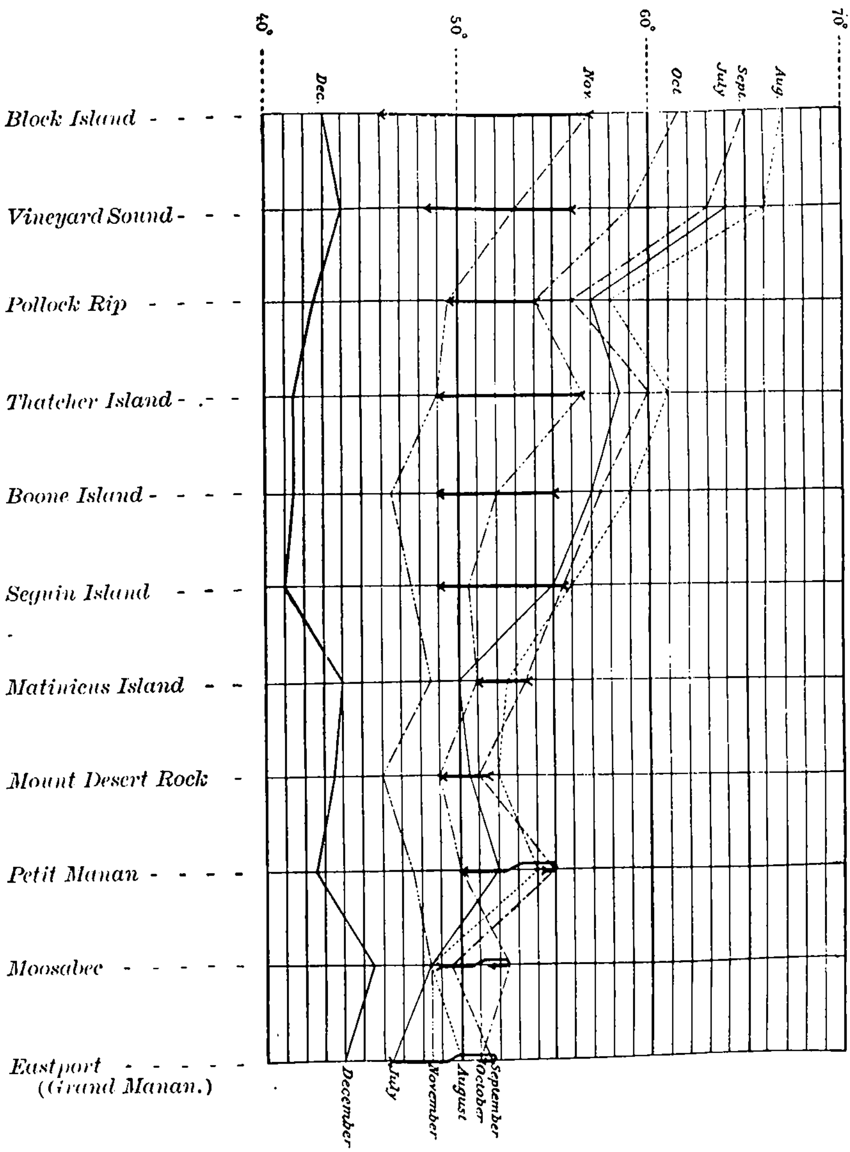


CHART SHOWING THE SEASONS AND TEMPERATURES OF THE SPAWNING OF HERRING.

region during the former season, and this has led to the generalization that the herring spawns on a falling temperature. The chart shows that the statement is true so far as concerns the coast west of Mount Desert Rock, this fact being indicated graphically on the chart by the direction in which the arrow points. At Petit Manan, the next station east of Mount Desert Rock, the herrings begin to spawn about August 15 and continue on a rising temperature until September 1, after which they spawn on a falling thermometer. At Moosabec a larger proportion of the spawning takes place while the temperature is rising, and at Grand Manan, assuming the surface temperatures to be approximately those of Eastport, almost the entire spawning period occurs while the thermometer is rising.

It may be assumed from the facts shown that the fall schools of herring mature only in water approximately of a temperature between 47° F. and 57° F., or if we consider the bottom temperatures, the limits would be between about 45° F. and 55° F. But this range is reached to the westward in both spring and fall, and the interesting question arises, if the herrings of eastern Maine mature when the thermometer reaches 47° and spawn upon a rising temperature, why do not those farther west spawn in spring instead of waiting until late fall or even winter?

The answer to this question will require much more study than has yet been devoted to it. It may be that the wide range in the annual temperature at the western limits of the herrings' spawning range and the comparatively rapid thermometric changes which take place there may produce an effect different from that produced by the more equable temperatures of the Bay of Fundy. At Matinicus Island, however, the temperatures have no wider range between July 1 and November than occurs at Eastport, yet it appears that the spawning of the herring does not begin before September 1, and takes place entirely on a falling temperature. These facts are mentioned here merely to call attention to the need of further inquiry.

In the Bay of Fundy the herring spawn in water from a few fathoms to 30 fathoms in depth, and further investigation would no doubt prove that the eggs are deposited in still deeper water offshore, as in parts of Europe, where, according to Ljungman, they are occasionally hatched at a depth of from 60 to 100 fathoms.

In the Schlei, in Schleswig, the herring spawns in water but a few feet deep, and in the Gulf of St. Lawrence, as is well known, the eggs are deposited in places so shoal that great quantities are sometimes carried ashore by the waves, Perley citing at least one instance of their being used as dressing for the soil. In Oak Bay the water is shoal, in most parts less than 3 fathoms, but in no part of the region here immediately under discussion did I learn of spawn being cast up or destroyed by the waves.

Upon our coasts, so far as known, the herring does not run into fresh, or even brackish, water to spawn. On all of the spawning-grounds the water is of full oceanic salinity—in the Bay of Fundy being about 1.026—but in the Schlei they are found spawning in water of a density of but 1.0076, which is practically fresh.

In the vicinity of Passamaquody Bay the two sexes of the herring appear to be represented in approximately equal numbers, although observations indicate a slight predominance of the females. In July, August, and September, 1893, record was made of the sexes of 929 specimens selected at random from fish caught at various times and places, with the result shown in the following table:

Condition.	Male.	Fem.
Unripe	288	307
Nearly ripe, ripe, and spent	163	171
Total	451	478

This indicates an average of 106 females to each 100 males, and although the examination of a larger series would doubtless change the result somewhat, this proportion can be asserted with reasonable assurance to be within a small percentage of the truth. The examination of a larger number of herring by Scotch fishery officers gave an average of 99 females to 100 males. The data in the foregoing table must not be adduced to show the proportions of ripe and unripe fish during the season mentioned, as that would depend entirely upon the time and place of capture. Most of the unripe fish examined were below the minimum size of sexual maturity, and were taken far from the spawning-grounds.

During the act of reproduction, as I witnessed it at Cross Island and Machias Bay, the fish were darting rapidly about, and those who have opportunity to see the fish spawning in more shallow waters, where observation is more favorable, state that both males and females are in constant motion, rubbing against one another and upon the bottom, apparently by pressure aiding in the discharge of the eggs and milt.

At the time of extrusion of the eggs they are covered with a sticky mucus which speedily hardens upon contact with the water and causes firm adhesion to the bottom upon which they fall. They are sometimes spread out into thin layers, or they may be in small irregular lumps or masses, according to the circumstances attending their discharge. They measure about 0.05 inch in diameter. In a ripe female the ovaries constitute about one-fifth of the total weight, and according to the investigations of Dr. Wemyss Fulton, the total number of ova ripening annually varies from 21,000 to 47,000, the average being about 31,000.

All the individuals of a school do not ripen at the same time, fish with roes and milts far from mature being associated with those in which the products are loose and free in the glands, but it was observed in 1893 that the proportion of ripe fish in a school increased as the spawning-grounds were approached. For instance, at Campobello, in

September, very few ripe fish were seen; at Northern Head, Grand Manan, about half were ripe a few days later, while upon the spawning-grounds at Machias Bay nearly all were ripe.

It would seem that the more matured individuals in a school, when approaching ripeness, make for the spawning-grounds and carry with them a portion of those less advanced. From time to time during the journey some of these drop off from the school, probably in pursuit of food which proves less attractive to the riper individuals, and thus by the time the spawning-ground is reached few but the riper ones are left. For a time before the discharge of the genital products little or no food is taken, but at the Northern Head of Grand Manan the more immature fish in the schools were found to be still feeding.

The fishermen assume that the herrings return to spawn upon the same grounds upon which they were hatched, but this statement is difficult to authenticate. If the aforementioned account of the origin of certain herring fisheries near the Gut of Canso be true (which I doubt), this tends to confirm the theory, as does also the continued annual spawning in Oak Bay, when apparently equally favorable places in the vicinity are neglected. Upon the other hand, it is well known that spawn herrings will sometimes disappear from their accustomed grounds for a year or a period of years and will then return as abundant as ever. Upon the whole, the evidence upon this point is entirely insufficient, and the fisherman's theory seems somewhat doubtful and but a corollary of a general hypothesis based upon the data relating to the shad, salmon, and other anadromous species.

It is not regarded as at all probable that an individual herring will spawn more than once each year, but it is reasonably certain that it spawns annually for a period of years unless its career is cut short through the agency of the numerous perils which beset it. In all ripe herring of whatever size there may be found, together with the ripe eggs, a large number of very minute ones which are destined in the ordinary course of nature to undergo the ripening process at some future spawning period. These immature eggs exceed the ripe ones in number, though the latter individually and collectively far exceed them in bulk. They are barely visible to the naked eye, but they can be readily detected with a simple lens as minute particles adherent to the walls of the ovary. Through the distension of the ovary by the ripe eggs they appear rather scattered, but in the unripe individual, whether prior to the first spawning or sometime subsequent to the discharge of the ripe ova, they appear densely crowded. The spent ovary is flabby, the vessels are usually gorged with blood, and the finger may be easily run into the cavity of the organ as into the finger of a glove, but in a short time, owing to the contraction of the walls, the organ again becomes firm and apparently solid. Herrings with freshly spent ovaries appear to immediately move off into deeper water, as it was found that very few in that condition were taken in the fisheries.

The early stages in the maturation of the genital glands appear to progress slowly. There is a gradual increase in the size of the organs, and in the case of the ovaries this is accompanied by a great increase in the size of the individual eggs. After they have reached full or nearly full size there is a period of quiescence, followed by a rapid completion of the final processes. The testes become soft and the milt will flow when they are ruptured, while the eggs become clear and loose in the cavity of the ovary. The clearing of the eggs does not take place throughout the whole ovary at once, but usually, although not always, begins at the posterior end and along the outer side next to the body wall; it then progresses forward and inward until apparently the whole ovary is involved, the last stages being the loosening of the eggs in the follicles and their dropping into the lumen of the organ preceding their discharge from the fish.

The rapid development of the genital organs, which, as before stated, when ripe constitute about one-fifth of the total weight of the individual, makes a heavy drain upon the substance and energy of the fish. Any fat which may have been stored up prior to this period tends to disappear, its substance furnishing, in part, the material and energy required in the maturation of the ova and spermatozoa. This calling upon the reserve, and the additional circumstance that the ripe fish take but little or no food, causes the spent herring to be poor and lean, but after spawning they rapidly fatten if an abundant food supply be available.

It appears that herring 8 inches in length are commonly found with ripe spawn and milt upon the coast of Norway and Sweden, but there is a wide difference of opinion concerning the age of such fish, the estimates of different naturalists varying from one to six years. Ljungman estimates their age at three years; Huxley thought the age at which spawning begins to be not more than sixteen to eighteen months, while G. O. Sars thinks that the minimum in most cases is five or six years.

From a large number of herring examined at Eastport in 1893 and 1895, I am led to conclude that ripe fish under 9½ inches, measured from tip of snout to fork of tail, are very rare, and that usually they do not mature genital products before they are 10 or 10½ inches long, while most of the spawn fish observed at Grand Manan and Machias, as well as those brought from Moosabec to Eastport in 1893 and 1895, were about 12 or 13 inches long. These statements apply to the autumn spawning fish only, as no opportunity was had of examining the fish of the spring school, although the fishermen state that the latter are good-sized fish. I believe that the first spawning takes place when the fish is between two and three years of age.

The period of incubation of the eggs varies according to the temperature, cold water retarding and warmer accelerating the period required for the development of the embryo. From experiments made by the United States Fish Commission, it appears that upon the coast of Massachusetts from ten to twelve days elapse between fertilization and the escape of the larva from the egg, and this is also about the time required upon the eastern portion of the coast of Maine, where the water temperature is about 50° F. during August and September.

As showing the effect of temperature upon the rate of development the experiments of Dr. Meyer may be cited. He found that with a temperature of 38.3° F. the development of eggs takes 40 days, with a temperature of 44.6° to 46.4° F. about 15 days, and with a temperature of 50° to 51.8° about 11 days, and that the influence of temperature upon the eggs of the spring herring does not differ from its influence on the autumn herring.

As soon as the yolk-sac has disappeared, which is in two or three days, the young begin to feed, according to Meyer, their food consisting of copepods and the embryos of gastropods and lamellibranchs. No opportunity was had at Eastport of examining the food of such young fish, but individuals from 2½ to 3 inches long and larger were found gorged with copepods, as were also young alewives, an allied species, 2 inches long. From the abundance of copepods in the neighborhood of the Bay of Fundy it is evident that the newly hatched herrings have available an abundant and suitable food supply.

The young herring grow rapidly, as may be seen from the following table of sizes of herring caught in the Schlei, in Schleswig. It is extracted from Meyer's paper, and the ages of the fish are approximately correct:

Age.	Length in inches.
1 month	0.68 to 0.72
2 months	1.36 1.44
3 months	1.80 2.00
4 months	2.20 2.44
5 months	2.60 2.88

The growth of the herring, as of other fish, is largely dependent upon the abundance of the food supply, and it is unsafe to make comparisons between regions where the biological conditions may be diverse, but a comparison may be made of the several sizes of the brit in the vicinity of Eastport.

On August 2, 1893, large numbers of herring 2 to 2½ inches long were seen in West Quoddy Bay. It is out of the question that these fish could have been hatched from the earlier eggs of the school spawning this year at Grand Manan, and it is equally improbable that they could have grown so little if hatched during the preceding fall, even as late as November. We must suppose, then, that they were derived from eggs deposited in Oak Bay, the nearest spring spawning-ground. The bulk of the herring there appear to spawn in May, and placing the time of hatching of the present specimens at the beginning of that month, we would have three months as an estimate of their age, certainly not any older than this if my information concerning the spring spawning is to be credited. In the latter part of September of the same year herring about 3 inches long were observed at St. Andrews, and in the middle of September, 1895, large numbers of about this size were seen playing at the surface in the St. Croix River between Deer Island and the "Perry Shore" of Maine, these also being, with little doubt, fish hatched during the preceding May. Comparing these two sizes with Meyer's table, it will be seen that they are equal to the Schlei herring a month older, and this is perhaps not surprising when we consider the great richness of the food supply of the Passamaquoddy district.

On August 2, 1893, the same day upon which the 2-inch herring were taken, large numbers of 5½-inch herring were caught in the weirs at Fry Island, New Brunswick, and in 6 hogsheads of such fish there were but two or three large ones. It seems most reasonable to regard these as fish hatched during the preceding fall, and as they could not have been spawned later than October (about the last of the spawning season in eastern Maine and New Brunswick) they were from 9 to 10 months old at the least.

A few days later (August 8 *et seq.*) large quantities from 6 to 7 inches long—a few of the largest being almost 7½ inches—were taken at various places near L'Etang. Two views of these fish present themselves—either that they were hatched from the earlier eggs of the summer and fall of 1892, or from spring eggs of that year. In consideration of the larger number caught at various places about this time, and of the limited extent of the spring spawning school at Oak Bay, it is the more probable that they are the progeny of the large fall schools, and when compared with the 5½-inch herring before mentioned, it may be fair to assume that they were hatched from the earlier eggs, say in July or August, and are, consequently, 12 to 13 months old. A few herring, 8 to 8½ inches long, with very immature ovaries, were taken with these, and may have been individuals of the spring spawning of 1892, i. e., 15 months old; they could hardly have been as old as two years.

As before stated, the smallest ripe herring seen were 9½ to 10 inches long, and there were few of these relatively to the ripe fish examined. If the ages already assigned are correct, these must be at least 2 years old, and can hardly be more than 3 years. It will be noticed that I assume an increase in length of but 1½ inches in eight or nine months, but it must be remembered that the rate of growth in fish is usually less rapid as they approach maturity, and that the maturation of the genital products makes such a heavy draught upon the nutrition that it in all probability considerably retards the rate of growth.

The vicinity of Eastport presents difficulties in the study of the rate of growth, owing to the extension of active spawning over a period of four months in summer and fall, which with the addition of the spring season makes it possible for fish hatched during the same year to differ six months in age. A great variety of sizes may be taken at almost any time during spring and fall, and standards are difficult to select. The matter was given considerable attention, however, and large numbers of specimens were measured, and while the reasoning just given partakes largely of speculation, the conclusions are believed to be not far from the truth.

ALLEGED DECREASE.

The complaint of the decrease of the herring in the waters of Passamaquoddy Bay and vicinity is not a new one. In 1850, when Mr. Perley wrote his report* upon these fisheries, the fishermen were already much concerned about this species, as will be seen from the following quotations:

The smaller herrings, such as are generally cured by smoking, were formerly very abundant on the shores of Deer Island. The fishermen of Campobello said that the people of Deer Island had broken up the schools and driven the fish away by the excessive use of small-mesh nets. (Op. cit., p. 115.)

Mr. Chaffey (Indian Island) said that herrings were not so abundant now as twenty years ago; of late years the quantity has fallen off greatly and they are now much smaller. He did not consider the weirs injurious to the fishery, but thought that the mischief was done at Grand Manan. When Mr. Chaffey first went to Indian Island brit were very abundant; they]averaged about 5 inches in length. These little fish are exceedingly valuable as food for larger fish, but from some unaccountable cause they have altogether disappeared, not a single specimen having been seen for ten years. * * * This locality (Campobello) was revisited in the latter part of October. Mr. Patch then stated that the herring season was over and that the quantity in the weirs was only about half the usual or average catch. The quality of the fish was good; not many small fish had been caught—he had only thrown away 3 barrels, while his whole catch amounted to 3,000 boxes. (Op. cit., p. 116.)

In 1880, when the volumes upon the Fishery Industries of the United States were being prepared, it seems that the same complaints were heard. We find on pages 505–506 of section V, vol. I, the following:

Are the sardine herring being exterminated? For a number of years prior to the establishment of sardine canneries the weir fishery was less important than formerly. This was by some thought to be due to the scarcity of fish, but it seems more probable that it was owing to the low price both of oil and smoked herring, which made the prosecution of the fishery unprofitable. Many fishermen claim that the herring are rapidly decreasing, and they cite the large quantities taken in former times and the present small catches at Lubec as proving their theory. The fish are undoubtedly less abundant in the vicinity of Lubec and in the waters of Cobscook Bay than formerly; but this seems to be explained by the peculiar method of fishing at that place.

Though the weir fishery had been extensively prosecuted for many years, the catch had not perceptibly diminished up to 1865, when the building of deep-water weirs, which extended so far out into the channel as to nearly meet from the opposite shores, effectually shut out the herring from their usual entrance to Cobscook Bay, which seems to have been a spawning-ground. The herring, thus practically debarred from this entrance, seem to have moved a few miles farther east, and are now more abundant in the vicinity of Deer Isle. In other sections there is no sufficient evidence to show any permanent decrease, though the catch of one year, for various reasons, may vary considerably from that of the following or preceding one.

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*Perley, M. H., Report upon the Fisheries of the Bay of Fundy, Fredericton, New Brunswick, 1851.

In 1893 the opinions of many of the fishermen were practically the same as set forth in the foregoing, but it was noticeable that such views were less prevalent in 1895.

A fisherman at Perry, Me., said:

I do not believe that they are as abundant now as they were fifteen to twenty years ago, but even now they are by no means scarce. That the fish have become much less abundant on this shore is certain.

A fisherman at Campobello, one of the oldest in the region, says:

The herring in this region have been decreasing for the past sixty years, and I attribute it to the many weirs catching young fish.

Another man at Campobello, who has been fishing sixty years, states his views as follows:

I think that the herring have decreased. At one time every cove and creek was full of them. Mr. Treat used to catch a great many such as we get now, and I have known him to get 100 hogsheads a number of times on a single haul.

At Eastport, a man who has had wide experience in the fisheries and who, as captain of a fishing tug, has of late had unusual opportunities for observations, very emphatically contended that there had been a heavy decrease in the herring. He says that the weirs do not average as large catches as formerly, and that the increase in the total catch is due to the relatively greater increase in the number of weirs and to their larger size.

The owner of a weir at Kendall Head says:

My weir here at one time had the reputation of being one of the steadiest and best, but it is now an utter failure. I own an interest in four weirs on the west side of Deer Island, New Brunswick, and I have noticed no decrease there in ten years. They have about held their own. The weir at Indian Point, New Brunswick, however, used to catch lots of fish, but it failed, utterly, five years ago.

Similar opinions were expressed by other weir fishermen at various places, and the net fishermen at Grand Manan stated the catch of herring was growing smaller, owing to the young herring being caught up in the weirs.

On the contrary, many men held either that there had been an actual increase or that the decrease has been very slight. This opinion, which, of course, excepts the winter herring, was especially prevalent in 1895, a fact, no doubt, due to the heavy catches which were being made at the time the investigation was being conducted.

A large packer at Eastport says:

More herring have been caught here in the last few years than in any similar period preceding. I doubt, however, if there has been an actual increase in the fish; there are probably fewer than formerly, but the decrease has not been great. The greater catch is due to the increase in fishermen and weirs.

A fisherman at Robbinston thinks that the weirs on the American side of St. Croix River have this year (1895) done as well as ever. Herring were caught steadily between Robbinston and Gleason Cove from June 15 to the latter part of September.

In the opinion of the oldest weir fishermen at Bocabec, New Brunswick, the number of herring in the region has actually increased, notwithstanding the increase in apparatus.

At St. George, New Brunswick, it was said that there were more herring at L'Etang and vicinity than ever before. As far as memory runs, there have been years of scarcity and years of plenty, but there has surely been no decrease.

A boatman said:

> At Deer Island (east side) one weir is said to have stocked $2,500 to $3,000 this season (1895), the fish being taken early, when better prices prevailed. Most of the fishermen have made little money this season, owing to the low prices due to the great supply. There appear to be more fish this year and last than ever before, and this statement is made with a full recognition of the effects of a greater number of weirs.

At Dark Harbor it was stated that there was no great decrease in the herring, nor was any expected so long as the extensive spawning-grounds around the island were protected.

At Lubec it was stated that the weirs in West Quoddy Bay did better in 1893 and 1894 than for many years. More herring were taken in the Quoddy region last year than ever before. In some places the fishery has failed, and in others it has improved.

An octogenarian fisherman near Pembroke says:

> We did not notice any falling off in the catch here after the sardine factories were established, nor do I think that there has been any material decrease in the number of herrings in these waters. I have not caught so many this year, but others have done as well as ever, and I never knew of there being more herring than there are this year. Last year (1894) there were certainly more herring taken into Eastport than have been seen there before.

Another fisherman in the same region says:

> The catch in Pemmamaquan River fluctuates very much. For instance, my weir in 1893 caught but one hogshead during the entire season, and last year (1894) until September it did practically nothing. After that date it fished very well indeed, and there was no lack of fish until the end of the season, and the other weirs in the vicinity also did very well. This year (1895) is the best season which I have ever had, and although others have not done so well as I, the catch is, nevertheless, a very good one.

A variety of opinions have been cited from divers localities in the region under consideration, and it is now necessary to consider the question from an historical and rational standpoint. It is to be understood that the discussion relates solely to the weir fisheries; the winter and Quoddy River herring fisheries have been elsewhere treated of.

It will be most convenient to first consider the matter locally, beginning at West Quoddy Bay and taking up each locality seriatim.

Prior to 1868 great numbers of herring were caught in West Quoddy Bay and Lubec Narrows, but for some reason the fishery failed about that time and the majority of the weirs fell into disuse. In 1865 the herring appeared in West Quoddy Bay about July 15, the usual time, and although the run was very heavy, it lasted but six weeks, the fishing ceasing about the latter part of August. In 1866 the run began June 22, and, being unexpected, the weirs were not ready for use, and many of the fish were lost. At that time there were but two or three weirs in Lubec Narrows, but in 1867 the number was increased to 6 or 8. From 1868 to 1893 the West Quoddy Bay weirs were an almost total failure, but in the latter year the herring again appeared there. They arrived October 16 and were taken nearly every day until November 29, and after that irregularly until December 13. At this time there were 5 weirs above the beacon. In 1894 this experience was duplicated with striking exactness, the fish arriving October 15 and remaining steadily until November 27. In August, however, two small lots were caught. The fish were rather larger than in 1893.

In 1895 up to the close of the investigation, about September 25, no herring were taken with the exception of a few small lots in August, these being similar to the run which appeared simultaneously at Herring Cove. A letter from Lubec, however, states that the herring came in considerable numbers early in October, but as there was little demand, owing to labor troubles, very few were taken from the weirs. It was supposed that the run was about equal to that of the preceding year.

The same informant, in a letter dated August 31, 1896, says:

> The catch on the American side, in the vicinity of Lubec, this year is beyond estimate. Boat loads may be dipped on the shores, in the docks, and in the weirs without the aid of light or seines. The oldest inhabitant never saw anything like it. In Johnson Bay the water is literally alive with herring. Certainly one can say without exaggeration that there are more fish in this immediate vicinity than there has been for the last two decades, put them all together.

Treat Island, about 1 mile inside of Lubec Narrows, was at one time the best fishing location in Passamaquoddy, and I am informed that $25,000 was vainly offered for this property during the height of its prosperity. Catches of 100 hogsheads on a single tide are said to have been not infrequent. The most trustworthy information that I have been able to obtain fixes the date of the failure of this weir at about the year 1870, and it has taken practically no fish since—i. e., to September 20, 1895. It was abandoned for a number of years, but has recently been placed in repair.

In Johnson Bay, the lower part of Cobscook Bay, the weirs were at one time of great value, but they now catch but little. The weir at Shackford Head was a very profitable one, but since 1885 it has failed to such an extent that it has not been kept in repair, and in 1895 was practically wrecked and no effort was made to fish it up to the latter part of September. On the contrary, in the lower portion of Pemmamaquan River, which is practically an arm of Cobscook Bay, there is no complaint. There were a few small "half-tide" weirs prior to about 1882, but there are now about 17 large weirs here and in East Bay, adjoining. There have been fluctuations in the catch from year to year, but there have been no long-continued periods of failure, such as are predicated of the more immediate vicinity of Eastport. In 1894 herring were abundant, and in 1895 all the upper arms of Cobscook Bay were teeming with them.

On the east side of Moose Island (Eastport) and on the main shore as far north as Gleason Cove the weirs have failed more or less completely, and many of them have been abandoned. Many years ago, at least fifty, a "half-tide" weir was built north of Harris Head. It was a small, cheap structure, but it took great quantities of herring. It sometimes caught more than could be used, and it was then necessary to knock down a section so as to liberate some of the fish and prevent them dying in the weir. This was afterwards replaced by a more elaborate structure, which, like its predecessor, fished regularly for many years, its owner stating that for fifteen years it averaged 300 hogsheads per annum, the catch ranging from 250 to 350 hogsheads. According to the same authority, about three years after the factories were established at Eastport it began to fail, and was soon abandoned and has not been rebuilt. South of Harris Head and on the south side of Kendall Head the experience was the same. North of Kendall Head the weir is said to have failed a little later. In 1894 there were two weirs at this point, but in 1895 one of them had been abandoned. The other had caught nothing up to September 20.

There have been two weirs in Gleason Cove since about 1882 or 1883, and until 1888 they did very well. In 1887 the two caught about 400 hogsheads, the best that they have ever done. Prior to that they caught from 150 to 200 hogsheads per annum. In 1888 there was a sudden dropping off. Since then they have barely paid expenses, and in 1894 the catch was practically nothing. In 1895 nothing was taken up to September 1. The herring usually came here about August 1, and lasted to the end of the season.

About a mile north of Gleason Cove a weir had taken about 100 hogsheads in 1895 up to the latter part of August, and I was informed that from 1,500 to 2,000 hogsheads of herring had been caught in 9 weirs between Gleason Cove and Robbinston prior to September 20, 1895, which catch, my informant claimed, was larger than any during the last decade. It was stated that there were more weirs on this shore in 1885 than at present, but if this be a fact they must have been built between 1880 and 1885. In 1880 there were about as many as in 1895.

From the foregoing it would appear that in 1894 and 1895 there were less herring than formerly on the American shore at Treat Island, in Johnson Bay, the lower waters of Cobscook Bay, and from the mouth of Cobscook Bay north to Gleason Cove. In all other places there was either no decrease or but a very slight one. In 1896 the fish were everywhere abundant, and large schools frequented all of the waters about Eastport and Lubec.

On the Canadian side, beginning with St. Andrew Bay and its several arms, we find almost unanimous testimony to the abundance of the herring during the past few years. On August 29, 1895, the fishermen at Chamcook stated that their weirs had been full of herring for two weeks or more, but they had not been seined, owing to the absence of transportation, the boats getting their fares in more accessible places. The weirs around the entire shore of St. Andrews Bay had been fishing well and steadily wherever they had received regular attention, and at Northern Harbor, on Deer Island, the weir had been catching from 18 to 20 hogsheads of "oils" daily for some time past. After September 1, however, the weirs in St. Andrews Bay caught but little.

There were more fish in these waters in 1894 and 1895 than for many years, notwithstanding the great increase in the amount of apparatus. In 1876 there was but one weir inside of a line drawn from the head of Letite Passage to Clam Cove. In 1878, as nearly as can be learned, there were 7 in the district so defined, and in 1893 this number had increased to about 33.

In 1895 herring appeared at L'Etang and vicinity about July 20, and they continued in abundance during August and September, in the latter month great quantities being taken in most of the weirs. There were many more than could be utilized for food purposes and many were used for fertilizer. They sold for a trifle, and one instance came to my knowledge where 19 hogsheads were sold for $5, or at the rate of 26 cents per hogshead. In other cases they were delivered on the farmer's shore at 75 cents per hogshead. During a large portion of the season many of the weirs, both here and in St. Andrews Bay, were hardly seined at all, although they contained large numbers of herring of marketable size. There was an overplus of fish everywhere and the boats naturally secured their fares at the most convenient places. Few of the fishermen made much money, but it was because the fish were too abundant rather than too few.

At Deer Island and the West Isles the herring as a rule come earlier, usually in June and July, the latter month and August being the best for the fishermen. Here also they were exceedingly abundant, but as there were fewer fish elsewhere at that time some of the fishermen had a profitable season, and one weir is said to have stocked between $2,500 and $3,000. There were also some herring at Deer Island about the middle of September, and one weir took 100 hogsheads on two runs of tide. In 1894 they were also extremely abundant in the vicinity of Deer Island, and considerable quantities of smoking herring were caught, although but comparatively few were taken in 1895.

The following history of weirs 63, 64, 65, and 66, of Dr. B. L. Hardin's chart of 1893, was secured:

No. 66 is a small weir, opposite Kendall Head. In 1886 it caught 40 hogsheads in about three weeks, and since then has averaged 15 to 25 hogsheads per year.

No. 65 got 100 hogsheads in 1893, but in 1894 it did not do so well, getting only 40 hogsheads.

No. 64 got 100 hogsheads in 1894, and in 1895, to about August 20, it caught 40 hogsheads. In 1894 it caught 60 and 40 hogsheads on two tides, but in addition about 60 hogsheads were released, so that the actual catch was 160.

No. 63 got 65 hogsheads in 1894, but in 1895 had caught nothing up to the beginning of September. These weirs, which are on the west side of the island, are all relatively small, owing to the rapid deepening of the water, which prevents their extension far from shore.

On the east side the weirs appear to do much better. Leonard's weir, to August 15, 1895, had sold about 200 hogsheads, and it was estimated that there were shut in at that time about 50 hogsheads, for which no market could be obtained.

At Welch Pool and Herring Cove, on Campobello it was stated by a fisherman of 60 years' experience that—

We catch nearly as many here as we formerly did, but the season has grown shorter. Up to about 1883 we used to catch them very early; when our weirs were not destroyed by the ice we have got them in March, and about twenty years ago we made a good haul about February 15, when we broke the thin surface ice in the pound, so that we could run our seine. These were smaller fish than the regular winter run, being of a size suitable for smoking. The fish which we formerly got in March do not now arrive until July. This change began about 1882 or 1883, and has been going on gradually ever since. I think that on the whole the herring have decreased.

Another fisherman, who began fishing seventy years ago, says that herring in this region have been decreasing for the past sixty years.

During 1895 considerable quantities of herring were taken at Harbor de Lute throughout the entire month of August, and it was said that a similar run occurred during 1894. They were of a size suitable for smoking, and similar fish were caught by "drifting" at Deer Island at about the same time. In 1895 there appeared to be fewer sardine herring at Campobello than at other places in the vicinity.

At Grand Manan the season of 1895, up to September 25, the time of my departure from Eastport, was a poor one, but 1893 and 1894 were both unusually good. In 1895 the weirs at Seal Cove, High Duck Island, and other places caught very little. At Seal Cove they usually catch considerable quantities of "medium stringing" herring, which were absent in 1895. Mr. McLaughlin, at Southern Head, says (1893):

The herring are as abundant as ever, and they still appear in enormous shoals in the Bay of Fundy. This conservation of the fishery, in spite of destructive methods, is largely due to the opportunities for spawning enjoyed by the fish during the close season at Southern Head. The fish, however, keep offshore more than formerly and I attribute this to the pollution of the shore waters by lobster pots, trawls, etc.

Mr. Simeon Cheney says (1893):

The herring are certainly as plentiful as ever in the open waters, but they are kept off shore by pollution of the water.

Captain Pettes, whose observations on the fisheries of Grand Manan extend back many years, states that of late he has seen as large bodies of herring as ever in the Bay of Fundy.

Others added testimony of a similar character, but the gill-net fishermen at Whale Cove stated that there had been a decrease, owing, as they suppose, to the pounds catching young fish.

During my visit, early in September, 1893, there was a very fair run of net herring, but they did not occur in 1895.

On the Canadian side, judging from both observation and testimony, there appears to have been no decrease in herring since the establishment of sardine factories, with the exception of a portion of Campobello, where perhaps a slight decrease may be noted.

Taking into consideration the entire Passamaquoddy region, more herring were taken in 1894 and 1895 than ever before. This was especially the case with sardine-herring, many more being caught than could be utilized by the factories, and this, too, notwithstanding the fact that the pack was unprecedented. In consequence of this, many of the weirs were not seined for several weeks, although containing an abundance of herring.

It may be objected, however, that this is due to a great increase in the number of weirs; that an unwarranted number have been constructed, and that by virtue of this increase there is still an overplus in the herring supply, despite an actual decrease in the abundance of that species. In other words, that there is an increase in the total catch, while at the same time the average catch per weir has decreased. This objection has been urged with some plausibility, but an examination of the records shows it to be unwarranted. As compared with 1879, the total catch in 1895 was proportionately greater than the increase in the number of weirs. According to the estimates made in "The Fishery Industries of the United States," the weirs on Deer Island averaged 100 hogsheads per annum in 1879 and 1880; those on the United States shore above Lubec caught 75 hogsheads each, while at Lubec the average was between 60 and 65 hogsheads in the years mentioned. The estimates are affirmed to include the total catch, and presumably take into account not only the herring used in the manufacture of sardines, but also those larger ones which were smoked. Statistics show that in 1893 the average catch per weir in all the waters between West Quoddy Head and Beaver Harbor was 148 hogsheads, and in 1895 the average for the same region was 171 hogsheads. These figures include only such herring as were utilized in the United States, and do not take into account those Canadian-caught fish which were smoked and pickled in New Brunswick or which were sold as fertilizer.

Distinguishing the weirs by their location, it is found that in 1893 those in United States waters caught 196 hogsheads on the average, while those on the Canadian side are credited with but 134 hogsheads each. In 1895 the catches were 181 hogsheads and 166 hogsheads, respectively. In both years, but especially in 1895, the Canadian weirs caught more than indicated in the returns cited, much of the catch failing to secure a market and some of the balance being used in the home production of smoked and pickled fish and as fertilizer.

The decrease in the catch upon the United States shore in 1895 as compared with 1893 was principally in West Quoddy Bay, the cause being an economic one rather than due to a falling off in abundance. The herring in 1895 came to West Quoddy late in the season, as is their custom, but as the operatives in the sardine factories were on a strike, the fish could not be utilized and were allowed to escape from the weirs.

In the light of all the evidence procurable there is but little to support the view that herring are decreasing in the vicinity of Passamaquoddy Bay owing to vast numbers of young consumed in the sardine business or to the fishing methods to which it has given rise. If interpreted strictly, the figures cited in the foregoing would indicate an actual increase, but as this would be "proving too much" the argument will not be pressed. It can be asserted, however, with perfect confidence, that there is nothing in the recent condition of the fishery to warrant anxiety concerning its future.

Those who have claimed that the herring have decreased have given a number of reasons to account for the falling off. When the fishery in West Quoddy failed in 1868 it was said to be owing to the increased number of large weirs cutting off the ingress of the fish, and it was supposed that this also caused the failure in places in Cobscook Bay. It was claimed that the herring formerly entered Passamaquoddy Bay by this route, and that when the passage was closed up by the weirs the herring moved eastward and entered by the Head Harbor passage. In 1893–94, according to one of the best-informed men in the region, the fish came out of Lubec Narrows, and the same authority states that this is the way they always did, and, moreover, the carefully prepared chart of the region made in the summer of 1893 shows that the pounds are arranged to catch fish passing out rather than in. If this be correct, it indicates that the weirs in Lubec Narrows were not responsible for the falling off in Cobscook Bay.

If the herring had been simply blocked out of the waters by the great number and large size of the weirs in West Quoddy and the Narrows it would seem probable that they would return soon after the number was decreased. The fishery failed in 1868, and after a futile maintenance for several years a number of the weirs fell into utter ruin. Yet, for twenty-five years the number of herring caught there was barely sufficient to pay expenses. The disappearance and reappearance of the herring from this locality is, in the absence of sufficient data, at present inexplicable.

Another hypothesis upon which it was sought to explain the late absence of herring from the immediate vicinity of Eastport is that of pollution of the water by the offal discharged by the sardine factories. It is stated that the failure of the weirs began in the vicinity of the factories and gradually progressed along shore. A number of specific cases were cited as illustrations of this; the weirs at Harris Head, Kendall Head, and Gleason Cove, on the United States side above Eastport, and at Indian Island, opposite Eastport, being examples.

The sardine factories are nearly all located at Eastport and Lubec, and weir owners state that the "gurry" hangs close to the United States side and by its offensiveness drives the herring into Canadian waters and incidentally into Canadian weirs. I was informed that until about 1890 most of the cuttings, etc., from the factories were thrown into the harbor, but at present they are sold to a fertilizer factory and converted into pomace and oil.

Although little refuse is now willfully thrown into the water, it can not be denied that more or less fish heads, oil, etc., eventually get into the harbor. Thin films of oil are frequently observed on the surface in Friars Roads, being readily recognized by the "sleek," as the fishermen call the unrippled surface produced by the oil film. The presence of herring (whitebait) in the estuary of the Thames, polluted, until recently, by the entire sewage of London, throws some doubt upon the effect of such pollution as takes place at Eastport. Granted the effect, however, it may be well doubted if it operates so adversely to American interests and affects those of New Brunswick so little as has been supposed.

The oil must be to some extent distributed over the surface by the winds, but the general body of polluted water is at the mercy of the tides, which are of such a complex character in Passamaquoddy Bay as to secure a very wide dissemination of materials which they may carry.

The flood tide sweeps in at Head Harbor, and, passing down between Deer Island and Campobello, splits at Indian Island, part of the water passing all but two or three of the factories at Eastport and into Cobscook Bay and the other part flowing north between Deer Island and the mainland. During a portion of the flood the tide also flows through Lubec Narrows into Johnson Bay. During flood tide, then, only such weirs as are located in Cobscook Bay will receive the polluted water. During the last of the flood and the entire ebb a strong current flows out of Lubec Narrows, so that the greater part of the time polluted water from the factories at Lubec would be discharged into West Quoddy Roads. But the failure of the weirs there could not have been due to offal from the canneries, for it occurred in 1868, and the first factory at Lubec was not operated until 1880, and it was several years later before they became numerous.

Polluted water from the factories at Eastport south of Clark Ledge would, on the ebb tide, be carried across toward Harbor de Lute on Campobello, where some of the best weirs in the vicinity are located. This deflection of the ebb tide is produced by the great body of water coming down from the western passage around the lower end of Deer and Indian islands and there meeting with the opposing current from Cobscook Bay and Friars Roads. The strongest tides on both flood and ebb are toward the Deer Island shore. Above Clark Ledge, as far as Kendall Head, there is an eddy on the United States side, so that polluted water from several factories located there would tend to circulate along shore. Above Kendall Head is another broad eddy, extending out almost to the international boundary line and as far up as Pleasant Point. In this region there are no factories, and the current sets south at all times, except on early flood tide. A similar eddy is found from Pleasant Point up past Gleason Cove.

Now, in the light of these facts, let us examine into the specific cases above cited. All the information obtainable concerning the weir at Harris Head points to the conclusion that it failed about the time of the establishment of the factories. It is possible for polluted water from some of the upper factories at least to gain access to the place, and in a cove south of the head I found great quantities of dead fish and offal lying on the bottom.

In regard to Kendall Head weir, it was stated that it began to fail about the time the factories were established at Eastport and that when the factory south of Kendall Head was built the failure became more rapid. It had failed about one-half before the factory was built south of the head. In 1894 the factory was burned, but no fish were caught in 1895. It is doubtful if any considerable quantity of polluted water is able to reach this weir, on account of the character of the tides, and, moreover, no increase has been noticed since the pollution has been lessened by the use of cuttings for fertilizer, which, according to the best authority, began about six years ago.

In regard to Gleason Cove, it was asserted at Eastport that the weirs were built eight years ago, and that they fished very well until about one year ago, when a factory was built in the cove. Since then it had done nothing. Here, it was supposed, was a case where the failure had occurred so recently that it offered a field for close investigation. Upon inquiry on the ground, however, it was found that the weirs were built about 1880 or 1882, and that until 1887 they averaged about 75 to 100 hogsheads of herring per year. In 1887 they caught 200 hogsheads each, but since then they have hardly paid expenses, and in 1894 the catch amounted to nothing. I am convinced that no great quantity of polluted water from any of the factories has reached these weirs at any time, and, moreover, the greatest catch was made at a time when the factories were almost as numerous as now, and when relatively and absolutely more offal was discharged into the water. The factory at Gleason Cove has had no influence upon the weirs there.

Concerning Indian Island, Eastport informants said that this weir has been falling off ever since the establishment of the factories at Eastport, and that the fish never entered it when the wind was southwest and the oil and "gurry" was carried over from Eastport. Inquiry from the man who fishes this weir disclosed the fact that the catch had fallen off of late years, but the direction of the wind had no effect, so far as he had noticed. It may be observed that the direction of the wind can not affect to any great extent the distribution of the polluted water, but only the surface oil film. The evidence, so far as it was possible to sift it in definite cases, did not point to the fact that the offal was largely responsible for the falling off in the catch of the weirs on the United States side in the vicinity of Eastport.

Moreover, there is good reason for believing that at the time to which most of the dissatisfied ones point as the period of greatest abundance there was greater pollution of the water than at present. Of recent years but little of the offal of the factories at Eastport has been willfully thrown into the water. That which is so disposed of results entirely from the washing of the factory floors and the tapping of the tanks used in washing and salting the herring. As before mentioned, the heads and other refuse from the fish are sent to the fertilizer factory, and such materials only get into the water by accident. This practice has been adhered to since about 1890.

The older fishermen refer to the period between 1855 and 1870 as the time when herring were most abundant. Prior to the first date given no use was made of the small herring, such as are now used for oil sardines, but about that time Mr. Treat, who owned the famous Treat Island weir, began pressing such fish for oil. It was at the time a profitable industry; the fishermen at once took hold of the new idea, and it is estimated that within the next decade at least 100 presses were constructed by the fishermen of Quoddy. During and just following the civil war there was a great demand for fish oil, and for awhile it paid better to press even the large herring than to smoke them.

Large quantities of pomace resulted from this industry, and for a considerable period following 1855, but a relatively small proportion of it was used for fertilizer. In some places this refuse was thrown into the water; in other localities an effort was made to keep it above the tide level, but it is said that even then a considerable amount found its way into the tide together with the water from the butts. Of course, as much of the oil as possible was saved, but with the crude methods then in use there was no doubt considerable discharged with the refuse.

All of this matter could not have been thrown into the water without producing an amount of pollution equaling or exceeding that now produced by the factories. Before the manufacture of fertilizer from the cuttings the pollution resulting from the manufacture of sardines was perhaps appreciable, but it is not so in the vicinity of Eastport at the present time. It may be that the recent abundance of young herring in the vicinity of Eastport and Lubec is due to the improvement in the character of the water since the cuttings have been disposed of otherwise than by being cast into the harbor. The improvement in the catch, however, has been delayed too long after the application of the supposed remedy to make the supposition very probable.

The sardine canneries are not alone held responsible for the pollution of the waters. Occasionally, through neglect, or on account of stormy weather, a weir is not fished; and if the water be shallow, fish will sometimes die in numbers at low tide. It is stated that if these dead fish be not removed no herring will enter any of the weirs to which the polluted water is carried by the current. After the removal of the source of offense they will fish as well as before. It is said frequently to happen, where there are strong tidal currents, that the weirs above, and even the contaminated weir itself, will fish as usual, while all weirs downstream will fail. Southeast of Grand Manan many of the weirs are built in the tideways between the islands, and I was told by a number of credible persons that the facts above stated were frequently observed.

The importance of careful attention to the weirs is conceded by the Canadian fisheries regulations, and penalties are imposed upon those whose carelessness permits fish to die in the weirs. The latter are provided with gates, so that the surplus fish may be liberated should more be caught than can be utilized. It is customary for the fishermen to visit the weirs at about half ebb, when the tide serves, so that the probable catch may be estimated and exit given to the surplus should it promise more than is desired for immediate use.

Some of the fishermen at Grand Manan think that the lobster and trawl fisheries are prejudicial to the shore fisheries for herring. The former was particularly objected to on account of the alleged practice of using putrid bait in the traps. I had no opportunity of judging for myself, as my visit was made during the close season, but I was told that the waters all alongshore are sometimes polluted by the decaying bait, and that the constant hauling of gear tends to frighten herring and keep them off shore. My own impression is that it would require many more lobster pots than are now fished in the Bay of Fundy to effect any serious pollution in a region where the volume of water is so large and the currents so swift. The same may be said of the trawl lines.

Many of the weir owners and others state that the gill-net fishery aids materially in driving the herring from the shore waters, and in Machias Bay a township ordinance prohibits entirely this method of taking herring. In some places and at some times the gill-net fishing is of a character to warrant opposition. In September, 1893, herring were spawning at Moosabec Reach in great numbers, and many gill netters resorted there. The gill nets over night became laden beyond their strength, and when the attempt was made to haul them in they parted, and the pieces, with hogsheads of herring, were left to rot on the bottom. It is said that the herring are sometimes driven from their spawning-grounds by this means, and that after such an event they often remain away for years.

A. J. Meloon and others, of Cutler, Me., say that about 1873 Great Head was noted for the abundance of spawn herring, but, presumably owing to the great numbers of dead fish left on the bottom in pieces of nets, they forsook the locality, and have since then only occurred in small numbers until 1893, when they were again abundant. The same informant said that eight years ago spawn herring occurred in great schools at Ingalls Island, Machias Bay. He took 50 barrels out of one 50-fathom net, which was torn all to pieces. Barrel after barrel of herring could be hauled up from the bottom by grappling for the torn nets, and as a consequence of this destruction they did not again appear in numbers until 1893. Libby Island, also in Machias Bay, was given as another instance of the disappearance of the herring as a result of the abuse of the gill nets. I afterwards learned, however, that there are no weirs upon the island, and as the use of the gill nets is prohibited it is not really known whether or not the herring have appeared there since.

I believe these statements of the effects of lost gill nets to be overdrawn, and that the absence of the herring for a long time subsequent to such loss is due to accident or to other causes than the pollution of the water. When the pollution has been excessive, there is, no doubt, some effect for the time being, but it is impossible to believe that the pollution can last for more than one season, and if not it is difficult to understand why the herring should avoid the locality thereafter unless we attribute to them a high order of memory.

Instances are constantly occurring where the herring have ceased, for a year or a period of years, to spawn in certain localities where the pollution of the bottom could have no bearing on the matter. Heedless and unnecessary waste of food-fishes is to be deplored, but it seems unwarranted to assume that dead fish strewn upon the bottom will keep the fish away for periods of from five to twenty years thereafter.

Other fishermen place stress upon the injury effected by the capture of spawning fish in the gill nets. As has been argued elsewhere, there is no greater damage done by catching the fish during the spawning season than by taking them at any other time—for instance, just before spawning. It seems that these accusations are but a manifestation of the universal warfare between the users of fixed and portable nets.

On the other hand, it is claimed that the continued catching of immense numbers of young fish for the sardine industry must produce a decrease in the herring and that it is only a question of time when this decrease will make itself manifest if it has not already done so. At first sight it would seem that this might be reasonable, and the only reason that such a decrease has not taken place is no doubt because the number of herring killed by man is insignificant when compared with the total number of this species in the seas and the number which yearly fall victims to the various natural dangers which beset them.

In discussing the effects of physical phenomena other theories regarding the failure of the herring fisheries in certain localities have been amply considered. Such theories are that the fog-alarms have scared the herring away from the vicinity of West Quoddy and other places and that the failure of Treat Island weirs is due to the noises and the disturbance of the water caused by steamers passing to and fro between Lubec and Eastport and through Lubec Narrows.

When all the factors in the case are reviewed, I think that it has been shown that not only has there been no decrease in the sardine-herring in the region under discussion, but that there are at present no practices connected with the fishery which are liable to seriously affect their future abundance.

WINTER HERRING.

From the early part of the present century herring were known to frequent portions of the coast between Quoddy Head and Lepreau during the winter months. They came in large numbers, and although certain localities appear to have been for a time deserted by them, there is no tradition among the fishermen that there was ever a period until recently when the winter school of herring did not occur in some portion of the region embraced in this report.

Mr. Perley, in a "Report upon the Fisheries of New Brunswick and Nova Scotia," written in 1850, mentions their sudden and unprecedented appearance in the neighborhood of Lepreau during the winter of that year. In any attempt to account for the disappearance of the "winter herring" from our coast it would be of the utmost importance to establish such a sudden appearance of the species at an unusual season. Careful inquiries were therefore made, especially among the older fishermen, whose recollections antedated the time of this alleged first known run of winter herring. Special attention was called to the statements of Mr. Perley, and the fishermen were asked if they could verify them. In every case it was stated that the herring were known to occur on the coast in winter long before the date mentioned. An old and experienced fisherman, who was for a number of years the Canadian fisheries overseer at Lepreau, and who in his boyhood lived at L'Etang, said that he could remember herring along the coast during the winter months since 1829 and that the fishermen of that day appeared to regard their presence as a matter of long-established fact. These herring were apparently of the same character, with reference to size and condition, as those which afterwards became the object of pursuit in the important frozen-herring trade.

Another fisherman at Campobello, who began fishing seventy years ago, says:

> I think that until the last six years there never was a time, with occasional exceptional years, when the herring were absent from this coast in winter. Mr. Perley was mistaken when he said in his report that the herring were unknown inshore in winter prior to 1850. There was never much fishing for them before that time, but they were here, nevertheless, and I distinctly remember their presence in the winter of 1840. I can fix that date from the circumstance that I built a vessel during that year.

This and similar testimony from others, as well as the fact that even the older fishermen know of no traditions of the sudden and unusual appearance of herring in winter, point to the probability that these winter schools were well-established phenomena as long ago as the beginning of the century, and perhaps at the time of the first settlements of English-speaking peoples. There may have been single years or periods of years when the herring did not come ashore in certain rather circumscribed regions, but this is a phenomenon observable in almost all fisheries. It is stated traditionally that herring ran into

L'Etang in winter at the time of the first settlement of the country, but that for a series of years at the beginning of the present century they were totally absent from that region during the winter months. The period of their absence appears to have been about twenty years, and they must have returned a number of years prior to 1829, for, as stated above, they were at that time regarded as well-established winter visitors. Perley, who, as stated, regards their appearance on other portions of the coast as unusual, says that they frequently ran into L'Etang in the winter in great bodies.

However far back in time we may place the first appearance of herring upon this coast in winter, the fact remains that it was not until within the last thirty years that a consistent effort was made to render this vast food supply widely available.

From the early part of the present century, if not before, limited quantities were caught and prepared for home consumption or to serve as bait for the line fisheries. The fish intended for food were at first usually prepared by smoking, the method of freezing the fish not being adopted until larger markets for winter herring presented themselves and shipments began.

At first the fish were taken solely by torching, a method which is elsewhere explained. No gill nets whatever were used in the herring fishery in this region until 1829, and they were not introduced into the winter fishery until about 1845 or 1850. About that time Messrs. Greenlow, of Deer Island, New Brunswick, began to use nets of about 2-inch mesh for winter herring, smoking the fish for market, but soon afterwards the fishermen began a limited trade in frozen fish with St. John and the tributary region. This domestic trade in frozen herring gradually grew, but owing to the limited market it never became very extensive.

In the meantime the American vessels from Gloucester had developed an important market for frozen herring in the United States. In 1854, according to a Gloucester authority, a partial fare of frozen herring was brought from Newfoundland by a Gloucester master, and with some effort was disposed of, some as bait for the Georges men and some as food, the latter being peddled through the country. The following year several vessels made the venture to Newfoundland, and, the product being well received by the fishermen and the public, the trade soon developed into one of considerable importance and profit, and in a few years gave employment to a large fleet of stanch vessels.

About 1864–65, the abundance of winter herring in the Bay of Fundy having become known, a vessel made a trip to that region with excellent pecuniary results, and the fishermen and vessel-owners were not slow in seeing the advantages to be gained by developing the trade. The voyage to Newfoundland, being made at the most inclement season of the year, was attended not only with the risk of maritime disaster, but, as some found to their cost, there was always the possibility of a bad season and the loss of a fare even after the outward voyage had been successfully accomplished. The trip to the Bay of Fundy was shorter, and the vessels being always within reach of a sheltered harbor, it could be attempted in inferior crafts.

It is stated that the first fare of winter herring shipped to the United States from the vicinity of Quoddy was carried by a Captain McCrea, of Gloucester. Be that as it may, he was soon followed by many others, and frozen herring from the Bay of Fundy soon largely supplanted the Newfoundland herring in the markets of the United States. The fleet sailing to the former region was steadily augmented, while that in the Newfoundland trade as steadily declined. On account of the severe weather they had to encounter, the Newfoundland vessels were stanch and able seagoing craft, while many of the Bay of Fundy vessels were old and small.

Some of the fishermen fished from small boats only, making their headquarters ashore and not going far from home, but most of them used sloops and small schooners, ranging from 8 to 35 tons burden, in which they could follow the schools about from place to place during the season. There was considerable improvement both in model and build of the vessels as the fishery became better established, but the size remained about the same. The smaller vessels usually carried a crew of three men and one boat; the largest had seven men and three boats. Vessels of from 15 to 20 tons were the most common, and such a craft usually carried a crew of five men, who used two boats in attending their nets.

The fishery was commonly conducted on shares; the owners of the vessel receiving one-seventh of the catch, the remainder going to the captain and crew, who "found and grubbed" themselves. At the approach of the season for winter herring the crews of each craft would come together and fit out with the necessary provisions, nets, and gear. The vessel then repaired to some convenient harbor and awaited the arrival of the fish, the fishery beginning as soon as the herring came in and the weather became sufficiently cold to freeze the fish when exposed to the air.

The presence of the fish was detected by fishing trial nets, each vessel setting a net or two nightly. As soon as it became known that any of these nets had taken herring, there was great activity among the fishermen. Each boat was sent out with two men and its complement of nets. In the first years of the fishery each man fished two nets, but afterwards the quota was increased to three per man. The nets were 30 fathoms long and 150 meshes deep, the mesh being 2¼ inches. Those first used in New Brunswick were Scotch nets of linen, but afterwards cotton nets were adopted, owing to their cheapness and the greater ease with which the fish could be shaken from the meshes. Until about 1880 they were set near shore, in about 10 to 20 fathoms of water. The vessels lay in the harbors, one man remaining aboard to cook and take care of the fish, and the remainder of the crew rowing back and forth to their work. During the last six or seven years of the fishery, when the nets were set 5 or 6 miles from shore, the distance became too great for the men to row, and the vessels would then run out and drop the men to set or lift their nets, picking them up again when they had completed their task. When the men first began to fish in the deep water at a distance from the shore their inexperience often caused them to lose their nets and gear, but afterwards they grew more accustomed to the changed conditions and were able to avoid such losses.

The nets were set in the afternoon and were lifted the following morning. The herring would rarely enter them during the daytime, and it was observed that on dark nights the fishing was better than when it was moonlight.

The fishery for winter herring being principally within the waters of New Brunswick, most of the fishermen were citizens of that province; but a number of Americans engaged in it, especially during the latter years of the fishery, often setting their nets close inshore and freezing their fish either ashore or on the decks of their vessels. In addition to the regular fishermen, many farmers and mechanics who had no work during the winter followed the fishery with considerable profit. The winter fishery for herring was the most important and profitable fishery, especially on the "North Shore" between Beaver Harbor and Lepreau, and the fishermen cared but little for the failure of the summer fisheries if they were assured of a good run in winter.

The Americans were interested more extensively in buying than in catching the fish. As already stated, prior to 1860 comparatively few fish were sold as bait, but at about that time that market became very important, and large numbers were sold to Nova Scotia fishermen and to Americans engaged in the trawl and hand-line fisheries on the Georges Banks. Before the days of the frozen-herring trade it was customary for the bank fishermen to carry several nets for the purpose of catching bait. Herring were often found on the Georges Banks in winter, sometimes in vast schools, but the practice of catching them was abandoned when the line fishermen found that they could obtain bait with more certainty and greater dispatch by purchase from those engaged in the frozen-herring trade. When vessels from Gloucester and other American ports began to regularly engage in the business, they soon absorbed the bulk of the catch, although a considerable number of fish still went to Nova Scotia. These vessels bought the fish from the local fishermen and carried them to the great fish markets, whence they were transshipped as bait or were sent over the country as a cheap fish food for man.

The frozen herring were always sold by count, never by weight or by the barrel, and the price ranged from 15 cents to $1 or more per 100, according to the weather and market. The first fish usually brought a higher price, and last winter (1894–95) the first frozen herring from Grand Manan sold for $1 per 100. The average price paid was about 25 cents per 100, and at this rate the "stock" per man fishing the whole season was between $150 and $200, some making more and some less than the figures given, according to their skill and industry.

Frequently, when a sudden thaw made it impossible to freeze the fish, the fishermen were willing to sell the herring for a mere song in order to avoid having them spoil on their hands. Considerable loss was sometimes sustained through the occurrence of mild periods and warm rains in midwinter. When the fish had been partly frozen before the thaw, they could often be kept in good condition for three or four days by placing them in the hold and closing the hatches. If the weather then grew colder they could be again brought on deck and the freezing process concluded, until they were quite stiff and brittle. Constant attention was required, as a sudden thaw or rain might in a few hours cause much loss.

American vessels came from Boston, Gloucester, Portland, Isle au Haut, and other places to purchase the herring from the local fishermen, and when the fishery was at its height as many as 125 cargoes were carried to American ports, in addition to a considerable number shipped in barrels from Eastport in steamers. Vessels missing their fares at Newfoundland often came to the Bay of Fundy to pick up a cargo before returning to Gloucester. The vessels commonly resorted to Eastport, where they would wait for the fishermen to come to sell their fish, or more frequently they would run to some harbor in the vicinity of the fishing fleet and would there purchase the herring as they were frozen. The latter was the usual procedure, especially during the latter years of the fishery, when the competition for fares was often very brisk.

Between 1845 and 1855 the frozen-herring trade for the market was confined to the shore between Sand Cove and Point Lepreau, but about the latter year it extended westward to Beaver Harbor and Grand Manan, and later to Eastport, and even to some extent as far as Cutler. The herring were found in winter from St. John to Cutler and from Grand Manan, in the Bay of Fundy, to St. Andrews, in Passamaquoddy Bay. They were not found every winter throughout this entire region. Sometimes they would not enter St. Andrews Bay at all, but at other times they would be found there in great numbers, and almost the entire fleet would fish there all winter. As many as 14 vessels have been known to leave there with full fares in one day.

The winter run of herring did not strike the whole coast at once; they usually first appeared on the outer or Bay of Fundy side of Campobello and thence extended eastward and to a limited extent westward. A school of fish usually arrived on the shore at Herring Cove early in October, and remained about three or four weeks. This school appeared to be distinct from the true winter herring, which, before 1880, reached the place mentioned with fair regularity about November 15, and remained until late in December, when they began to slack off, although some were usually to be found there throughout the winter. The fishermen from Beaver Harbor came down to Campobello for a fortnight's fishing early in the season, as the schools did not strike Beaver Harbor for about ten days after their arrival at Herring Cove, and it would not be until about the first week in December that they would reach the neighborhood of Point Lepreau.

It would appear, then, that these schools of winter herring arrived first at Grand Manan, soon afterwards at Campobello, and thence they extended gradually up the Bay of Fundy to St. John, or entered St. Andrews Bay via Head Harbor and the Eastern or Letite Passage. At the eastern end of Campobello, at Head Harbor, the migrating schools had two alternatives, they could either continue up the Bay of Fundy or could enter St. Andrews Bay. When they took the latter course in large numbers there was a corresponding dearth upon the Bay of Fundy shore, but sometimes the schools would divide, a portion taking each route and the fishery becoming more widely distributed.

The foregoing is a general statement and does not strictly describe the migration every season. Sometimes they were first caught nearer the eastern end of Campobello, and there were always more or less extensive local movements which tended to affect their distribution. They often moved about from place to place according to no observable system, but the fishermen were able to follow them with more or less certainty by observing the movements of the schools of whales and flocks of gulls. For instance, in 1877 there was good inshore fishing at Campobello up to the middle or latter part of December, but during the rest of the winter they were offshore, and it was during that winter that the fishermen gained their first experience in deep-water fishing, at some expense of nets and gear. West of Beaver Harbor the principal schools were that year found about midway between the main shore and The Wolves, but farther eastward, at Popologan and Lepreau, they were closer inshore.

It is probable that temporary disappearances of the winter herring from the coast in previous years were due to their dropping offshore into the deeper waters of the Bay of Fundy, but the fishermen appear to have been unaware of the fact until 1877, although large numbers of whales and gulls, which accompany the schools, were often observed. In the following year, 1878–79, the schools were as close in as ever, and the fish were especially abundant in the vicinity of L'Etang. In 1879–80 they appeared inshore in great numbers and were quite generally distributed along the coast, and the same may be said of 1880–81 and 1881–82; but in 1882–83 they were principally offshore throughout the whole coast, and they did not again appear, to stay, in shallow waters up to the time when they finally disappeared, in the winter of 1889–90.

Coupled with this apparent reluctance to come inshore, the latter years of the fishery were characterized by a gradually later and later date of arrival. The schools were not preceded to any extent by stragglers, the bulk of the fish arriving in a body, and consequently the date of their arrival was well defined. As already stated, prior to 1880 the winter herring arrived at Herring Cove about November 15, but by 1887 their arrival was delayed until January 6, and in 1888–89, the last year of the fishery, they did not come until January 10. In 1887 they were caught at Grand Manan before they reached Campobello, but for three or four years they did not arrive at Point Lepreau until February, and in 1888–89 it was almost March before they were taken at the latter place. In 1889–90 a few were caught at several places on the "North Shore," but not enough to pay expenses, and from that time to this none have been caught in that region, although lobstermen every winter set a few nets in the hope of catching bait for their lobster traps.

It is stated that at Grand Manan the winter herring disappeared a year or two before 1889–90, but it appears that the fishermen from that place did not set their nets as far from shore as did those on the mainland, and this probably accounts for the difference. Since then there have been several short runs or "spurts," and in the winter of 1894–95 for several weeks between December 22 and January 10 the fishing was as good as ever. Considerable quantities of herring are still taken from Dark Harbor during the winter, but these are, no doubt, fish which have run into that almost landlocked pond earlier in the fall and have been unable to find their way out. They are consequently not to be considered with the winter herring, although small bodies of fish are said, by those in charge of the fisheries, to occasionally run in during the winter months. There appears to be some doubt as to whether the fish left earlier or later toward the last or whether the change was only in the date of their arrival.

During the last three or four years of the fishery the numbers of the herring appeared to be about constant, but before then there had been a gradual decrease since 1880 or 1881, or at least the catch was more irregular and uncertain. This, however, may not have been due so much to a decrease in the size of the schools as to the greater difficulty in the way of catching them. When the fishermen had to set their nets 4 or 5 miles offshore there would be, of course, much greater liability of some of them missing the school than when the fish covered the more circumscribed area nearer shore, and this would lead many to suppose that a greater decrease had occurred than was actually the case.

As already stated, the schools of winter herring were detected by means of trial nets, although their presence was often indicated by the accompanying whales and gulls which feed upon them. These, however, also feed upon the small herring which likewise are found in the bay in winter. These small herring are often seen schooling—that is, playing at the surface of the water—but the regular winter schools rarely appeared at the surface, and then only when driven by their enemies.

There appears to be considerable difference of opinion concerning the effects of winds and weather upon the movements of the winter herring. According to some the herring is a "leeward fish"—that is, it drifts to leeward in pursuit of its food—and consequently mild southerly and southwesterly winds were the most favorable, bringing the schools toward shore. Others insist that the cold northerly winds brought the best inshore fishing, and still others state that great bodies were at different times seen inshore in all kinds of weather. Indeed most of the more intelligent and better-informed fishermen will agree to this last statement when questioned, and it seems probable that it is the most consonant with the facts of the case. Probably strong northerly winds were better than corresponding southerly winds, as then the boats could run out and in under the lee of the shore, this being a matter affecting the distribution of the fishery rather than of the fish.

The herring of the winter school were usually rather lean and poor and of moderate size; rarely a few fairly fat ones were caught, and they remained in about the same condition until spring. The fishermen state that their stomachs contained shrimps and red seed, and this statement is confirmed by the contents of a few stomachs obtained at Flaggs Cove and Long Island, Grand Manan, about the middle of January, 1894. Six of these contained copepods (red seed), and another was gorged with Thysanopoda, the "shrimp" of the herring fishermen. During the summer these shrimps are extraordinarily abundant in the Passamaquoddy district, but it is said that they are not often seen at the surface in winter; but if this be true, they no doubt abound at a distance from the surface where the temperature is more equable.

In December the genital glands of the winter herring were very small, but in March some were always found with these organs in a well-advanced state, though by no means ripe. A specimen taken at Grand Manan in January, 1894, had testes about 1 inch in breadth and quite thick, a condition which throws doubt rather than light upon the question of the spawning period of these schools. Such a specimen might be either an autumn spawner whose development had been delayed or a precocious individual whose normal time of reproduction was in the spring, in either case a condition not rare.

In attempting to coordinate these winter schools with others occurring in the Bay of Fundy considerable difficulty is encountered. As the winter herring no longer occurs upon the coast, the investigation must depend almost entirely upon the testimony of the fishermen, whose information is naturally largely restricted to the requirements of their calling, and who usually bother themselves but little with the history of a species as long as it maintains its abundance. Most of them have opinions upon the subject of the relations existing between the different schools, but when they are pressed for reasons it is found that their theories are based upon insufficient data. Some of those whom circumstances caused me to regard as the most observant and better informed among them frankly confess themselves unable to state whether these winter herring belong to the school which spawns at Grand Manan in summer and fall or to that which formerly spawned, and to some extent still spawns, in St. Andrews Bay and Oak Bay in spring, during the latter part of April and early in May. That these two spawning schools are not composed of the same fish is unquestionable, but it is possible, though not very probable, that the winter herring may comprise members of both of these schools attracted shoreward for the sake of the food to be there obtained.

The shoreward movement of schools of herring is usually conditioned by one of two desires—the instinct of reproduction or the desire for food. As the winter herring always arrive with very immature genital glands, it is evident that the first of these is not to be considered in this connection, and we must assume that the desire for food is the impelling motive to which the fishermen have been, until recently, indebted for this profitable fishery, though, as will be shown, some at least probably remain to spawn.

As before stated, there is a run of herring at Herring Cove and the neighboring portions of Campobello in October. According to the fishermen, these fish are still caught as usual and are similar to a school which appeared at the place mentioned in September, 1895. These herring were evidently spent, and no doubt had just arrived from the spawning-grounds at Grand Manan or elsewhere, and the October school should doubtless be traced to the same source. After the October school left there was an interval of about a week or a fortnight before the arrival of the regular winter school, which, the fishermen say, differed in appearance from those which came earlier. This difference, however, may be due solely to difference in condition caused by relative remoteness from the spawning season, amount of food, etc.; but if we accept the statement that the roes and milts are small in November and well developed in March, it would establish a distinction between the schools of October and of the late fall and winter. The same herring does not spawn twice in a season, and those spawning at one time do not apparently associate with those spawning at another; in other words, the schools of adults tend to remain distinct, and not only spawn at different times, but select different grounds for the purpose.

It is well known that the winter herring remained in St. Andrews Bay usually into the month of April, though the testimony of the fishermen would indicate that they sometimes did not go there at all, or at least during cold weather. It is equally well known that they spawned in St. Andrews Bay and Oak Bay about the beginning of May, and this date would about correspond with the spawning season of herring which contained large but hard spawn in March.

These several facts, then, would tend to induce a belief that the schools, or at least a goodly portion of them, which frequented the coast in winter spawned in the vicinity of St. Andrews Bay. It is admitted by all that the herring some years ago ceased to spawn in those waters except in limited numbers, and as nearly as the date could be fixed from rather vague information, the time of cessation corresponds approximately to the time of disappearance of the winter herring. It was found impossible, however, to get very accurate information concerning this spawning-ground, and apparently the fish were not the object of close pursuit at that time. A school of herring continued to spawn in Oak Bay, a few miles above St. Andrews Bay, up to the spring of 1895, a fact which may to some extent throw doubt upon the relationship between the schools which is indicated above.

The segregation of the herring of this region into schools, spawning at different times and places, has undoubtedly established slight structural changes, sufficient to constitute a racial difference capable of demonstration in a large number of specimens. If there should ever be afforded an opportunity of comparing a considerable series of winter herring with extensive series from the two spawning schools, it may be possible to determine with certainty the relations existing between them. Until the winter schools again return to our coast all inquiry into this matter must partake largely of speculation.

With the scant information at hand concerning the winter herring fishery of the Bay of Fundy, it is impossible to assign any satisfactory cause for their disappearance. There appears to be no warrant for the assertion occasionally made that they have been practically exterminated by overfishing. Most of the fishermen in the region, regard such an explanation as untenable. It is true that a falling off in the catch was noted during the last few years of the fishery, but this appears to have been due to irregularities in distribution rather than to an evident decrease in numbers, as when the schools were located the fishing seemed to be as good as ever. This is precisely what would be expected, on *a priori* grounds, if a given body of fish accustomed to frequent the immediate vicinity of the shores were to become distributed over the more open waters, where they would not only be more scattered, but also more difficult to locate and catch.

During the last year of the fishery there were yet a large number of herring, and it is utterly impossible to believe that these were so preyed upon by the fishermen as to be practically exterminated, so that none were left to return the following year. If they have not been caught out they must have left the coast as a body; but the reason for their desertion of their inshore haunts is also difficult to understand, and where they have gone since their total disappearance from the Bay of Fundy is equally lacking in elucidation. Extensive fishing might possibly cause the schools to forsake the shores at a time when they were not driven by the overpowering stimulus of reproduction, although it is doubtful; but it could hardly be sufficient to drive them entirely from the broad waters of the bay, nor would it be likely to actuate them to remain away after the cause had ceased to operate, unless we attribute to them a higher order of psychological development than most persons are willing to admit. The recollection of impediments in their path is not a sufficient reason to explain why they should avoid a locality after those impediments are removed. If, however, these winter schools were composed of fish which spawned in St. Andrews Bay in spring—a probable connection yet by no means established—then by preventing the access of the fish to the spawning-grounds the nets might, after compelling the schools to spawn elsewhere for several years, gradually change their distribution. This is an explanation offered by some, but in addition to the several hypotheses which it involves, it also has the well-nigh fatal defect that it does not explain the reason why the fish could not pass to the spawning-grounds after the cessation of the winter fishery on account of warm weather. The spawning season appears to have occurred in May, and as there was practically no fishery in most years after March 15, there was ample opportunity for the fish to come ashore in the meantime if such were their habit or desire.

After considering the several phases of the matter presented by the information at hand, the most that can be said is that we do not know any good reason for the disappearance of these schools and the loss of an important industry to the fishermen of the Passamaquoddy region.

An important question in connection with the winter herring is whether or not we are justified in expecting their return, and in this connection it may be well to examine experience elsewhere. In several places in Europe, but especially upon the shores of the Kattegat, in Sweden, there are herring fisheries which have long been known to be periodical. "They are called periodical because, as far as known, they have only lasted from twenty to eighty years, with intervals of sixty to one hundred, or an average of seventy years." It has been observed that toward the end of these periods the herrings have always arrived later and later in each successive year, and that they have at the same time kept farther and farther away from the coast. This appears to have been the case with each successive period during hundreds of years, and when such retardation begins to manifest itself in the fisheries of Bohuslän it has been customary to predict with certainty the approaching loss of the fishery.

Our herring fisheries, and especially the one with which this chapter deals, are recent as compared with those of Europe. We have no records running back for hundreds of years, and there is yet no data for asserting the periodicity of any of our herring schools, but it will be observed that the conduct of the winter herring prior to their disappearance might be described in the exact words applied to the herring of Bohuslän.

QUODDY RIVER HERRING.

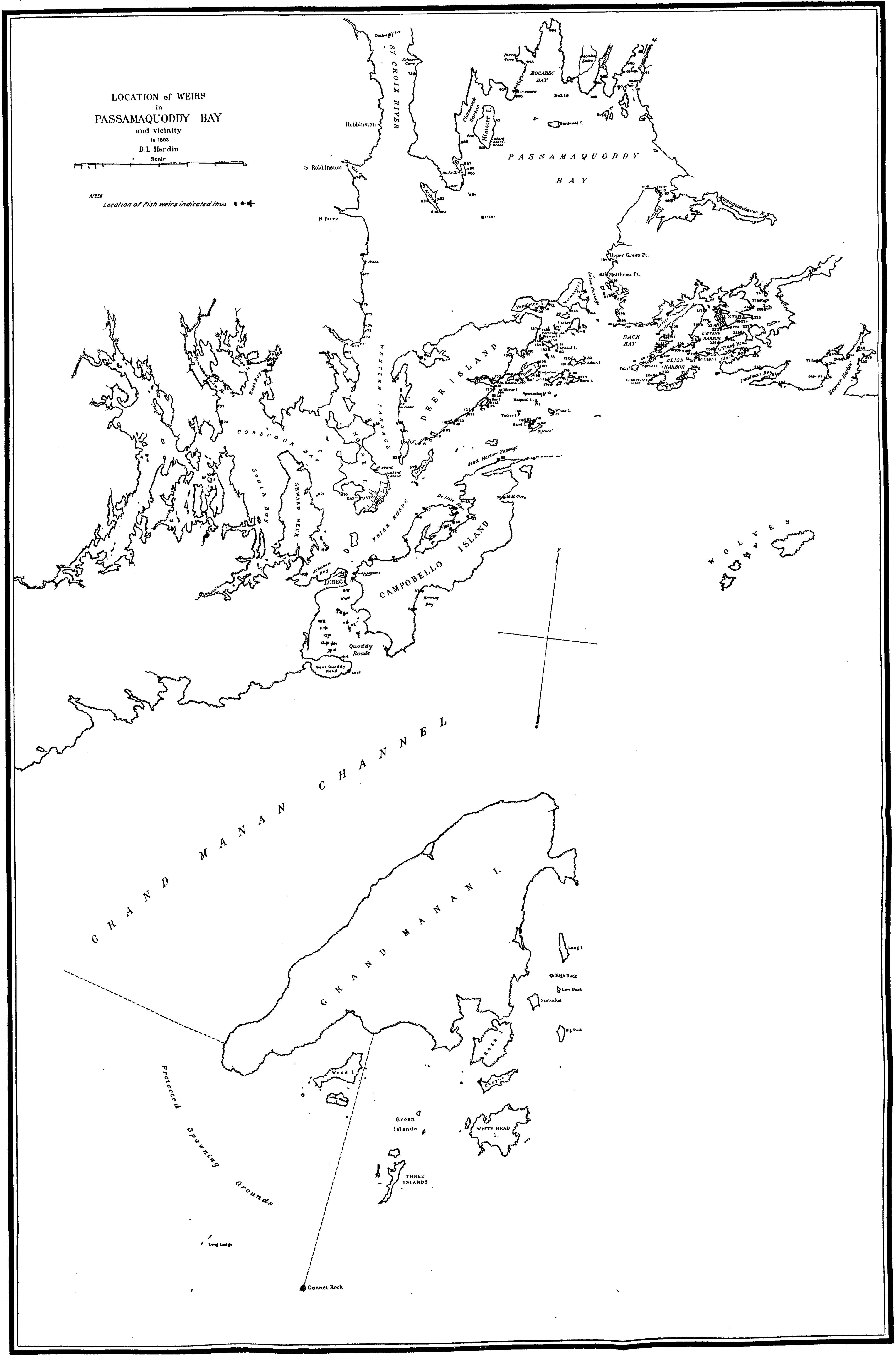
The justly celebrated herring which were known in the markets of the country under this name appear to have occurred practically nowhere but in "Quoddy River," the waters lying between Campobello on one side and Deer Island and the shores of Maine on the other.

The fishery began in 1829, although the fishermen appear to have been aware of the occurrence of these large fish prior to that. In the year mentioned Mr. Parker, a fisherman, brought a gaspereau net from St. John and determined to catch these herring for the market. This was the first net used in the herring fishery in the Passamaquoddy district, and it met with immediate success. The large herring were found to be more abundant than had been supposed, and the pecuniary results were such that in the following year fishermen came from St. John to get their share of the fish which found such a ready market. The local fishermen, not to lose such an opportunity, soon provided themselves with nets, and the fishery developed within a few years to such an extent that 40 or 50 boats were engaged almost nightly, the herring being caught by "drifting." The fish arrived in August and continued through September and October each year until 1877, when they rather suddenly disappeared. It was not until 1892 that they were again caught, but in that fall they again appeared in limited numbers and have since come each year without any increase in numbers.

The Quoddy River herring were very large and fat and always brought high prices. They were usually pickled, and in 1894 eighty-nine selected ones filled a half barrel, and after taking first prize at the New Brunswick Fishery Fair were sold for $5. The nets used had a 3-inch mesh and were 30 fathoms long and 150 meshes deep—about 2½ fathoms when hung.

These large herring never contained spawn, but spawning fish were sometimes mixed with them.

It is impossible at present to establish the relations of this school to the others in the vicinity, and no good reason can be assigned for their disappearance. At all times the school was a small one, and fish of similar character were rarely caught elsewhere than in the waters mentioned.


LOCATION of WEIRS
in
PASSAMAQUODDY BAY
and vicinity
in 1893
B. L. Hardin
Scale
Location of Fish weirs indicated thus
PASSAMAQUODDY BAY
ST CROIX RIVER
BOCABEC BAY
Robbinston
S Robbinston
N Perry
Minister I.
Upper Green Pt.
Matthews Pt.
Pendleton I.
BACK BAY
L'ETANG HARBOR
BLISS HARBOR
Magaguadavic R.
Deadman Bay
Beaver Harbor
DEER ISLAND
WESTERN PASSAGE
MOOSE I.
COBSCOOK BAY
SOUTH BAY
SEWARD NECK
EASTPORT
FRIAR ROADS
Head Harbor Passage
CAMPOBELLO ISLAND
Johnson Bay
LUBEC
Herring Bay
Quoddy Roads
West Quoddy Head
WOLVES
GRAND MANAN CHANNEL
GRAND MANAN I.
Long I.
High Duck
Low Duck
Nantucket
Big Duck
ROSS I.
Wood I.
Green Islands
WHITE HEAD I.
THREE ISLANDS
Protected Spawning Grounds
Long Ledge
Gannet Rock

U. S. COMMISSION OF FISH AND FISHERIES,
JOHN J. BRICE, Commissioner.

THE HERRING INDUSTRY OF THE PASSAMAQUODDY REGION, MAINE.

BY

ANSLEY HALL,
Statistical Field Agent, U. S. Fish Commission.

Extracted from U. S. Fish Commission Report for 1896. Appendix 10, Pages 443 to 487

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10.—THE HERRING INDUSTRY OF THE PASSAMAQUODDY REGION, MAINE.

By Ansley Hall.

INTRODUCTION.

The Passamaquoddy region, so far as it relates to the State of Maine, lies along the western shore of the St. Croix River and Passamaquoddy Bay in Washington County, its southern termination being at West Quoddy Head, which is the eastern extremity of the Atlantic coast of the United States. The principal localities in which the herring industry is prosecuted are Robbinston, North Perry, Pembroke, Eastport, Lubec, and North and South Lubec. The population of these places in the aggregate is about 9,000. Eastport and Lubec are the principal business centers, the former having a population of 5,000 and the latter of 1,800, or a little over 2,000 if North and South Lubec are included.

The importance of the herring industry in this region will be better appreciated when it is considered that in its various branches in 1895 it gave employment to 5,082 persons, male and female, of whom 139 were engaged in the herring fisheries, 539 in the smoked and pickled herring industry, and 4,404 in the sardine industry. A very large proportion of these is included in the resident population, and the remainder come from adjacent localities. The total amount of wages distributed was $584,593, of which $28,153 was paid to the employees of smoke-houses, and $556,440 to the operatives in sardine canneries. The amount of capital invested in the herring fisheries, in weirs, boats, and appliances, was $28,483; in the smoked and pickled herring industry, $110,938; and in the sardine industry, $709,037; a total of $848,458. The cost of materials used in the smoking and pickling of herring was $36,125, and in the preparation of sardines and other herring products, $792,292, a total of $828,417. The quantity of herring used for smoking and pickling was 14,647 hogsheads, or 14,647,000 pounds, costing $45,494, and in preparing sardines or other canned herring and Russian sardines, 36,496 hogsheads, or 36,496,000 pounds, costing $114,504; making a total of 51,143 hogsheads, or 51,143,000 pounds, costing $159,998. The value of the products prepared at the smoke-houses was $154,501, and at the sardine canneries, $1,666,818, a total of $1,821,319.

The present paper is based on an investigation made by the writer in 1896. It contains statistics of the herring industry in this region for the year 1895 and of the quantity and value of herring utilized and the products prepared in each of the years 1893 and 1894. The several branches of the industry, including the methods employed in the preparation of the products, are described, and the trade conditions prevailing during the past few years, especially in connection with the sardine industry, are briefly discussed.

THE WEIR FISHERIES.

Passamaquoddy Bay with its tributaries, is the fishing-ground from which practically all of the herring which are used for sardines in the Passamaquoddy region, and a large quantity of those for smoking and salting, are obtained. It is located on the eastern border of the coast of Maine, between that State and the Province of New Brunswick. Its length is approximately from 10 to 12 miles, and its width, exclusive of the small bays on the west side, which are tributary to it, is about 8 miles. The inner part of the bay is landlocked by a group of islands, the largest of which (and the only ones inhabited) are Campobello Island, from 8 to 9 miles long, stretching northeasterly across the west side of the mouth of the bay, and Deer Island, about 7 miles long, situated a little to the northward and lying in the same direction. The entire group, embracing from 30 to 40 islands, some of which are very small, is included in Charlotte County, New Brunswick. In addition to this group there are a number of other islands in various localities, but none of importance, except Moose Island, on the southeast part of which Eastport is located. It is on the west side of the bay, opposite Deer Island, from which it is separated by what is known as the Western Passage, and is connected with the mainland by a bridge at Perry. It is about 4½ miles long, and contains an area of 1,910 acres.

The shores of the bay are irregular, and there are numerous small tributary bays and rivers. The largest river is the St. Croix, which is the outlet of the Schoodic and Grand lakes, and forms a part of the eastern boundary of Maine, emptying into the headwaters of Passamaquoddy Bay at its northwest extremity. It is of considerable importance to navigation, and is also valuable as a fishing-ground. The international boundary line between the United States and Canada in the middle of this river has recently been extended southward along the American shore through Western Passage and Friar Roads to Lubec Narrows; but from that point to the ocean, through West Quoddy Bay, its location has not yet been definitely settled. The bay is so divided that comparatively a small part of its area is in Maine, the greater part, and, in fact, almost the entire bay proper, being in New Brunswick.

The most important tributaries in Maine which are utilized as fishing-grounds for herring weirs are the East, South, Cobscook, and Johnson bays and the Pennamaquan River. West Quoddy Bay, which is south of Lubec Narrows and between the mainland and the southwesterly end of Campobello Island, is also largely occupied by weirs owned at Lubec. On the New Brunswick shore, east of the St. Croix River, are Bocabec Bay, and Bocabec, Digdequash, and Magaguadavic rivers. At the mouth of the bay and farther east are Back Bay, Letite, L'Etang, and Beaver harbors, which are also included in this region. The most favorable locations for weirs are at the mouths of the rivers, in the small bays and coves, and about the shores of the islands.

The depth of water in many places is from 25 to 30 fathoms and in the deeper channels from 40 to upwards of 60 fathoms. The rise and fall of the tide varies from 20 to 22 feet. The entrance for large vessels is at the east side, and the main ship-channel lies between Deer and Campobello islands. Small vessels frequently enter at West Quoddy Head, and, coming through West Quoddy Bay, pass through the Narrows at Lubec, but the water is not of sufficient depth for large vessels, except at high tide.

This bay is supplied with many varieties of fish common to the New England coast, while in the rivers tributary to it there are considerable quantities of alewives, salmon, and smelt. It seems, however, to be especially adapted for herring, which occur in its waters in greater abundance than any other species. Its location being at the mouth of the Bay of Fundy, a habitat of the herring; its natural characteristics of bottom, abounding in sea-plants and crustacea, and its strong currents running in various directions among the numerous islands and along the irregular shores, make it a favorite feeding-ground and one of the most productive fishing-grounds for this species on the Atlantic coast.

Growth and extent of the weir fishery.—Brush weirs for the capture of herring and other species are said to have been introduced into Passamaquoddy Bay about 1820. They gradually increased in number with the discovery of their efficiency for the purpose for which they were adopted and the growth of the demand for their product. They were first set at the west end of Campobello Island and along the shores of North Lubec, but are now distributed all around the shores of the bay, in the tributary bays and rivers, and about the islands in almost every suitable locality. At first they were not very successful, which was probably due to the lack of knowledge on the part of the fishermen as to the selection of favorable places for setting them, but in 1828 they were successfully operated and have since practically superseded the use of all other apparatus in the herring fisheries in these waters. In the upper part of the rivers they are set for smelt and salmon, but are used in other localities almost exclusively for the capture of herring. A few herring for smoking purposes are still taken with dip nets by the light of torches, which is the method known as "torching," and at times seines have been used to some extent, but the large quantities of herring utilized in the preparation of sardines are now taken in weirs.

There is no record of the number of weirs fished in the bay prior to 1849. The number estimated to have been operated in that year, exclusive of those at Grand Manan, where they were introduced in 1835, was approximately 93. Of these, 65 were on the American shore and 28 on the Canadian islands. In 1879 the number had increased to 136, of which 62 were on the American side, and 74, including 11 weirs in the Lepreau, Beaver Harbor, and Letite districts, were on the Canadian side. In 1886 in the same territory there were 330 weirs, 88 on the American and 242 on the Canadian side. This increase in number was chiefly due to the enlarged demand for herring for sardines.

The development of the sardine industry caused a marked increase in the importance of the weir fisheries. The extent of the fishing territory on the Canadian side of the bay being much greater than on the American side, the Canadian fisheries were benefited in a corresponding degree. Their prosperity, both as to the quantity of herring marketed and the price received, has kept pace with that of the sardine industry, from the fact that the greater part of the herring used for canning purposes has been derived from the Canadian weirs.

The weirs vary in number each year, and the catch, while depending more or less upon the abundance of herring, is governed largely by the requirements of the canneries. In recent years there have not been so many weirs operated as there were in 1886. This does not necessarily imply that the fishery has decreased, but simply that the catch, which has been as large and sometimes larger than at that time, has been taken with less apparatus. In 1893 the number of weirs on the American side of the bay, including those in West Quoddy Bay, was 47, and on the Canadian side, including those as far east as Beaver Harbor, there were 193, making a total of 240, or 90 less than in 1886.

In 1895 there were 53 weirs operated by American fishermen. They were located as follows: From Robbinston to Kendall Head, 9; at Treat Island, 1; in East Bay, 8; in Pennamaquan River, 6; at Seward Neck, 2; in Johnson Bay, 2; and in West Quoddy Bay, 25. A number of those in the last-named locality were on the disputed grounds south of Lubec Narrows and along the Campobello shore, and were owned chiefly by Lubec fishermen. A more detailed statement is given in the following table, which shows the extent of the American weir fishery in Passamaquoddy Bay in 1895:

Designation.	No.	Value.
Fishermen	139	....
Sailboats	78	$5,696
Rowboats	72	868
Pile-drivers	11	230
Rafts and reels	43	515
Weirs	53	18,300
Weir seines	52	2,224
Dip nets	105	500
Scoop nets	141	150
Total value	....	28,483
Herring taken* ....hhds.	9,684	15,134

*A small quantity of herring taken by "torching" is included. It should also be explained that the figures relating to the catch are an estimate based on data received from the canners, smokers, and fishermen, and are intended only as an approximation.

During the same season there were, exclusive of 3 weirs on the southeast side of Campobello Island, 228 in the territory belonging to New Brunswick. Of these, 104 were located about the islands in the outer section of the bay, 35 north of the Magaguadavic River, and 89 from that river to Beaver Harbor, inclusive, making a total of 281 weirs on both sides of the bay. In previous years considerable quantities of herring were obtained from weirs in the vicinity of Point Lepreau, but the abundance of the catch in 1895 rendered it unnecessary to transport them so great a distance.

Product of the weirs.—The total product of the American and Canadian weirs can not be definitely stated, but some idea of the large quantity of herring taken in them during the season may be gained from the fact that there were used in the canneries, smoke-houses, salting-sheds, and for fertilizing purposes at Eastport, Lubec, and the adjacent localities 47,979 hogsheads, or 239,895 barrels, weighing about 47,979,000 pounds, the value of which to the fisherman was approximately $99,845. Of this quantity, 36,431 hogsheads were used for sardines, 9,675 for smoking, 1,799 for pickling, and 74 for fertilizer. This comprises the entire catch, with the exception of possibly a few thousand hogsheads used in New Brunswick for similar purposes. It is probably the largest quantity that has ever been taken in these waters in one season, and considerably exceeds that of 1893 and 1894, but the price was much lower than in those years, averaging only a little over $2 per hogshead, which made it a very unprofitable year for the fishermen. Although the fishery has been prosecuted vigorously for the last twenty years to supply the constantly increasing demand, the fish were observed to be more than ordinarily abundant. To this fact and the prevailing low prices during the year for sardines and other fish products may be attributed the low price received by weir fishermen for herring.

Description of brush weirs.—The brush weir is perhaps the most primitive form of apparatus in use at the present time in the fisheries of the United States, but it has proved to be especially well adapted for the capture of herring. Its origin is not definitely known, but it is supposed to have been first used either by the Indians or early white settlers about the shores of Nova Scotia. Its use in that region led to its introduction into the fisheries of Passamaquoddy Bay. Modifications of this device may be found in various sections of the country, but the typical brush weir is confined chiefly to the coast of Maine and is more numerous in Passamaquoddy Bay than elsewhere. The principle which it involves, so far as its effectiveness for fishing is concerned, is essentially the same as that of the ordinary pound net. The fish are led into a large inclosure by means of long leaders and wings, which usually terminate in a funnel-shaped entrance. Their escape is prevented by the extension of these wings into the inclosure, thereby forming a triangular hook at each end of it, so that the fish, as they circle around inside the weir, are directed past the entrance. In some instances a "drop" made of netting arranged at the mouth of the weir is used for this purpose. After the fish have entered the drop is let down and completely closes the weir.

The form of the weir varies according to the nature of the bottom or shore where it is located, and the different forms are sometimes designated by names which indicate their characteristics. A weir located beside a bar where the bar is left bare at low tide and serves as a part of the inclosure is termed a "bar weir"; one located near the shore, with perhaps one wing extending diagonally into the water while the shore answers the purpose of a wing on the other side, is called a "shore weir." "Channel weirs" are located in a channel between islands or ledges where the fish are known to pass through.

These forms are usually semicircular, with wings or leaders running from the inclosure to the shore to direct the fish into them. Another variety commonly used more closely resembles the ordinary pound net in its arrangement. It consists of a semicircular pound or inclosure with long wings extending out diagonally on either side and a leader or "center fence" running toward the shore. This is sometimes called a "patent weir." It has the advantage of capturing fish on either the ebb or flood tide, while other forms often fish only when the tide is setting in one direction or the other, as the case may be.

The location of the weir is an important consideration. The herring travel along the channels or where there are strong currents, and usually against the tide; hence it is necessary that the weir be placed so as to intercept their course. Their habits are closely observed by the fishermen, and wherever they are known to frequent the weir is placed and arranged as may be best calculated to lead them into it.

Construction of the weir.—Brush and poles comprise nearly all the material used for building weirs. In building a weir the usual method is to first drive the mouth stakes. These are placed from 15 to 20 feet apart. The stakes to form the body of the weir are then driven about 3 feet apart. The length of the stakes is from 18 to 35 feet, according to the depth of water in which the weir is set, and they are about 6 or 7 inches or more in diameter at the butt end. They are driven into the bottom, which is usually mud, about 6 feet. Brush is then woven in and out between the stakes alternately, beginning at the bottom and filling up toward the top. The brush under water is pushed down in place by means of an implement called a spudger, which consists of an iron head a foot or more in length, with prongs projecting at each end and having a handle some 10 or 12 feet long. The brush is laid horizontally and in such a manner that the ends in one row will be overlapped by the centers in the next row. Frequently, after the stakes have been thus filled a binder, also made of brush, is placed on top. Brush is then inserted perpendicularly through the binder and shoved down securely in the brush below. The wings and center fence are built similarly.

The length of the wings is generally from 35 to 40 feet inside the weir and from 75 to 100 feet outside. The entrance to the weir at the ends of the wings or "hooks," as the section of the wings inside the weir is called, is about 10 to 12 feet. The leader or center fence is about 125 stakes, or 375 feet in length. The leader does not always begin close to the shore, but often at a greater or less distance from it, as circumstances may require, nor does it extend all the way to the entrance of the weir, but usually terminates within about 25 or 30 feet of a line drawn from one mouth stake to the other, and a still greater distance from the "hook" stakes, or those at the ends of the wings.

In some instances the weirs are not brushed in the manner above described, but after the brush is filled in at the bottom as far up as the surface of the water at low tide long strips or ribbands are spiked on to the outside of the stakes. These are placed some 3 feet or more apart. Brush is then interwoven perpendicularly, reaching to the top of the weir, and completes it without further binding. This method is said to take less material and make the weir lighter and less liable to be torn away by the tide.

Still another method is to drive the large stakes farther apart and construct sections on shore with smaller stakes held together by ribbands and interwoven with brush to within 3 feet of the bottom of the stakes. They are then carried out to the weir by means of boats and shoved down into the mud between the large stakes and firmly secured. In this manner all the spaces are filled till the lower section of the weir, or the part that is under water at low tide, is completed. Ribbands are then spiked horizontally on the poles above the low-tide mark and the upper part of the weir filled in with brush placed perpendicularly. But the method first described is said to be more commonly practiced in West Quoddy Bay and other sections along the American shore.

The poles used in weirs are generally of white birch. The material at the bottom below low-water mark is chiefly spruce and cedar, because of their more brushy character, the lower part of the weir requiring to be as closely woven as practicable. Birch and alder brush, the former being preferable, are used for the upper part. Boats are used both for carrying material and doing the work while the weir is in course of construction. When the weir is completed, long brush with bushy tops is placed at the ends of the wings and leader and at the bunt or extreme off-shore part of the inclosure as signals, so that the location can be seen by vessels, in order to avoid damage by collision at high water, when the weir is almost wholly submerged.

Other methods of building weirs are sometimes resorted to. In localities where the bottom is rocky and poles can not be driven a large platform is constructed of planks and timber into which the poles are set. After the framework is completed the platform is sufficiently ballasted with stone to sink it to the bottom. The weir in other respects is built in the usual manner.

Cost of weirs.—Weirs are built in the spring from April 1 to June 1. It is customary in the fall, after the fishing is over, to remove the brush from the upper part of the weir and save it for use the next season. It is therefore necessary to rebuild all the weirs every year. In addition to replacing the brush, which has been removed, much other work frequently has to be done to put the weir in proper condition for fishing. The storms and ice during the winter are liable to destroy some of the poles or cause other damage, which has to be repaired. The expense of these repairs each season is often considerable.

The cost of building a new weir depends largely on its size and location. Some of the weirs are small or located where a ledge or bar or the shore can be utilized to form either a part of the inclosure or serve the purpose of a wing or leader, thereby lessening the extent of hedging required. The cost of those located in sheltered positions is also reduced on account of not having to be built of so heavy material. In other instances the weirs are located in open water and exposed places where all the parts have to be constructed of brush and poles and very strongly built to resist the greater force of the sea. In localities of this kind the additional material and labor required make the weirs much more expensive. The cost of building a weir, therefore, varies from about $40 to $1,000, the average cost being from $200 to $400.

It is customary for a number of men, usually from two to five, to build, own, and operate a weir together in equal shares. In many instances the proprietors of factories and smoke-houses own a share in the weirs and furnish their share of the capital and quota of men to build and operate them. The length of time occupied in building an ordinary weir varies from about three to six weeks. The work is generally done by the fishermen.

Names of the weirs.—The fact may not be wholly void of interest that, notwithstanding the large number of weirs operated in this region, it is customary with the fishermen to give each weir a name. Although the names are frequently more original than elegant, they serve the useful purpose of distinguishing one from another when speaking of them, which might otherwise be difficult. They are sometimes named for one of the owners, or on account of some characteristic manner, habit, trait of character, or circumstance connected with his personal history, or perhaps owing to some incident that occurred while the weir was being built, or possibly from its location. The following are the names of some of the weirs in West Quoddy Bay: Godfrey weir, Yankee Doodle, Wild Man, Phelps weir, Haddock Point weir, Longstakes, Hyder Ali, Raffler, Dicebox, Grasper, Greenback, Democrat, Jeff Davis, The Colonel, Jews-harp, and Uncle Sam. The owners recognize the names and use them when referring to their weirs.

Fishing season.—The season for fishing weirs, as prescribed by State law, is from April 15 to December 15, but it is seldom that fishing begins as early as the legal season allows. The sardine canneries do not open before May 1, and many of them not before August, consequently there is not much demand for fish until May or June. In recent years the fish have not been very abundant in the early part of the season, and this circumstance, coupled with the limited demand, has made it unprofitable to operate the weirs until later in the summer. The best fishing is said to occur from about the first of August to the end of November. There is also a better demand for the fish at that time than earlier, both for canning and smoking purposes. But the weirs are put in order by the first of June, and the fishing is prosecuted as vigorously as the abundance of fish and the demand for them may warrant until the end of the season.

Seining the weir.—The stationary character of all the parts of a weir make it necessary to use a seine for taking out the fish after they have been entrapped. The seines used for this purpose vary in length according to the size of the weir, but are usually from 18 to 22 fathoms, or 108 to 132 feet. They vary in depth from 10 to 18 feet at the ends and from 15 to 30 feet in the middle or bunt. The size of the mesh is 1 inch stretched. They are made of about 9 thread No. 20 cotton twine. Linen twine is never used for weir seines. The floats, which are either of cork or cedar, are placed 6 inches apart or thereabouts and the leads about 4½ inches apart. A stone or iron weight of about 50 pounds is sometimes attached to the lead line at each end of the seine to keep it close to the bottom. A purse line extends around the bottom of the seine, passing through a series of 2-inch iron rings, which are attached to the lead line about 3 feet apart. The seines cost when new from $40 to $60 each. Very large ones sometimes cost as high as $75 or $100 each.

In operating the weir from two to five men are engaged, each one of whom has a boat and is either an owner or represents one of the owners in the weir. The seine, like the weir, is owned on shares. The time selected for seining the weir is at low tide, whether in the day or night, for it is customary to fish on both tides. In most instances the seine is kept on a seine-reel located on a raft, which is moored near the weir; in others it is taken ashore to dry, and is carried out to the weir each time in one of the boats. In the night torches are used if a light is required to see whether there are fish enough in the weir to warrant the labor of hauling the seine, or for any other purpose in which a light might be necessary to the men in their work. When the time arrives to haul the seine, the boat containing the seine is taken inside the weir. Attached to each end of the seine is a pole or staff. One of these poles is pushed down into the bottom beside one of the hook stakes at the mouth of the weir and made fast to it. The seine is then stretched across the entrance and the boat is gradually moved around the sides of the weir, thus drawing the seine around the weir until the two ends are finally brought together with the fish inclosed in it. The bottom of the seine is then pursed up, the top being hauled in at the same time. In this way the fish are brought together in a body sufficiently compact to enable the fishermen to dip them out of the seine into boats.

The fish are dipped out of the seine with large dip nets. The bow of the dip net is from 3 to 5 feet across; the handle is about 12 feet long, and the bag, which is made of twine, is from 6 to 8 feet deep. The nets cost from $4 to $6 each, and form a part of the equipment of each boat. One of these nets will hold from 3 to 4 barrels of herring. The net is dipped in among the fish and filled. It is then lifted and the bow brought over the gunwale of the boat, the mouth of the net being turned downward with the handle extending lengthwise of the boat and resting across the thwarts. With the net in this position the men pull in on the twine, which causes the fish to slide out of the net into the boat. This process is termed "rolling" them into the boat and relieves the men of the necessity of lifting so large a quantity of fish, the weight of which would be, when taken from the water, from 600 to 800 pounds. So long as the fish are in the water their weight is not appreciated, because they support themselves. When the work of taking out the fish is completed, the seine is thrown back into the water and the fishermen begin at one end of it and haul it into one of the boats in regular order. In this way it is washed and prevented from tangling. It is then replaced on the reel or carried ashore, as the case may be, and dried ready for use at the next tide.

The method of disposing of the fish as they are taken from the weir varies according to circumstances. In most instances regular collecting boats for transporting fish visit the weirs while the seining is in progress. If one of these is present the fish are carried to it by the weir boats, and after being dipped with scoop nets into baskets and measured they are put on board the collecting boat and transported to the canneries and smoke-houses. Fish that are too large for sardines are utilized for salting and smoking purposes. The proceeds arising from the sale of the fish are divided equally among the owners. In some localities many of the weir fishermen carry on the smoked-herring business quite extensively and utilize all their own catch, except the sardine herring. Their boats are much larger than the regular weir boat, so as to be suitable for transporting the fish as well as for fishing the weir. In cases of this kind the fish are divided among the owners, each one taking his share as they are dipped from the seine.

A peculiar custom obtains with reference to dividing the fish or proceeds in case of one or more of the owners of the weir being absent and not participating in the fishing operations. If the number present is not less than two, the weir is seined and the proceeds divided equally between those who are there. The investment of the other owners in the weir is not taken into consideration. This is what is termed "shooling" the owners who are absent. If none of the owners are in attendance and other fishermen discover that there are fish in the weir, they are at liberty to seine it and appropriate the catch to their own use. The weir is then said to have been "shooled."

Weir boats.—Open sailboats are generally used by the American fishermen for operating the weirs, because so many of them utilize a considerable part of their catch in the preparation of smoked herring and require a boat that can be used for transporting fish as well as for seining the weir. The boats vary in length from 16 to 20 feet on the keel and from 20 to 26 feet over all. The width is from 7 to 9 feet amidships, and the depth from 3 to 3½ feet. The bow is sharp, with a moderately raking stem, rounding at the foot. The stern is also sharp in most instances, and rakes rather more than the stem. The sternpost rises flush with the gunwale, and sometimes slightly above it. The bottom is straight and the keel is about 6 inches in depth outside of the planking. The stem and stern are both high, and the gunwale has a strong sheer. The older boats are clinker-built, but most of the new ones are carvel-built. There is a washboard from 8 to 16 inches wide, with a coaming. The ceiling runs the entire length of the boat, and there is no floor. The ballast, consisting of stones, is placed on top of the ceiling. There are five thwarts. Kidboards are used under the forward and after thwarts, and in large boats under the center one, but seldom under the other two; these provide two compartments for convenience in carrying and handling fish. There is a forward and after standing room, and a cuddy in the bow and stern. The steering gear is hung on the outside and operated with a tiller.

The boats are timbered with oak, white ash, or hackmatack. The knees are usually spruce. The planking is white pine from three-fourths to seven-eighths of an inch in thickness. The washboards are of pine, the coamings oak or ash, and the thwarts spruce. Only one mast is used, the length of which varies from 22 to 30 feet. It is stepped well forward, being from 2 to 4 feet from the stem, according to the size of the boat, and is not supported by standing rigging. A mainsail, rigged with gaff and boom, is the only sail carried. It varies in area from 40 to 60 yards. Each boat is supplied with one pair of oars and a small anchor weighing about 15 pounds and having a 2½-inch manila cable. The boats are generally very round on the bottom, so that they will roll down easily when the fish are being dipped from the seine. A square-stern boat is rarely seen. They differ from the sharp-stern boats mainly by having no keel and being fitted with a centerboard. The greater number of the boats are built at Lubec, and cost from about $100 to $200 each, and their carrying capacity is from about 5 to 10 hogsheads of fish.

Rowboats.—Small rowboats are also used to some extent as tenders to the sailboats. These are either ordinary dories, 15 feet in length, and bought mostly at second hand and costing not more than from $7 to $10 each, or small, round-bottom boats built new for the business. The latter kind are called "gigs" or "dingies." They are from 11 to 15 feet in length on top, and from 3 to 3½ feet in width, with two to three thwarts, and have one pair of oars. They cost from $10 to $18 each, according to their size. They are used for plying between the sailboats and the shore, and for various work while fishing the weirs when a larger boat could not be so conveniently managed. Large rowboats of a similar description, varying in value from $20 to $50 each, are also used in some localities for fishing the weirs. In some instances they are only used for operating the seine, the fish being carried in a sailboat; in others they serve both purposes.

Collecting boats.—Collecting boats are used for transporting herring from weirs to the canneries and smoke-houses. Each cannery employs from one to four, and sometimes a larger number, of these boats, but fish for the smoke-houses, especially those not connected with the canneries, are more often transported by the boats used in fishing the weirs. The greater number of collecting boats are large, sloop-rigged sailboats, averaging from 28 to 30 feet in length and costing when new about $300 each. In some instances small vessels of both sloop and schooner rig are used for collecting fish. Nearly all of the vessels and boats have sharp or "pink" sterns. They vary greatly in size, and for the whole fleet range in value from $75 to $1,000 each. The carrying capacity of the sailboats is from 5 to 10 hogsheads of herring, and the vessels often carry a much larger quantity. Small steamboats are also used to some extent for carrying fish and towing the sailboats when the wind is unfavorable or insufficient for the use of sails. Tarpaulin is used on open boats for covering the fish to protect them from the sun, while the hatches serve that purpose on larger craft. The boats are usually owned by the boatmen and have a crew of 1 or 2 men each.

The number of vessels and boats employed by the canneries in 1895 as collecting boats and lighters was 88, valued at $32,437. In addition to these, there were 26 employed by the smoke-houses, having a value of $8,756, making a total of 114, valued at $41,193.

THE SMOKED AND PICKLED HERRING INDUSTRY.

General note.—Smoked and pickled herring are prepared more extensively at Eastport and Lubec than in any of the other localities in this region or elsewhere in the State. The smoking of herring was introduced at Eastport in about 1808, and at Lubec in 1812. The two places had a population at that time of about 1,500. It is probable that herring were pickled and packed in barrels for market by the fishermen of this section before the beginning of the present century. The smoked-herring trade, which is the more important of the two branches, increased with considerable rapidity and eventually became a large industry. It is estimated that the quantity of herring smoked each year from 1845 to 1865 was not less than 500,000 boxes. After the close of the civil war the demand fell off to some extent, and during the period of the Washington treaty, from July 1, 1873, to June 30, 1885, it was so reduced by the large importations of smoked herring from the British Provinces, which were admitted under the terms of the treaty free of duty, that in 1880 the output for the entire State was only 370,615 boxes, or 4,434,111 pounds, having a value of $99,973. In the meantime the imports increased from 1,029,095 pounds valued at $34,670 in 1874, to 10,441,355 pounds valued at $129,034 in 1885. Since 1885 the industry has gradually regained its former importance, and was probably more extensive in 1894 and 1895 than ever before. In the year following the abrogation of the treaty the imports for consumption dropped more than one-half, being only 4,246,970 pounds, and have since continued to decrease, while the exports have practically doubled.

Pickled herring are usually packed in the salting sheds connected with the smoke-houses, the work being performed by the same persons who are engaged in the smoking operations. There is, therefore, seldom any extra outlay for buildings in which to carry on this branch of the industry. The season for smoking and pickling is chiefly from the 1st of August to the middle of December.

Description of smoke-houses.—The smoke-house is generally only one of a number of buildings used in carrying on the smoked-herring industry. In addition to it, there are sheds and shops of various kinds, in which is done a variety of work incidental to the business. There is a shed for pickling and salting herring, a shop in which the smoked-herring boxes are made and where the herring are packed, and there is sometimes a cooper shop for use in making herring barrels. The buildings are usually located on a wharf or near the shore for convenience in landing the fish from the boats. The frame of the smoke-house is covered with boards and made sufficiently tight to prevent the smoke from escaping. There are board windows in either side and ventilators in the roof. The latter are provided by arranging the boards on either side of the ridge-pole, so that they can be raised or lowered by means of cords attached to levers. The building is entered by large doors in the end. The value of the smoke-houses, including the sheds and equipments, varies from $60 to $3,500 each; for an entire stand of buildings the average value is from about $200 to $500.

In the early days of the industry the smoke-houses were very inexpensive, being built of slabs obtained at small cost from the sawmills in the vicinity. A very few of these primitive structures, now almost a century old, are still in use, but in most instances they have been replaced by better ones. As the business increased larger smoke-houses were built in order to make it possible to meet the greater demand for the product. The largest one now in use is at Lubec. The length of the building is 231 feet, 115 feet of which is included in the smoke-house, and 116 feet in sheds of various kinds. The width is 25 feet, the length of posts 16 feet, and the height of the ridge-pole 29 feet. The smoke-house is divided into three compartments, each having 10 "bays" or spaces in which to hang herring, and its capacity is about 45,000 boxes of medium or 60,000 boxes of large herring. It is as large as three smoke-houses of the ordinary size. The smoke-houses have no floors, as the area has to be used for the fires. The interior is arranged with a series of vertical rows of 2 by 4 inch scantlings. The spaces between the rows are termed "bays," and are 38 inches in width. The scantlings in each row begin near the ridge-pole and extend horizontally crosswise of the building, each one being placed from 13 to 14 inches below the other, to within 6 or 8 feet of the ground. In smoke-houses of the average size there are usually 10 "bays," and the capacity is about 15,000 boxes of medium or 20,000 boxes of large herring.

Equipment.—The only equipment used exclusively in a smoke-house are the herring sticks. A large number of these are necessary in the larger houses, as it requires on an average about two sticks to each box of herring. The sticks are prepared at the sawmills in long strips. The size of the sticks as they come from the mill is one-half inch square for medium and five-eighths inch square for large herring. After being cut into lengths of 3 feet 4 inches each, the edges taken off, and one end sharpened, they are ready for use. They cost at the rate of about $3 per 1,000 at the mill, and are estimated to be worth from $4 to $5 per 1,000 after being made at the smoke-house.

The pickling and salting shed is supplied with wooden tanks for use in pickling the herring. These are from 7 to 8 feet long, 5 feet wide, and 3½ feet deep, having a capacity of about 4 hogsheads, or 20 barrels, of herring each. From 2 to 9 tanks are required in each salting shed. In many instances hogsheads are used instead of tanks. There is also a variety of other utensils, such as tubs, baskets, shovels, and "herring horses." The latter consists of an oblong wooden frame having four legs, the sides extending far enough beyond the end to serve as handles. It is used to hang the herring on to dry, after they are strung on the sticks and before putting them into the smoke-house. Its capacity is from 25 to 30 sticks of herring. The cost of the whole outfit for a smoke-house and salting shed varies from $50 to $500.

Materials.—A large quantity of material is used in preparing smoked and pickled herring. The lumber of which the herring boxes are made is usually of spruce or fir, and is manufactured at the sawmills into what are termed "shooks." A "shook" consists of the bottom, cover, sides, and ends for one box. The boxes are made, that is, nailed together, at the smoke-house. The dimensions of the shooks depend on the size of the boxes. The bloater boxes are 18½ inches long, 11½ inches wide, and 7½ inches deep in the clear. The thickness of the ends is seven-eighths inch and of the other parts three-eighths inch. The regular herring boxes are 12 inches long, 6½ inches wide, and 2¾ inches deep, the thickness of the ends being five-eighths inch and of the other parts one-fourth inch. The "bloater shooks" cost from $60 to $70 and the "box shooks" from $9 to $12.50 per 1,000, which is the material for that number of boxes. Although the shooks are one of the largest items of expense, other materials, such as nails, wood, salt, and barrels, cost considerable in the aggregate. The amount paid for shooks in 1895 was $16,970; nails, $1,313; wood, $4,124; salt, $8,461; barrels, $5,257, making a total of $36,125, being nearly one-third the entire cost of producing the pack of smoked and salted herring.

Herring utilized.—The herring utilized for smoking and salting are derived chiefly from the weirs in Passamaquoddy Bay and its tributary waters. In 1895 the quantity obtained from the American weirs in the bay for these purposes was 5,903 hogsheads, valued at $12,121, and from the Canadian weirs 5,571 hogsheads, which cost $20,036. The average value per hogshead of the former was $2, and of the latter about $3.60. This difference is explained in a measure by the fact that a large part of the American fish was smoked by the fishermen, who carried them to the smoke-houses in their own boats, while those from the Canadian weirs were collected at the rate of $1 per hogshead. A considerable quantity of herring was also obtained from other sources. From Machias Bay there were 1,296 hogsheads, costing $4,605; from Grand Manan, 935 hogsheads, $2,323; from the Magdalen Islands, 768 hogsheads, $4,669, and from Newfoundland, 174 hogsheads, $1,740. The total quantity used was 14,647 hogsheads, or 73,235 barrels, the cost of which, landed at the smoke-houses, was $45,494. Of these, 12,148 hogsheads, costing $36,215, were smoked and packed in boxes, and 2,499 hogsheads, costing $9,279, were salted in barrels. The herring from Passamaquoddy Bay, Machias Bay, and Grand Manan are received in a fresh condition, while those from the Magdalen Islands and Newfoundland are cured on board the vessels and need no further salting after they arrive at the smoke-houses. The Newfoundland herring are used largely in preparing the grade of smoked herring termed "bloaters," but those from the Magdalen Islands do not serve that purpose so well and are generally either packed in barrels as round herring or smoked and packed in regular boxes lengthwise.

Pickling.—When the fresh herring, intended for smoking, are landed at the salting sheds, they are immediately put into the pickling tanks, which have first been partially filled with a weak pickle. The pickle is made of salt water with about 1½ bushels of Liverpool salt or a smaller quantity of Cadiz or other coarse salt in each tank. The salt is stirred in the water until it is wholly dissolved. If the fish are poor the water is sometimes used without the salt being added. The quantity of fish which is at first put into the tank is generally from 2 to 3 hogsheads, or enough to be of sufficient weight to rest or, as the fishermen term it, "ground" on the bottom. A light layer of salt, or about one-half bushel, is then distributed over them, after which another layer of fish of from 1 to 2 barrels is put in. This is again covered with a layer of salt rather heavier than the first, being from 1 to 1½ bushels. The remainder of the fish necessary to fill the tank is then put in and covered with from 3 to 5 bushels of salt. Each tank when filled contains 4 hogsheads of fish, and the quantity of salt used on them varies from 6 to 9 bushels, according to their size and fatness and the condition of the weather. It is also necessary to have the greater part of the salt at the top of the tank, so it will not work down through the fish and lodge at the bottom without being dissolved. In that case the fish at the bottom are liable to become too salt and those at the top not salt enough. For smoking purposes the fish are pickled in a round condition as they come from the water. When hogsheads are used instead of tanks the quantity of fish and salt in each layer is regulated to correspond with the capacity of the hogshead.

The small herring are generally allowed to remain submerged in the pickle from 24 to 36 hours, and the larger ones, especially if they are very fat, about 48 hours and sometimes a longer period. If the herring are small and not fat, the length of time required for them to "strike" may not exceed from 12 to 15 hours. Fish will also absorb salt more readily in warm than in cold weather, and if they have been caught a few hours before being salted they do not require so long a time in the pickle as when immediately taken from the water.

When the fish have been properly "struck" or salted, if the weather is fine, so as to afford them an opportunity to dry before being put in the smoke-house, they are taken out of the pickle; but it sometimes happens that the weather is rainy, and they have to remain in pickle much longer than would otherwise be necessary. As a result they become more or less oversalted. In such cases, when favorable weather returns, they are taken out and put in tubs of salt water to be freshened or "soaked out." Newfoundland and Magdalen herring, which are heavily salted on board the vessel when caught, invariably require to be treated in this manner before being smoked. Generally about four tubs of water are used, which are in succession filled with fish. As soon as the last tub is filled the fish are taken out of the first one, and then out of the others in regular order, each tub being at once refilled with other fish, and this process is continued until all the over-salted fish have passed through the water, remaining there only long enough to secure the desired result. If the quantity of fish is large the water in the tubs is changed whenever requisite. It is customary to use salt water for nearly all purposes. The fishermen and smokers claim that fresh water has a tendency to make the gills of the herring tender, and more liable to break and allow the fish to fall from the sticks after being hung in the smoke-house. They also think that the salt water makes the flesh of the fish more firm and not so apt to become soft after being smoked. The salting sheds are, therefore, sometimes furnished with steam pumps for obtaining the necessary supply of salt water.

Herring are also salted in considerable quantities, in both a round and split condition, to be packed in barrels. In the process of pickling them for this purpose more salt is used and they require to remain a longer time in the pickle. When salted round, the fish are put into the tank in thin layers, each of which is covered with a layer of coarse salt, the quantity of salt being increased toward the top of the tank until the last layer is about 2 bushels. The quantity of salt required to each tank of fish is 10 bushels or more. They are then allowed to remain in the pickle from 6 to 10 days. If the fish are to be split before being salted, they are first put into the tanks in pickle round, and are then taken out almost immediately and laid on the tables to be split or dressed. They are split down the belly, gilled, and eviscerated. The heads and tails are not removed and the roes are left in. They are then washed in salt water and returned to the tanks in strong pickle.

The first layer is about 2 hogsheads, after which about 2 barrels are put in at a time, and each layer is well covered with salt. The fish are allowed to stand two or three days and are then stirred with a spudger, an implement made of a thick piece of board a few inches wide and about 10 inches long and nailed in the center to the end of a wooden handle. After being "broken up" they are given a layer of salt and allowed to stand about five days longer. While the fish are being cured the pickle is closely watched, and whenever necessary more salt is added to keep it "sweet" or in good condition. Great care is taken to keep the fish completely submerged with pickle. Boards supporting heavy weights are frequently laid on them for that purpose. The quantity of salt required for split herring does not differ materially from that used when pickling them in a round condition. After the fish are thoroughly cured they are taken out of the tanks and packed in barrels for shipment.

Scaling.—It was formerly customary to remove the scales from the herring intended for smoking purposes before taking them from the boat. The fishermen, with their rubber boots, walked through the mass of fish without lifting their feet, and the contact of the fish with each other and with the legs of the men removed the greater part of the scales. This laborious process was called "treading them out." It is said to have begun in 1820 and was continued until about 1880. Another method of scaling the fish during that period was to stir them with a spudger. In recent years it has not been considered necessary to resort to these or other methods for removing the scales, since the frequent handling which the fish undergo renders them practically scaleless when they reach the smoke-house. The scales of the herring come off very easily when the fish are first taken from the water, but if allowed to dry they become set and are removed with difficulty. The methods for removing them above described insured a more thorough and uniform scaling of the fish than would otherwise be effected, but if the work was not carefully performed it was liable to result in bruising the fish and in an increased loss in "broken-bellied" herring.

Stringing.—When properly salted, the fish are taken out of the pickle to be strung on herring sticks, preparatory to being hung in the smoke-house. This is done with ordinary dip nets, or "wash nets," as they are called in this locality. As the fish are dipped out they are washed or rinsed in the brine with the nets, after which the pickle is allowed to run off of them and they are laid on the stringing tables. The dipping and stringing proceed simultaneously.

The "stringers," or persons who string the herring, are of both sexes, the females often predominating in number. In some instances the fishermen do the work themselves, but generally men and women and boys and girls are hired for this purpose. The number of stringers employed in each smoke-house varies from 2 to 8 and sometimes more, according to the amount of work to be done. They receive 20 cents per 100 sticks for stringing large herring and bloaters and 25 cents for small herring. The cost of stringing is estimated to average ½ cent per box, but is probably a little less than that. At these prices each stringer can earn from $1 to $2 per day. There are from 25 to 35 herring on each stick, and a person can string from 500 to 1,000 sticks in a day. The work is performed very rapidly. The herring is taken with its back in the palm of the right hand, the stick being held by the blunt end in the left hand; the left gill-cover is then raised by a movement of the right thumb and the pointed end of the stick is inserted and passed through the mouth, the fish being moved down to its proper place. The work is often done by reversing this order, the fish being taken in the left and the stick in the right hand, but in either case the herring when strung hang on the stick with their backs toward the stringer.

As a wage-producing occupation stringing is not considered important. If the stringing of the entire pack of 1895 had been paid for at the rate of one-half cent per box for regular herring and 3 cents per box for bloaters the amount would have been $7,592, which is considerably more than was actually paid, as part of the work was done by fishermen. The number of stringers employed being 271, the average amount of wages received by each was, therefore, less than $28.

Draining and drying.—After the herring have been strung on the sticks they are washed in a trough of clean salt water and hung on the herring horses. They are then carried out into the open air, where they are allowed to remain until the water drains off of them and they have become sufficiently dry to hang in the smoke-house. The time required for drying varies according to the condition of the weather, but is usually from one to several hours. The drying not only hardens the gill-covers and prevents the fish from falling from the sticks in the smoke-house, but it also improves their quality when smoked. The work of stringing and drying the herring is generally done in the fore part of the day and in the afternoon they are hung in the smoke-house. If the weather is not fine it is sometimes necessary to dry the fish in the smoke-house, after leaving them in the open air long enough for the water to drain from them. When this method is resorted to the doors and windows are opened to give a free circulation of air and fires are kept burning until the drying is completed.

Filling the smoke-house.—The smoke-house is not usually filled all at one time, and it often happens that the work occupies several weeks. The herring are taken care of as fast as they are obtained from the weirs, the time required to fill the smoke-house depending somewhat on the abundance and constancy of the supply. If the supply is steady, the work progresses as rapidly as herring can be prepared; otherwise the period may be extended to three or four weeks, and perhaps longer.

When the herring have been sufficiently dried in the sun they are carried on the herring horses to the smoke-house, where the sticks are placed in the "bays," their ends resting on the scantlings or beams on either side of each "bay." The work of "hanging" the herring requires the services of at least two men, and if a larger number are engaged in it they work in pairs. One man stands in the "bay," with his feet on the beams, while the other stands on the ground or floor and hands the sticks of herring up to him, two at a time, keeping the sharp end of the stick downward so that the herring will not slip off. The sticks are made long enough to reach across the "bay" and to nearly the center of the beams which support them at either end.

The lower part of the "bays" is usually filled first. The fires are then kindled and the herring smoked until they acquire a good color. When this is effected the fires are allowed to go down, the doors and ventilators are opened to let out the smoke, and the herring are shifted to a place nearer the top of the smoke-house. The lower part is then ready to receive another lot of fish. This preliminary smoking occupies from about twelve to fifteen hours. The work is continued in this manner until the smoke-house is filled. Two smoke-houses are very often filled at the same time. In that case, after the top of the house has been filled by shifting the herring, the lower part is completed by putting about three tiers of herring in each house on alternate days. When two houses are filled together, the work can be done in almost as short a time as would be required to fill one alone.

The object of putting the herring into the house by degrees, instead of all at one time, were that practicable, is to insure their becoming thoroughly dry before being finally subjected to the smoke, and also to smoke them more evenly and secure a greater uniformity of color. If a large body of fish were put into the smoke-house at once they would gather dampness and great difficulty would be met with in preventing them from spoiling. To fill a smoke-house holding 20,000 boxes of herring, in a proper manner, requires at least two weeks, and a somewhat longer period if two such houses are filled at the same time. The length of time also varies according to the size of the smoke-houses. Small houses may sometimes be filled in a few days.

After the smoke-houses have been filled the additional length of time required to complete smoking the herring is about three weeks. Regular herring are placed as close together on the sticks as possible without touching each other, the gill-covers generally keeping them far enough apart. The sticks, when hung, are placed about 3 inches from each other. Bloaters, owing to their larger size, need to be farther apart, both on the sticks and in the smoke-house, to allow the smoke to circulate more freely among them. They are usually hung by themselves at the bottom of the smoke-house, and while smoking are given all the heat they will bear. The "soft bloaters," which are intended for domestic use, and to be held on hand only a short time, are smoked about ten days, while the "hard bloaters" require to be smoked from three to four weeks. The smoke-house is closed while the herring are being smoked and the fires are constantly tended and kept burning in a smouldering manner, so as to produce the greatest amount of smoke.

Fires and wood.—The fires for smoking the herring are built on the ground at equal distances apart over the entire area of the smoke-house. The wood used is of various kinds, but white birch is generally preferred; driftwood, which has been soaked with salt water, is also used. The main consideration is to have wood that will burn slowly and produce an abundance of smoke. The fires are kept burning very slowly, the smoke-house being visited every few hours during the night as well as the day. If too much heat is generated the herring are soon damaged and may be completely spoiled.

Packing the herring.—The fish are not generally taken from the smoke-house until it is necessary to pack them for shipment. In the meantime, to prevent them from gathering dampness, the smoke-house is left open during the day and occasionally fires are kindled. When the time arrives for shipping them they are removed from the smoke-house to a shop or packing room, where they are assorted into grades according to their size and quality and packed in the herring boxes.

The principal grades, exclusive of "bloaters," are the "medium-scaled," "lengthwise," and "No. 1." Another grade, called "tuck-tails," are also packed to some extênt. The medium-scaled herring derive their name from the now obsolete custom of removing the scales before "striking" them in pickle. They are considered to be of a more desirable size and quality and sell at a higher price than any other grade of regular herring. It is customary to divide them into two sizes, known as large and small medium herring. They are packed crosswise of the box, and each box contains from 30 to 35 of the large and from about 45 to upwards of 50 of the small size, or an average of about 45 of the two combined. The lengthwise herring are larger than the medium-scaled, and receive their name from being packed lengthwise of the box. Each box contains from 15 to 18 fish of this grade. The tuck-tails, which are also crosswise herring, are so called from the fact that, being longer than the width of the box, the tails have to be tucked or bent over when they are packed. There are usually from about 20 to 22 in each box. The grade known as "No. 1" are the smallest and least valuable quality of herring and frequently sell for not more than 5 cents per box, each box containing from 60 to 75 fish. The "bloaters" are larger than the regular herring and are packed crosswise of the box, each box containing 100 fish. The number of regular herring to the box varies considerably, according to the size of the fish, and the dealers frequently indicate the size of the grade desired by stating in their orders the number to be packed in a box.

The fish for salting, when taken from the tanks, are rinsed or "washed out" in the pickle with the "wash nets" and laid on tables, from which they are packed in the barrels. The packer first scatters about a pint of salt over the bottom of the barrel and then closely packs the fish in single layers, each of which is covered with a pint or more of salt. When the barrel is two-thirds full, the quantity of salt to each layer of fish is increased to about 2 quarts. The barrel, when filled, is left unheaded for several days or a week for the fish to settle. About a half bushel of Cadiz or other coarse salt is used in packing a barrel of round herring and a larger quantity is required for split herring. When the fish have settled, the barrels are headed, and a hole is bored in the head or bilge, as the case may be, and strong pickle is poured in through a funnel. The barrel, being full of fish, will only hold about two buckets of pickle. The rule is to make the pickle strong enough to float a salted herring. It requires about 1½ bushels of Cadiz or 3 bushels of Liverpool salt to a hogshead of salt water. After a time the staves of the barrel become soaked with pickle and more pickle is added, as it is necessary for the barrel to be completely filled. The holes are then plugged and the fish are ready for shipment.

Markets and transportation.—The principal markets for smoked herring are Boston and New York. The greater part of the pack is shipped by the regular lines of steamboats, which make from one to two trips each week during the entire year, there being no railroad communication with Eastport and Lubec. A considerable quantity is also sent to New York and some to Boston by coasting vessels. When shipped by steamboat, the boxes, except those containing bloaters, are tied together in bundles of five boxes each to render them more convenient to handle. This necessitates the use of "fish ties" (so called), which consist of strands of manila rope 14 feet in length. The rope costs from 8 to 9 cents per pound, and 3½ pounds, after the strands are separated, make 60 ties. Ties are not used when the herring are shipped by sail vessels. The freight rates from Eastport to Boston or New York by steamboat are 1½ cents per box for regular herring and 7 cents per box for bloaters. The rates on coasting vessels from Eastport to New York for carrying the regular herring are the same as those charged by the steamboats, but are reduced to 5 cents per box for bloater herring.

Herring salted in barrels are shipped chiefly to Boston and New York, and also to Norfolk and Portsmouth, Va. It is claimed that fish which are fat, however well cured and packed, will not keep well in a warm climate, and are therefore seldom shipped to southern markets. The rates of freight are 30 cents per barrel from Eastport to Boston and New York and 55 cents to Norfolk and Portsmouth. Both smoked and salted herring are shipped, to a greater or less extent, to various other points of distribution.

Prices.—The greater part of these products, more particularly the smoked herring, are sent to the dealers in the various trade centers to be sold on commission. The prices received have been much lower in recent years than formerly, and there has been a gradual decline in the prices of both smoked and salted herring since the beginning of 1893. In that year bloater herring averaged 77 cents per box, medium-scaled nearly 12 cents, lengthwise about 11 cents, No. 1 over 9½ cents; in 1894 bloaters averaged 74 cents, medium-scaled 9 cents, lengthwise 8 cents, and No. 1 about 6 cents; in 1895 the average price of bloaters had fallen to 59 cents, medium-scaled to about 8 cents, lengthwise to 7 cents, and No. 1 to about 5 cents. The value of pickled herring declined in similar proportions. In 1895 the price received for round herring was from $2 to $2.50 per barrel and for split herring from about $3 to $3.50. These prices were from 50 cents to $1 less per barrel than in 1893.

Extent of the smoked and pickled herring industry.—The number of smoke-houses operated in 1895 was 89. Of these, 19 were connected with sardine canneries and 70 were conducted by the fishermen and others independent of the canneries. The value of the smoke-houses, including a small number of salting sheds where only pickled herring were prepared, was $49,842. The amount of cash capital used in carrying on the smoked and pickled herring business was $52,340. There were 26 collecting vessels and boats, used for carrying the fish from the weirs to the smoke-houses, valued at $8,756, making a total investment of $110,938. The industry gave employment to 539 persons, exclusive of fishermen, and the amount of wages paid was $28,153. The cost of materials was $36,125, and the quantity of herring utilized was 14,647 hogsheads, or about 14,647,000 pounds, valued at $45,494, the total expenditure for wages, materials, and raw products being $109,772.

The manufactured products consisted of 1,246,461 boxes of smoked herring, weighing in a smoked condition about 7,320,385 pounds, the value of which was $124,356. There were also prepared 10,858 barrels of pickled herring, or 2,171,600 pounds, valued at $29,326. In addition to these there was a small quantity of herring oil, pomace, and refuse fish, amounting to $819. The total value of the output was, therefore, $154,501. In 1893 the value of the products in the aggregate was $145,606, and in 1894 it was $170,198. The business was more extensive in 1894 than in either of the other years, and the prices were higher in 1893 and 1894 than in 1895.

THE SARDINE INDUSTRY.

General development.—The canning of sardines in the United States was begun at Eastport, Me., in 1875. During that year 1 cannery was operated. In each of the four succeeding years 1 new cannery was added to the number, so that in 1879 there were 5 in operation. In the spring of 1880 8 more were built at Eastport, 1 at Robbinston, 1 at Lubec, 1 at Jonesport, 1 at East Lamoine, and 1 at Camden, making a total of 18 operated in that year; 13 of these were at Eastport, which had then become and still remains the principal business center of the industry.

In 1881 3 new canneries were built at Lubec and 1 in each of the four years following, which, with the 1 built in 1880, made a total of 8 in that locality. In the meantime the canneries at Eastport and adjacent villages, Robbinston, Perry, and Pembroke, had increased to 24, so that in the year 1886 there were 32 in operation in the region bordering on Passamaquoddy Bay and its tributary waters. In addition to these there were 13 canneries located along the coast from Cutler westward, making a total of 45 operated in the State in that year. The westward movement of the industry, which began in 1880, continued with considerable energy until 1886, and threatened for a time to endanger the supremacy of Eastport and Lubec in the control of the business, but in consequence of unfavorable conditions for obtaining fish and shipping the manufactured product, and partly, perhaps, on account of the factories being scattered over so large an extent of coast, the limit then reached has not since been greatly exceeded.

At Eastport and Lubec the sardine industry, during the first ten years of its existence, increased to such proportions as to outrank all other branches of business in importance. A large amount of capital was invested and a majority of the people, the inhabitants of the Canadian islands included, in the capacity either of fishermen, boatmen, or factory employees, engaged in it. The number of canneries decreased somewhat from 1886 to 1889. In the latter year only 23 were operated in this section, and 37 in the entire State, but in 1892 the number had again increased to 32, the total number in the State in which sardines constituted the whole or part of the pack being 46. There had, therefore, been practically no increase in the aggregate number of canneries since 1886. In 1895 there were 36 canneries in operation at Eastport, Lubec, Robbinston, Perry, and Pembroke combined. That the industry in this region has grown rapidly and attained large proportions is illustrated by the following table, showing the number of factories in operation, the quantity and value of sardines packed, and the average value per case at different periods from 1875 to 1895. For the purpose of better comparison, the products here shown have been confined to sardines proper. A variety of other products prepared at the canneries each year in considerable quantities, and which increase the value of the output to a greater or less extent, have been omitted. These consist chiefly of Russian sardines, anchovies, pickled herring, lobsters, mackerel, and herring or other species put up in round and oval cans, smoked herring and secondary products, as herring oil and pomace, and the refuse of copper, solder, and tin.

Table showing the number of canneries operated, the number of cases and value of sardines packed, and the average value per case in various years from 1875 to 1895, in the Passamaquoddy region, Maine.

Year.	Canneries.	Cases packed.	Value.	Average value per case.
1875	1	600	$6,600	$11.00
1880	15	74,255	743,618	10.14
1886	32	337,553	1,343,723	4.00
1889	23	371,195	1,417,685	3.82
1892	32	461,552	1,618,960	3.50
1895	36	680,949	1,641,303	2.41

From the above figures it will be seen that while the increase in the number of canneries was at times very rapid, notably from 1875 to 1886, there has been no period in which the annual output of sardines has not increased with still greater rapidity. This has been especially the case during the past few years. In 1875 the number of cases packed by one cannery was 600. In 1880 the average number of cases per cannery was approximately 4,950. The average in 1886 was 10,548, and in 1889 it was 16,139 cases. There was a slight falling off in 1892, the average number of cases per cannery being 14,423, but this was a large increase over that of the year 1886, when the same number of factories was in operation. In 1895 the average reached 18,915 cases per cannery. The pack aggregated 680,949 cases, the value of which was $1,641,303, and was larger, both in quantity and value, than in any previous year. The canneries along the coast, although not engaged in the business so extensively, add materially to the quantity placed on the market each year. The figures for 1895 are not at hand, but in 1892 the pack in that section was 101,789 cases, valued at $345,756.

Decline in prices.—A decline in the value of American sardines began very early in the history of the industry. The small pack prepared in 1875 sold at an average of $11 per case. The price declined very gradually each year until 1880, when it had fallen to an average of $10.14

per case. From 1880 to 1886 was the period of the greatest development of the industry, and also the one in which the most rapid decline in the value of the products occurred. The average value of sardines in 1886 was only $4 per case, or less than half the price received in 1880. Even this comparatively low value was not maintained for any great length of time. Prices continued to decline steadily each year, and in 1889 the average value was $3.82, in 1892 it was $3.50, and in 1895 only $2.41 per case. In the last-named year the goods were in many instances sold for much less than the actual cost of production.

It may be interesting to note the decline in the average value of the variety known as "quarter oils." This grade contains 100 cans in each case, and has always been packed more extensively than any other. In 1875 the quarter size of oil sardines was sold at an average of $10 per case. In 1880 the average was $9, in 1886 it was about $4.50, in 1889 $3.87, in 1892 $3.65, and in 1895 only $2.48 per case.

Cost of production.—The quarter size of oil sardines being the leading grade manufactured, it may properly be selected as a basis for determining the cost of production. The cost of producing this variety in 1895, including the expense of shipping and selling the goods, is estimated to have been from $2.50 to $2.60 per case. It must be remembered that the cost of production varies from year to year. As the price of sardines declined, the cost of material and labor required in their manufacture decreased in nearly the same proportion. This resulted both from the necessities of the industry and various other causes. The small herring—one of the most important items of material used—were never especially valuable for any other purpose. With the constantly growing demand created for them by the canneries, they continued to increase in value, even after the price of the canned products began to decline; but as the supply was generally ample, the highest limit was finally reached and the cost has since been governed almost wholly by the price of sardines. During the past few years, therefore, the price of herring has been very low, because the manufacturers could not afford to pay more, notwithstanding the fact that the quantity utilized was larger than ever before.

Tin plate is also much less expensive than formerly, and other materials have undergone more or less reduction in cost. The price paid for decorating tin plate has been greatly reduced. In the case of articles, the prices of which will not readily yield to the conditions of business, a cheaper quality has been substituted. The oil used for packing sardines is one of the important items of this kind, and there are a number of others less prominent. The cost of the product is further lessened by the introduction of more skillful and economical methods in the manufacturing processes than were formerly practiced.

Wages have been reduced to some extent, although a fairly remunerative rate has thus far been paid. Efforts to reduce them below a certain limit have usually been unsuccessful. The loss resulting from the constantly declining prices of the products has also been offset in some measure by increasing the capacity of the canneries. In these and various other ways the cost of preparation has been kept below the receipts of sales. It is obvious, however, that the time must come, sooner or later, when it will be useless to hope for profits from the further cheapening of material and labor, and the only relief possible must be found in the improvement of the market. This point seemed to have been reached in 1895, when the value of the product was in the aggregate only a little above the cost of production, and both the cost and value were lower than ever before in the history of the industry. Some firms derived a small margin of profit on the year's business, others came out practically even, while others met with a loss.

The following statement was furnished by one of the manufacturers, and exhibits in detail the cost per case of manufacturing, shipping, and selling quarter-oil sardines in 1895. It is presented in substantially the form in which it was received, the principal change being that the cost of the fish has been placed at $3.14 per hogshead, which was the average for that year, and the commission and discount have been computed on a value of $2.48 per case, the average price received for this variety of sardines. No allowance has been made for taxes on property or interest on capital, but all other expenses are included. For convenience in manipulating some of the items, the statement is prepared on a basis of seven cases.

Statement of the cost per case of quarter-oil sardines in 1895.

Material:	
Tin plate for 7 cases, at $3.40 per box	$3.43
Decorating 35 sheets of tin plate	.58
Oil for 7 cases, at 30 cents per gallon	2.10
Solder for 7 cases, at 25 cents per case	1.75
Fuel for soldering, soldering coppers, and acid	.21
Shooks and nails for 7 cases	.53
Fish, at $3.14 per hogshead	1.10
Coal, wood, sawdust, and salt	.12
Waste of material, 1 per cent	.10
Material for 7 cases	9.92
Material for 1 case	1.42
Labor:	
Cutting, rimming, and bending tin	.20
Cutting two-thirds of 1 box of tin on dies	.14
Seaming cans for 7 cases, at 5 cents per case	.35
Making cans for 7 cases, at 12 cents per case	.84
Sealing cans for 7 cases, at 30 cents per case	2.10
Cutting and flaking fish for 7 cases, at 10 cents per case	.70
Packing 7 cases, at 10 cents per case	.70
Making 7 cases, at 1 cent per case	.07
Labor—Continued.	
General labor on 7 cases, at 18 cents per case	$1.26
Trucking 7 cases, at 1 cent per case	.07
Labor for 7 cases	6.43
Labor for 1 case	.92
Expenses of shipping and selling:	
Freight on 7 cases, at 10 cents per case	.70
Commission on 7 cases, at 5 per cent	.87
Discount of 1 per cent for cash payment	.17
Fire and marine insurance	.06
Expenses on 7 cases	1.80
Expenses on 1 case	.25
Total cost of 7 cases	18.15
Total cost of 1 case	2.59
Summary of the cost per case:	
Material	1.42
Labor	.92
Cost at cannery	2.34
Expenses of shipping and selling	.25
Total cost per case	2.59

An estimate similar to the above, made in 1886, showed the cost of quarter-oils at that time to be $4 per case at the factory. The material then cost $2.83 and the labor $1.17, whereas the material now costs $1.42 and the labor 92 cents, a total of $2.34 per case. The cost per case was therefore $1.66, or 41½ per cent less in 1895 than in 1886. In the estimate for 1886 the fish were reckoned at $6 per hogshead, but the average for that year was about $9; hence it is probable that the actual difference in the cost of production was even greater than these figures show. It will be noticed that the reduction in cost since 1886 has been more largely in material than in labor, the cost of material in 1895 being nearly 50 per cent less than in 1886, while that of labor was only 21½ per cent less. Of the total difference, 85 per cent is in material and 15 per cent in labor. Prior to 1886 the cost of manufacturing sardines was somewhat greater than it has been at any time since, but it was probably never more than about $7 per case. The price of the products has therefore fallen much more rapidly than the cost of production, and consequently the profits have been constantly diminishing. It was not until after 1880 that the cheapening of the cost of the products became an imperative necessity.

Overproduction.—The enormous decline which has taken place in the price of sardines can not be wholly attributed to any one cause. On the contrary there are a number of agencies which have exercised more or less influence in producing this result. It seems not improbable, however, that the overstocking of the market was largely responsible for the decline in prices until after 1880, and has continued to be an important factor ever since that time. As early as 1881, when the capacity of the canneries at Eastport began to be greatly increased and many new establishments were being built, both in that section and along the coast westward, the danger of overproduction became plainly apparent. In fact there was then a surplus of stock on hand. The following extract,* from the pen of Mr. Henry Sellmann, one of the pioneers in the business, illustrates the condition of the industry at that time:

There is much danger that the business may be greatly overdone. A considerable portion of the goods put up in 1880 remained unsold on January 1, 1881, and the combined capacity of the various canneries is already much greater than the present demand. Under the strong competition that must necessarily follow many of the smaller firms must go under; margins of profit will be reduced to a minimum, while the investment of capital under an accumulation of stock will involve much risk. As a result of this condition the standard of excellence will be lowered, and many worthless goods will be placed on the market at a low figure, and it will become simply a question of the brands of one cannery over another.

This prediction has been fulfilled in nearly every particular, though competition between different brands has not developed to any appreciable extent. Had this ensued the result would have been less disastrous than it has been. Unfortunately all brands have been reduced to practically the same standard on the market, and the cheaper grades have, with occasional exceptions, set the price for those of better quality.

Since 1880 there has scarcely been a season in which a considerable surplus of stock has not been carried over to the next year. In 1885 there were about 140,000 cases on hand, worth upwards of $640,000, and in 1886 there were about 40,000 cases or more unsold on January 1, worth not less than $160,000. Since that time the market has been overstocked almost constantly. In 1895 a large part of the pack was carried over, and the highest prices quoted for domestic quarter-oils, in the best condition, through January, February, and March of 1896,

*The Fisheries and Fishery Industries of the United States, sec. v, vol. 1, p. 521.

were from $2.40 to $2.50 per case, and in April from $2 to $2.30 per case. These low prices prevailed during the entire year, though certain choice brands put up in small quantities brought better prices. On account of these conditions the pack for 1896 was greatly curtailed.

Quality of sardines.—In the strong competition between the various manufacturers the quality of the goods has in a measure been sacrificed to the interest of producing large quantities. When the industry was first established, it was the ambition of the packers to make the quality of the domestic product equal, if possible, to that of the sardines imported from France and other countries, and thus secure at least a part of the trade which was then wholly supplied by the foreign manufacturers. It was also hoped that when the supply should exceed the demand of the home market the surplus stock might be exported. To this end, therefore, the best quality of material was used, and the greatest care was exercised in the methods of preparation, and for a few years the quality of the sardines put up at Eastport, while somewhat inferior to the best, was equal to that of the average brands imported. Had these efforts been continued until the present time, it seems not improbable that a still higher standard of excellence would have been attained. Attention was, however, soon directed toward reducing the cost of the products. One of the most important changes made was that of substituting cotton-seed and nut oils of various kinds for olive oil. This practice began to some extent before 1880, but did not become general until after that date. The cheaper oils were first introduced for frying the fish, but in a short time they were also used for packing them in the cans. Changes have also been made in the methods of preparing sardines, in order to render the performance of the work more rapid and thus increase the capacity of the canneries at a reduced ratio of cost.

There appears to be some doubt in the minds of the packers whether or not the herring (*Clupea harengus*), which is used for sardines on the coast of Maine, is susceptible of being so prepared that it will be equal in quality to the best imported sardines. It may be quite safely asserted that the character of this species does not offer any insurmountable barrier. The sardine (*Clupanodon pilchardus*) used in France, which is the young of the pilchard, the English sprat (*Clupea sprattus*), and the California sardine (*Clupanodon cœruleus*) all belong to the same family of fishes as the herring, and it is probable that any superiority which one may have over another, when packed in oil, depends more on the quality of the oil and the method of treatment than on the natural characteristics of the species. That the experiment is a hopeful one, as to its effect on prices, is indicated by the fact that in 1895 a considerable quantity of goods were so improved in quality that they were sold for at least 50 cents more per case than the best average brands. The improvement consisted mainly in frying the fish and in the exercise of greater care in their preparation. There is no doubt that their value might have been still further enhanced by the use of either olive oil or olive oil blended with other oils of a delicate flavor.

Selling on commission.—The products of the sardine canneries have always been sold chiefly on commission. When the business was begun, and for a number of years thereafter, it was wholly under the control of certain large firms of importers in New York, who had been for a long time extensively engaged in the import sardine trade. At first much of the capital necessary in establishing and carrying on the business at Eastport and elsewhere on the coast of Maine was furnished by them. In fact they owned some of the factories and held an interest in many others. It was only a natural consequence, therefore, that they should control the disposition of the products. About 1880, after the industry had become established, many of the merchants and others of Eastport invested in it, and gradually the ownership was transferred to the local capitalists and manufacturers; but the dealers and brokers in New York still remained closely connected with the business in the capacity of agents for the canneries.

Description of canneries.—The sardine canneries are located on wharves, in order that they may be easily reached by the collecting boats. They are usually two-story frame buildings. In some instances the frames are covered with corrugated iron, to render the building less liable to be destroyed by fire. The interior is partitioned into separate rooms, for convenience in performing the various kinds of work. The value of the canneries depends upon their size and location, and the completeness of the wharves, buildings, and fixtures, and varies from about $1,500 to $15,000 each. One of the best establishments in the business is that of the Lawrence Packing Company, at North Lubec. It has a very spacious wharf area, and the building is large and well constructed. The main building is 150 feet in length and 32 feet in width. An ell is attached, which is 98 feet long and 30 feet wide. The building is divided into 9 rooms. On the first or lower floor is the cutting, salting, testing, die and shear, and storerooms. The second floor has the sealing, packing, and can-making rooms and a storeroom for cans. The attic is used for sawdust and as a general storeroom. The oil and mustard tanks are also located there, and their contents conveyed to the packing rooms by means of pipes. In addition, there are 3 other buildings, each being suitably arranged for its purpose. These are the office, 15 feet long and 12 feet wide; the engine room, 40 feet long and 20 feet wide, and the box building, 50 feet long and 25 feet wide. All the rooms in this factory are lighted with electricity.

The canneries are not all so well arranged as the one above described, but there seems to be a tendency toward improvement, especially when new ones are being erected. The use of electricity for illuminating purposes was introduced in 1893, and has since become quite general. A number of the canneries at Eastport are now supplied with electric dynamos, which are said to cost from $300 to $500 each, while others obtain their lighting power from the city.

The names and location of the firms engaged in the canning industry in this region in 1895 are as follows:

Name of firm.	Location.	Name of firm.	Location.
S. B. Hunt	Robbinston.	Dennis Collins	Eastport.
Gleason Cove Packing Co	Perry.	William H. Holmes & Co	Do.
St. Croix Packing Co	Do.	James A. McLain	Do.
Pembroke Packing Co	Pembroke.	N. H. Kemp	Do.
West Branch Sardine Co	West Pembroke.	New England Sardine Co	Lubec.
E. A. Holmes	Eastport.	Gun Rock Packing Co	Do.
Charles E. Capen	Do.	Eureka Packing Co	Do.
George O. Grady & Co	Do.	Parker & Pike	Do.
H. Blanchard & Sons	Do.	Columbian Packing Co	Do.
T L. Holmes	Do.	E. W. Brown & Co	Do.
M. C. Holmes & Co	Do.	Lubec Packing Co	Do.
Daniel McCullough	Do.	Lawrence Packing Co	North Lubec.
North End Packing Co	Do.	E. & W. Avery	Do.
Hallett Brothers	Do.	Royal Packing Co	Do.
Broad Cove Packing Co	Do.	North Lubec Packing Co	Do.
Martin & Caraher	Do.	Saunders & Avery	Do.
Paine & Kemp	Do.	Small Brothers	Do.
J. D. Young	Do.	Johnson Bay Packing Co	Do.

Persons and wages.—A majority of the employees are residents of the towns and villages in which the canneries are located. There is also a considerable number who come in from the country and the Canadian islands in the vicinity of Eastport and Lubec to work in the canneries during the summer and return home again at the close of the season. Each cannery employs from 50 to upwards of 250 persons, or an average of about 123. Those at Eastport are generally larger than at the other localities, and employ more help. The greater number of them have from 140 to 180 operatives. The employees in all instances comprise both men and women, and a large percentage of boys and girls. The work is usually done by the piece, but clerks, foremen, and general laborers are paid by the day or week.

The boatmen who collect the herring at the weirs and transport them to the canneries are generally paid at the rate of $1 per hogshead. Some of them receive a salary of $30 to $45 per month, and an additional 50 cents per hogshead.

The rates paid for piecework to other classes of help in 1895 were approximately as follows: Tin cutters, 25 cents per each box of tin of 112 sheets, whether of the large or small size; rimmers and benders, 1¼ cents per 10 cases, or if, as in some instances, two boys are employed, $1 per day each; seamers, 6 cents per 100 quarter and 8 cents per 100 three-quarter cans; can-makers, 12 cents per 100 quarter and 15 cents per 100 three-quarter cans; sealers, 30 cents per 100 quarter and 35 cents per 100 three-quarter cans; fish-cutters, 5 cents per box, equal to about $1 for each hogshead of fish; flakers, one-half cent per flake; packers, 10 to 12 cents per case of 100 quarter and 10 cents per case of 50 three-quarter cans; leak-menders, 50 cents per 100 quarter and 65 cents per 100 three-quarter cans; and case-makers, 1 cent per case. Foremen receive from $2 to $3 and engineers $2 per day; general laborers from $1.25 to $1.50 and $2 per day. In most instances the rates paid for piecework are sufficiently high to enable the operatives to earn large wages if they were steadily employed, but the canneries have to stop at frequent intervals on account of not having fish, especially in the early part of the season. As the work runs, the best-paid pieceworkers do not generally average more than $2 per day, or from $10 to $12 per week, while others average only about $8 per week. The packers are all women and girls and are said to average $10, and sometimes earn $20 per week. Sealers are one of the best-paid classes, and make from $15 to $20 per week. The fish-cutters, who are mostly women and boys and girls, often go from one factory to another, and when steadily employed can earn from $2 to $2.50 per day. The flakers are also women and girls. The rates of wages paid by the canneries, though only moderate, are higher than are to be obtained in almost any other occupation in these localities.

Decorated tin.—Before the sardine cans are made in the cannery it is necessary that the tin for the sides and around the ends of the can shall be decorated or printed with a label. This work was formerly done in New York, but is now nearly all done at Eastport, where a decorating factory was established by Mr. G. W. Capen in the spring of 1889. The building is 90 feet long, 30 feet wide, and 3 stories high, and the value of the entire plant is equal to that of some of the best sardine canneries. The business now gives employment to about 25 persons. The factory opens and closes with the canning season, which is from April 15 to December 15. Another plant was operated during a part of the season of 1895, so that hereafter there will probably be two factories of this kind at Eastport. The decorating is done by a lithographing process similar to that for lithographing on paper, except that the colors are confined to red and black, with a yellowish tint imparted by the use of shellac.

The tin plate for decorating is of two sizes, and comes in boxes of 112 and 224 sheets, respectively. The dimensions of the tin in the smaller boxes are 14 by 20 inches, or 280 square inches to each sheet; and in the larger, are 15½ by 16 inches, or 248 square inches to each sheet. The former size is commonly termed "oil tin," and the latter "mustard tin." The quality is indicated by the weight of the tin in a box. Until recently only one kind was used. This contained 85 pounds in each box of 112 sheets, and 156 pounds in each box of 224 sheets. It was found that a lighter and somewhat less expensive grade would serve the purpose equally well, and consequently many of the packers adopted what is termed an 80-pound tin, which means that 112 sheets of 14 by 20 inch tin weighs 80 pounds, and 224 sheets of 15½ by 16 inch tin, on the same basis, weighs 150 pounds. Both kinds are now used to a greater or less extent in most of the canneries.

The decoration is printed in strips crosswise of the sheets. For quarter-oil cans the 14 by 20 inch sheets are used and there are 20 strips printed on each sheet. The same size of tin is also used for quarter mustard cans, but, owing to their greater depth, admits of only 16 strips being printed on each sheet. The larger sheets, 15½ by 16 inches, are used for the half-oil and three-quarter mustard cans, each sheet having 12 strips of the former and 8 strips of the latter size. It will be understood that in each instance one strip is the requisite quantity for a sardine can, except for the cover and bottom. The prices charged for decorating in 1895 were $1.85 per box of 112 sheets, and $3.70 per box of 224 sheets. The rates have been considerably reduced since 1889 and 1890, when the price per box was $2.50 for the small and $5 for the large boxes, and still further reductions are being made.

Plain tin.—The covers and bottoms for the cans are cut from the plain or undecorated tin. The 14 by 20 inch size, with 112 sheets to the box, is more generally used for this purpose. For quarter oil cans one sheet of tin will make 18 covers, or the same number of bottoms, or the covers and bottoms for 9 cans. One box of tin will, therefore, make the covers and bottoms for 1,008 cans, which is 10 cases and 8 cans of this variety. The three-quarter mustard size being larger, there are only 14 covers or bottoms, or covers and bottoms for 7 cans in each sheet of tin, being 784 cans or 15 cases and 34 cans in each box of tin. The cost of the tin per box, when landed at the factory, is from about $3.32 to $3.40 for the small boxes, and from $6.30 to $6.40 for the large ones. The difference in the cost of the 80 and 85 pound tin is, approximately, 5 cents per box. On orders of 10,000 boxes or more this, it will be seen, is an item worthy of consideration. The quantity of plain and decorated tin used in the canneries in 1895 was 87,891 boxes, or about 4,000 tons, which cost, including the expense of decorating, $378,907.

Solder.—The solder used in making the cans is an item of considerable importance. In most of the canneries the engineer occupies his spare time in making it. Sometimes a number of canneries have their solder made together and hire a man for that purpose. Nearly all now make their own solder, and a few sell solder to those who desire to buy a part of the quantity used. The appliance, or solder machine, consists of a brick furnace of medium size over which is arranged a large iron kettle. At the top of the kettle is a funnel fixed in such a position as to be directly over a wheel in the rim of which is a groove. These machines, including the furnance, cost from $150 to $500 each, according to their size. The furnace is heated with a wood fire.

The solder is made of pig tin and lead in proportions of about 70 pounds of the former to 100 pounds of the latter. After the pigs of lead have been melted in the kettle the tin is put in. When the mass has become sufficiently soft it is stirred until the two ingredients are thoroughly mixed. It is then dipped with a ladle into the funnel and allowed to run down over the wheel, which forms it into wire, and drops in coils into a pan below. The coils at first contain about 20 pounds of solder, but are afterwards separated into sections weighing from 3 to 6 pounds each for greater convenience in using. The solder kettle is usually large enough to hold from 400 to 500 pounds of solder at one time, and one man can perform the work. In addition to the wire solder there is also a small quantity of stick solder made. The cost of solder, including material and labor, is generally considered to be from 8½ to 9 cents per pound. Great economy is exercised in the use of this as of all other materials, and the quantity now used is comparatively much less than formerly. It requires about 3 pounds for each case of quarter-oil and other varieties of sardines having 100 cans to the case and about 2½ pounds per case of three-quarter mustard and spiced sardines having 50 cans to the case. Some of the larger canneries now use about 60 tons of solder during the season, whereas it used to take from 90 to 100 tons to do the same amount of work. The quantity of solder used in 1895 was as follows:

Localities.	Pounds.	Value.
Eastport	1,010,962	$88,329
Lubec	369,464	32,628
North Lubec	302,469	27,292
North Perry, Robbinston, and Pembroke	176,220	16,232
Total	1,859,115	164,481

The above figures show a total of 1,859,115 pounds, or about 929½ tons of solder used in the 36 canneries operated in the localities named, having a value of $164,481, which is $49,977 in excess of the value of the fish used for sardines. The average per cannery was a little over 25 tons. In the manufacture of the solder there were used 776,147 pounds of pig tin, costing $115,767, and 1,125,907 pounds of pig lead, costing $41,668. The difference between the weight of the material and that of the solder prepared from it represents the waste or dross, some of which is sold as refuse product.

Soldering fluid.—This is a preparation of muriatic acid and zinc, which is used as a flux in soldering the cans. It comes in barrels containing 50 gallons or 500 pounds, more or less, to the barrel. Its cost averages a little more than 1½ cents per pound for the fluid and $1 additional for the barrel. It is applied to the tin with a brush. The total quantity used is about 500 barrels, or 249,635 pounds, costing $4,189. The fact that the soldering is done on the outside of the cans prevents the acid from being injurious to the sardines. The possibilities of danger in this respect will be still further removed by the new method of testing the cans, elsewhere described, should it become general, as they are thoroughly washed before being filled.

Can-making.—The sardine cans are made in one of the departments of the cannery. The work is classified as decorated and plain tin cutting, rimming and bending, seaming, can-making, and sealing. The cutting of decorated tin consists in separating the printed strips from each other with a machine, which is termed the "shears." As the strips have no space between them, great accuracy is required on the part of the cutter in order to avoid spoiling them, but the work can at the same time be done so rapidly that one man can cut about 12 boxes of tin per day. The plain tin is cut on a machine, the "dies," which not only cuts but also shapes the covers and bottoms for the cans. After the tin is cut, the decorated strips go to the rimmer and bender, who bends them into the proper shape and otherwise completes them. The seamers solder the ends of the strips together and insert the bottoms. The can is then taken to the can-makers, so called, who solder in the bottoms. The sealing, which may not, perhaps, be regarded as strictly related to the can-making, is done after the fish have been put in the cans, the work being simply to solder on the covers.

The implement with which the solder is applied to the cans is termed a "copper," from the fact that it is made principally of that metal. The soldering coppers are bought by the case or box, each box containing 25 pairs, sometimes weighing 4, but generally 5, pounds per pair, and costing from $17.50 to $22 per box. To fit them for use it is only necessary to adjust the iron shank of the copper to a wooden handle and forge the point on an anvil to any shape that may be desired by the operative, after which they are kept sharp by filing them. The heat for soldering is furnished by a small blast stove in which kerosene oil is used for fuel. Coke is also used to a limited extent for fuel, in this branch of the work, in some of the canneries.

Case-making.—The cases or boxes in which the sardines are packed for shipment are, like the smoked-herring boxes, made from what are termed "shooks." These are prepared at the sawmills and are ready for use when they arrive at the cannery. A "shook" contains the material for the sides, ends, bottom, and cover of the case, and the work of making the case consists simply in nailing the parts together, except nailing on the covers, which is done in the shipping or testing room after the goods are packed. The "shooks," which are usually of spruce, cost from $65 to $70 per thousand. The nails are 5-penny box nails, and cost from $2.50 to $3 per keg, about 50 kegs being required for 22,000 cases. The cost of one case is from 8 to 8½ cents—the shook costs from 6½ to 7 cents, nails about one-half cent, and making 1 cent.

Treatment of the fish.—When the fish arrive at the cannery they are hoisted from the collecting boat to the wharf in baskets. This is done by hand or steam power, but usually the latter, as nearly all the canneries are supplied with engines. The baskets are carried into the cutting room, either on wheelbarrows or by being attached to hooks suspended from an overhead track which passes close to the ends of the cutting tables. They are sometimes carried on cars which run on tracks on the floor. As the fish are brought in they are turned out and distributed along the middle of the tables, so as to be within easy reach of the cutters, who stand on either side at convenient distances apart. In the larger canneries there are sometimes from 50 to 100 persons around the cutting tables at one time. The fish-cutting consists in removing the heads and viscera, the work being done with great rapidity. The cutter takes several fish in the left hand at once and, with a large knife in the right, cuts off the heads one at a time. A sweep of the knife removes the viscera and throws the "cuttings" into a barrel at his side. The fish are thrown by a movement of the left hand into the cutting-box which is located under the edge of the table. The cutting-boxes are each considered to hold fish enough to pack one case of sardines, and it is generally estimated that if the herring are of suitable size and in good condition, so there will be no waste except "cuttings," one hogshead will pack from 20 to 22 cases, and possibly a larger number. The cutters are attended by a man who removes the boxes and rolls aside the barrels when filled, putting empty ones in their places, so that the work may continue without interruption.

As soon as the fish have been cut they are taken to the salting-room and put into a washing-tank, where a man stands with a wash net or ordinary scoop net and washes them. The water in the washing-tank is being constantly changed, coming in by a hose and running out of a vent near the top of the tank. The fish are then dipped out into the pickling-tanks. The tanks are sometimes hogsheads cut off just above the bilge, but usually they are built of planks and are about 3 feet wide and 2½ feet deep, being generally about 15 feet long and divided into two or three sections. They are filled with strong pickle, in which the fish are allowed to remain from twenty minutes to an hour. The length of time depends somewhat on the fatness of the fish and the condition of the weather. If they are very fat or the weather is cold it requires a longer time, but ordinarily not more than from 30 to 40 minutes. After being sufficiently "struck" in the pickle they are dipped out into baskets and allowed to drain, after which they are put on the elevator and sent up to the flaking-room. The flakers, who number from 2 to upward of 12, take the fish from the baskets and lay them on the flakes in rows. The "flakes" or frames are about 3 feet long and 22 inches wide, and are filled in with galvanized wire an inch or more apart. Each flake contains 5 rows of from 18 to 25 fish each, or from 90 to 125 to the flake, according to the size of the fish, and about 10 flakes are required to pack a case of sardines.

As soon as the fish are flaked they are ready for the oven. In the progress of the work the flaking is done faster than the baking, and the flakes when filled are placed in racks, where they remain until needed. The oven is of the rotary kind, such as is used by bakers. There are a number of iron frames suspended from arms extending from a cylinder in the center, which is revolved by steam power. During the revolutions, which are made slowly, the frames remain in a horizontal position, like the cars of a Ferris wheel, the heat being supplied by a furnace underneath. The ovens were introduced in 1879, and are now used in nearly all the canneries. They serve the twofold purpose of drying and cooking the fish. The flakes are placed on the frames in the oven and the fish subjected to the heat for a length of time varying from 15 to 30 minutes, or until they are cooked as much as possible without being discolored. They are then taken out and replaced in the racks to cool. The work is conducted by an experienced baker, who generally has an assistant or "helper." When the fish are sufficiently cooled the flakes are taken from the racks and carried to the packing-room. In the large canneries there are from 30 to 50 persons employed as packers, who are assisted by men or boys to bring the fish and place them on the packing-tables.

The herring are packed in cotton-seed oil, mustard sauce, or vinegar with spices. The spices used are usually mustard seed, allspice, cloves, and bay leaves. Vinegar is also used for diluting the mustard sauce. Under the regulations prevailing in 1895, prescribed by State law, not less than one gallon of the preservative should be used to each case of sardines. The quantity seems to have fallen short in some instances, which may be partially explained by the fact that in dipping the oil or other packing materials the rapidity with which the work is done is liable to result in the measures not being completely filled unless considerable care is exercised. The packers first fill the cans, one at a time, with the oil, mustard sauce, or vinegar, as the case may be. For this purpose sealed measures, containing one-hundredth part of a gallon for quarter and one-fiftieth of a gallon for three-quarter cans, are used. Some of the factories use an oiling machine, which fills 25 cans at a time. After the cans have been filled the fish are packed in them in three layers of from three to four fish each. The fish vary from 4 to 6 inches in length. The small ones are packed in the quarter and the large ones in the three-quarter cans. Herring too large for sardines are packed to some extent in vinegar and spices in 3-pound oval and 1-pound round cans. They are also salted in barrels and sold as Russian sardines. These are afterwards repacked in smaller packages by the dealers and the requisite spices added. The final work of the packers is the "heading off" or placing the covers on the cans. The cans are then taken to the sealing room, where the covers are soldered on by the sealers, and are then ready for bathing.

The bath tank is generally separated into two compartments, which are filled with water and heated by steam. The steam is conveyed from the boiler of the engine by iron pipes, which pass around the inside of the tank in a number of coils. The pipe in the tank is perforated, so that the steam may come in contact with the water. Each compartment of the tank is fitted with six coolers or large wire baskets. The cans are placed in the coolers and lowered into the tank, where they are completely submerged in boiling water. The quarter-oil cans are allowed to remain in the bath about one and one-half hours, and three-quarter mustard, or other large cans, about two hours. They are then hoisted out, and the bottoms of the coolers, which are arranged to slide out, are removed, and the cans are released at the head of a chute or screen in the floor which leads down into the testing room. They are first cooled and dried in sawdust, and then shoved down the chute by means of a wooden scraper. The hoisting apparatus by which the coolers are managed consists of a chain gear operated by hand. In some instances the coolers are operated by an ordinary block and tackle; in others coolers are not used, and the cans are removed from the bath tanks with dip nets made of wire or iron links. In canneries not having engines the tanks are heated by a furnace. When the cans reach the testing-room they are carefully examined or "tested." The covers of the cans are always concaved, so that when they are put on the air is excluded; but it often happens that the soldering is not done perfectly, and as a consequence the oil leaks out, the vacuum becomes filled with air, which expands in the heat of the bath and causes the cover of the can to present a bulged appearance. These are called "swelled heads," and are easily detected by the testers.

An appliance has recently been devised and used by Messrs. George O. Grady & Co., of Eastport, for testing the cans before they are filled. It consists of a cylindrical tank about 5 feet in length and 1 foot in diameter, fixed in an upright position at the end of a table. The tank is filled with water to within about 18 inches of the top by means of a pipe leading from the boiler of the engine. Air is forced through another pipe into the space above the water by the air-pump which supplies air for oxygenizing the flame of the kerosene oil stoves used in soldering. The pressure of air, which requires to be about 12 pounds, and the quantity of water are regulated by steam and water gauges. On the table, a few feet from the tank, is a tin pan or tray, in the center of which is a rubber pad a little larger than a sardine can. A pipe fitted with a valve leads from the tank and passes up through the pad from the under side of the table. The can when tested is placed bottom upward over the nozzle of the pipe and held in position by pressure applied with a lever worked by the foot. The operator then turns a thumb-piece on the pipe, which opens the valve and lets a small stream of water into the inverted can. If it is not perfectly tight the leak is immediately disclosed by the fine jet of water which passes through it. The water, after being used, escapes by a waste-pipe in the tray. One advantage of this method is that it shows which class of solderers has done the poor work, whether the seamers or can-makers, and the defective cans are returned to them for the leaks to be mended, after which they are again tested in a similar manner. If any cans are imperfect after coming from the bath the fault is known to lie with the sealers. An improvement is contemplated by arranging the valve to open with the lever when the pressure is applied, and thus avoid the movement of the hand in turning the thumb-piece. The apparatus costs about $15, and is operated by one person.

The cans which are discovered to be defective after coming from the bath are culled out and turned over to the leak-menders. The leaks not only have to be mended, but the air allowed to escape and the can refilled with oil. A puncture is made usually on the bottom of the can at one end near the edge. The cover and bottom are then pressed back into their proper concave shape and another puncture is made in a similar place at the opposite end, after which the can is stood endwise in a pan of oil until it is refilled. The punctures are then closed with solder, and the can is again put through the bath. The perfect cans, after the sawdust and dampness are wiped off, are ready to be packed in the wooden boxes or cases for shipment. In each case there are 100 cans of the quarter or half sizes, or 50 cans of the three-quarter size. The latter, when packed in vinegar and spices, are called "marinees."

Pomace and oil.—The "fish cuttings" and refuse fish which accumulate at the canneries are made into pomace and sold for fertilizer. When the herring are cut for sardines the "cuttings," which include the heads and viscera, are first deposited in barrels. They are afterwards removed to the press room and emptied in a heap on the floor, being spread in layers and covered with salt, to prevent them from decomposing. The quantity of salt used is about 3 bushels to 5 barrels of cuttings. After remaining in the salt a short time they are put into three quarter hogshead tubs and thoroughly cooked with steam. The steam is conveyed from the boiler of the engine through a pipe, open at the end, which enters the side of the tub near the bottom. The tubs are kept covered while the fish are cooking. After being cooked, the cuttings are dipped with scoop nets from the tubs into the pomace presses. There are usually two of these presses used in each cannery. They are so arranged that one end can be removed for convenience in taking out the pomace after it has been pressed. The pressure is applied with a jackscrew operated by hand. While the fish are being pressed the oil and water which they contain are carried off into an oil tank by means of an open spout. The pomace, when taken from the press, is packed into barrels which are made for that purpose and hold about 275 pounds each. It is sold largely to farmers in the vicinity at an average of about $9 per ton. The oil is skimmed off the water in the tanks and put in barrels for shipment. The price received in 1895 was about 14 cents per gallon. The prices for pomace and oil have declined considerably during the past few years.

It requires about 3 hogsheads of fish to yield 1 hogshead of cuttings and 5 hogsheads of cuttings to make 1 ton of pomace. It is generally estimated that the yield of oil to each ton of pomace is from 20 to 23 gallons, but the proportions in which the two products are sold show the average quantity of oil to the ton of pomace to be a little less than 16 gallons.

Refuse products.—Refuse fish which are not converted into pomace and oil are either sold by the barrel to the farmers for fertilizer or to a factory which was established at Eastport in 1893 and has since been engaged in the manufacture of various grades of fish fertilizer, chiefly from the refuse or damaged fish obtained at the canneries and smoke-houses in that vicinity. The refuse of tin and soldering coppers and the solder dross are also to a great extent saved and sold.

Extent of the sardine industry.—There were 36 sardine canneries operated in 1895, having a value of $250,500, and the amount of cash capital was $426,100. There were also 88 collecting boats and lighters used in connection with the canneries, valued at $32,437, the total investment of fixed and working capital being $709,037. The number of persons engaged in the industry, including proprietors, boatmen, and cannery employees, was 4,404. Of these, 4,172 were employed directly in the canneries and received in wages, during the season of eight months, $556,440, or an average of about $69,555 per month. The amount of wages distributed at Eastport, exclusive of the earnings of boatmen, was $306,448, or an average of $38,306 per month. At Lubec the average amount distributed per month in wages was $13,085, and at North Lubec, $11,711. The cost of materials used in the manufacture of sardines was $792,292 and the quantity of herring utilized was 36,496 hogsheads, or about 36,496,000 pounds, which cost the manufacturers $114,504. The total amount paid for wages, materials, and herring was $1,463,236. It may be proper to explain that this does not fully represent the cost of the herring products, since there are many items of expense which it is impracticable to include.

The number of cases of sardines prepared, including 1,151 cases of plain herring in 1-pound cans, was 682,100, the value of which was $1,644,526. There were also 1,326 barrels of Russian sardines, valued at $3,390, and a large quantity of secondary products, having a value of $18,902, the total value of all classes of products being $1,666,818. The quantity of products prepared at the canneries in each of the years of 1893 and 1894 was much less than in 1895, but owing to the higher prices received in those years the value of the output was considerably greater. In 1893 there were 530,043 cases of sardines and other canned herring, valued at $1,724,582; 810 barrels of Russian sardines, valued at $2,461; and secondary and waste products to the value of $14,868; the total value being $1,741,911. In 1894 the number of cases of sardines and other canned herring was 622,487, valued at $1,862,972; 721 barrels of Russian sardines, valued at $2,076; secondary and waste products, $18,366; a total of $1,883,414.

LEGISLATION.

The few laws which have been enacted for the purpose of regulating the sardine industry have, in most instances, been confined in their scope chiefly to provisions for the cleanliness and wholesomeness of the products. Chapter 40, sec. 18, of the Revised Statutes of the State of Maine provides that no sardines shall be canned between the 15th day of December and the 15th day of the following April. An act passed in 1893 forbids the canning of any herring sardines without first beheading and eviscerating them.

In 1895 a law was passed providing that not less than 1 gallon of oil, mustard sauce, or vinegar should be used in packing each case of sardines. Its purpose was to improve the quality of the goods, and also to prevent the exercise of undue economy in the use of oil or other ingredients. There was, however, considerable objection to its provisions on the part of some of the packers, on the ground that if there was a demand for sardines packed with less than 1 gallon of oil they should be allowed the privilege of packing them.

This act was in force during 1895 and 1896, and is as follows:

SECTION 1. In packing herring, mackerel, or other fish in hermetically sealed cans, either in oil, mustard, or vinegar, there shall be used not less than 1 gallon of oil, of good standard quality, for every 100 cans so packed of the size known as one-quarter oils; 1 gallon of mustard sauce of good quality for every 50 cans of the size known as three-quarter mustards and for every 100 cans of the size known as one-quarter mustards; 1 gallon of vinegar for every 100 cans of the size known as one-quarter spiced and for every 50 cans of the size known as three-quarters spiced. Proprietors of fish-packing factories shall provide sealed measures holding one one-hundredth part and one-fiftieth part of a gallon each, which shall be used in measuring all oil, mustard sauce, and vinegar used in packing fish as above provided; and all fish packed as aforesaid shall be, when so packed, good and sound, except that they shall be cleaned, headed, and eviscerated, and of good uniform size.

SEC. 2. Whoever packs or cans, or causes to be packed or canned, any fish in violation of this act shall forfeit $20 for every 100 cans or 50 cans, as aforesaid, as the case may be, so packed by him or by his employees, to be recovered by complaint.

In 1897 a new law was enacted, in which the provisions of the act of 1895 were modified, and those of the former acts above quoted are, with the exception of a change in the length of the canning season, embraced. The canning season was formerly from April 15 to December 15, but is by the provisions of this act shortened 40 days, beginning May 10 and ending December 1. It is also provided that not less than 3 quarts of oil shall be used in packing each case of "quarter-oil" sardines; 3 quarts of mustard sauce for each case of "three-quarter" and of "one-quarter" mustards, and 1 gallon of vinegar for each case of "one-quarter" and of "three-quarter" spiced or tomato sardines. The full text of the recent law is as follows:

SECTION 1. The commissioner of sea and shore fisheries shall require a strict observation of the following rules: Whosoever catches, takes, preserves, sells, or offers for sale any herring for canning purposes less than 8 inches long, measured from one extreme end to the other, or packs or cans sardines of any description between the first day of December and the tenth day of the following May, forfeits $20 for every 100 cans so packed or canned and for every 100 herring so taken; and whosoever bakes, fries, packs, or cans any herring or other fish or sardines without heading and eviscerating the same, and whosoever sells, offers for sale, or has in his possession for sale any sardines packed without being so headed and eviscerated, shall forfeit $20 for every 100 cans so packed, sold, offered for sale, or in possession for sale, to be recovered by indictment or action for debt, one-half to the complainant or prosecutor and one-half to the town in which the offense is committed. In packing herring, mackerel, or other fish in hermetically sealed cans, either in oil, mustard, or vinegar, there shall be used not less than three quarts of oil of the first quality, pure summer or winter cotton oil, or any food oil of equal quality, for every 100 cans so packed of the size known as quarter oils; three quarts of mustard sauce of good quality for every 50 cans of the size known as three-quarter mustards and for every 100 cans of the size known as one-quarter mustards; one gallon of vinegar for every 100 cans of the size known as one-quarter spiced and for every 50 cans of the size known as three-quarter spiced or tomato. Proprietors of fish-packing factories shall provide sealed measures holding one one-hundredth part of a gallon each, which shall be used in measuring all oil into quarter-oil sardine cans, and measures holding one-fiftieth part of a gallon, which shall be used in measuring all mustard sauce and vinegar into three-quarter size cans used in packing sardines; and all fish packed as aforesaid shall, when so packed, be good and sound, except that they shall be cleaned, headed, and eviscerated. Whoever packs or cans, or causes to be packed or canned, any fish in violation of this section shall forfeit $20 for every 100 cans or 50 cans, as aforesaid, as the case may be, so packed by him or by his employees, to be recovered by complaint.

SEC. 2. All cans shall be decorated, stamped or labeled with quality, packer's name and place of business, or merchant's name for whom the same are packed. All leaks, whether swelled or not, shall be thoroughly mended and filled with oil or vinegar, as per kind of sardines, and then bathed in boiling water for not less than 20 minutes, or in retort, at a temperature of 240 degrees, not less than 5 minutes. Whoever sells or offers for sale any sardines in violation of this section shall forfeit $1 for every can so sold or offered for sale, to be recovered by action, indictment, or action for debt, one-half to the complainant or prosecutor and one-half to the town in which the offense was committed.

SEC. 3. No can of sardines shall be packed with less than six fish, and no fish shall be packed as sardines unless they have been headed and eviscerated within 24 hours from the time they arrive at the factory. No fish shall be baked for sardines in ovens unless they shall first be properly flaked in rows and laid on without overlapping. Whoever flakes, bakes, or packs any sardines in violation of this section forfeits $5 for every 100 fish so flaked, baked, or packed, to be recovered by indictment or action for debt, one-half to the complainant or prosecutor and one-half to the town in which the offense is committed.

SEC. 4. All decorated cans, tin-plate and metal labels now in possession of any packer, and all sardines packed previous to the approval of this act, are exempt from the provisions of the same.

SEC. 5. The commissioner of sea and shore fisheries shall insist upon the strict enforcement of this act and require from his wardens who have jurisdiction in localities where sardine canning factories are located to give a good and sufficient bond, in the sum of $5,000, to guarantee the faithful and strict enforcement of the provisions of this act and its penalties, and in no case shall a packer of sardines be accepted as a surety.

SEC. 6. The commissioner of sea and shore fisheries, or his deputies, shall inquire into violations of the laws relating to sardines and enforce the penalties thereto, and for the purpose of inquiring into any violation of the said laws and enforcing the penalties thereof, such commissioner, or his deputies, may at all reasonable times enter any manufactory or canning establishment and make investigations concerning the methods employed and the condition of the product, and, if necessary, open packages and cut open cans of sardines for such investigation. Sufficient wardens shall be appointed by the commissioner of sea and shore fisheries to enforce the provisions of this act, and for the city of Eastport and the town of Lubec not less than two each, and one warden each additional for every town where sardines are canned in the State of Maine. No person shall be eligible for appointment as warden who is the owner in a sardine factory or a relative of such an owner.

SEC. 7. All acts or parts of acts that conflict with this act are hereby repealed.

SEC. 8. This act shall take effect when approved.

STATISTICS OF THE HERRING INDUSTRY.

The statistics of the herring industry of the Passamaquoddy region, except those relating to the weir fisheries, which are given in the chapter on that subject, are exhibited in the following series of tables: 1 and 5 show the number and classification of persons engaged in the smoked and pickled herring and sardine industries respectively; 2 and 6, the amount of capital invested, the cost of preparing the products, and the quantity and value of all kinds of products prepared, the four tables making a complete statistical presentation of the extent of these two branches of the herring industry for 1895; 3 and 7 show the quantity and value of herring utilized and products prepared in each of the years 1893 and 1894; 4 shows the various sources from which the herring were derived in 1893, 1894, and 1895.

1. Table showing by localities the number and classification of persons engaged in the smoked and pickled herring industry in 1895.

How engaged.	Eastport and North Perry.		Lubec.		North Lubec.		South Lubec.		Total.		Grand total.
	With canneries.	Independent.	With canneries.	Independent.	With canneries.	Independent.	With canneries.	Independent.	* With canneries.	† Independent.	
Proprietors	......	21	......	14	......	6	......	38	......	79	79
General laborers	16	60	24	35	7	2	......	16	47	113	160
Stringers, male	12	46	3	43	5	5	......	15	20	109	129
Stringers, female	10	10	9	18	9	10	......	76	28	114	142
Boatmen	......	26	......	2	......	1	......	......	......	29	29
Total	38	163	36	112	21	24	......	145	95	444	539

* Smoke-houses connected with sardine canneries.
† Smoke-houses independent of sardine canneries.

2. Table showing by localities the extent of the smoked and pickled herring industry in 1895.

Items.	Eastport and North Perry.				Lubec.				North Lubec.				South Lubec.		Total.				Grand total.	
	With canneries.		Independent.		With canneries.		Independent.		With canneries.		Independent.		Independent.		With canneries.		Independent.			
	No.	Value.	No.	Value.	No.	Value.	No.	Value.	No.	Value.	No.	Value.	No.	Value.	No.	Value.	No.	Value.	No.	Value.
Investment:																				
Smoke-houses	10	$4,250	21	$14,525	6	$3,600	17	$18,340	3	$1,500	6	$1,700	26	$5,927	19	$9,350	70	$40,492	89	$49,842
Collecting vessels and boats	......	......	16	7,321	......	......	5	1,050	......	......	2	260	3	125	......	......	26	8,756	26	8,756
Cash capital	......	5,850	......	19,240	......	5,800	......	12,450	......	3,000	......	1,150	......	4,850	......	14,650	......	37,690	......	52,340
Total	......	10,100	......	41,086	......	9,400	......	31,840	......	4,500	......	3,110	......	10,902	......	24,000	......	86,938	......	110,938
Materials, wages, and fish:																				
Bloater shooks	6,200	434	15,450	1,145	14,108	943	15,805	1,081	1,600	112	376	20	865	61	21,908	1,489	32,496	2,307	54,404	3,796
Box shooks	272,800	2,721	235,200	2,352	127,917	1,329	329,640	4,107	59,500	632	23,500	242	143,500	1,791	460,217	4,682	731,840	8,492	1,192,057	13,174
Wood for smoking, cords	214	639	273	815	200	698	322	1,183	55	204	30	76	180	509	469	1,541	806	2,583	1,275	4,124
Salt ... lbs.	720,600	2,166	807,460	2,883	244,000	829	547,500	1,541	94,500	330	72,000	260	124,020	452	1,059,100	3,325	1,550,980	5,136	2,610,080	8,461
Nails ... lbs.	8,600	270	4,800	191	5,450	173	11,088	390	1,600	53	1,200	46	4,800	190	15,650	496	21,888	817	37,538	1,313
Barrels	1,663	832	6,990	3,498	516	237	1,150	575	30	15	200	100	......	......	2,209	1,084	8,340	4,173	10,549	5,257
Wages	......	7,150	......	9,711	......	3,948	......	5,175	......	950	......	212	......	1,007	......	12,048	......	16,105	......	28,153
Herring for smoking, hhds	2,408	9,438	2,472	8,258	1,630	5,645	3,442	9,183	562	1,579	214	468	1,420	1,644	4,600	16,662	7,548	19,553	12,148	36,215
Herring for pickling, hhds	403	1,435	1,588	6,447	115	325	335	948	8	24	50	100	......	......	526	1,784	1,973	7,495	2,499	9,279
Total cost of preparation	......	25,085	......	35,300	......	14,127	......	24,183	......	3,899	......	1,524	......	5,654	......	43,111	......	66,661	......	109,772
Manufactured products:																				
Bloaters ... boxes.	6,200	3,760	15,450	10,090	14,108	8,074	15,805	8,840	1,600	800	376	202	865	509	21,908	12,634	32,496	19,641	54,404	32,275
Lengthwise ... boxes.	41,600	2,910	28,250	2,043	15,000	1,200	18,500	1,295	7,000	420	......	......	1,550	95	63,600	4,530	48,300	3,433	111,900	7,963
Medium scaled . boxes.	230,700	17,782	199,450	15,912	112,917	8,754	307,640	24,673	52,100	3,952	23,500	1,880	140,500	10,450	395,717	30,488	671,090	52,915	1,066,807	83,403
No. 1 ... boxes.	500	30	7,500	415	......	......	3,500	175	400	20	......	......	1,450	75	900	50	12,450	665	13,350	715
Total	279,000	24,482	250,650	28,460	142,025	18,028	345,445	34,983	61,100	5,192	23,876	2,082	144,365	11,129	482,125	47,702	764,336	76,654	1,246,461	124,356
Herring pickled ... bbls.	1,663	4,169	6,999	18,349	516	1,828	1,450	4,350	30	90	200	540	......	......	2,209	6,087	8,649	23,239	10,858	29,326
Secondary products:																				
Oil ... galls.	......	......	325	50	......	......	......	......	......	......	......	......	......	......	......	......	325	50	325	50
Pomace ... tons.	......	......	31	298	......	......	......	......	......	......	......	......	......	......	......	......	31	298	31	298
Refuse fish ... bbls.	......	......	595	140	......	......	855	107	......	......	20	4	1,234	220	......	......	2,704	471	2,704	471
Total	......	......	......	488	......	......	......	107	......	......	......	4	......	220	......	......	......	819	......	819
Total value of products	......	28,651	......	47,297	......	19,856	......	39,440	......	5,282	......	2,626	......	11,349	......	53,789	......	100,712	......	154,501

3. Table showing by localities the products of the smoked and pickled herring industry in 1893 and 1894.

Items.	Eastport and North Perry.				Lubec.				North Lubec.				South Lubec.		Total.				Grand total.	
	With canneries.		Independent.		With canneries.		Independent.		With canneries.		Independent.		Independent.		With canneries.		Independent.			
	No.	Value.	No.	Value.	No.	Value.	No.	Value.	No.	Value.	No.	Value.	No.	Value.	No.	Value.	No.	Value.	No.	Value.
1893.																				
Herring for smoking .hds.	1,886	$11,887	1,732	$7,871	706	$3,284	1,845	$6,354	360	$1,980	374	$1,254	882	$3,546	2,952	$17,151	4,833	$19,025	7,785	$36,176
Herring for pickling .hds.	361	2,267	780	3,640	50	225	23	104	......	......	10	30	......	......	411	2,492	813	3,774	1,224	6,266
Total	2,247	14,154	2,512	11,511	756	3,509	1,868	6,458	360	1,980	384	1,284	882	3,546	3,363	19,643	5,646	22,799	9,009	42,442
Manufactured products:																				
Bloaters .... boxes..	6,800	5,150	4,300	3,605	5,630	4,128	3,220	2,521	1,000	800	......	......	......	......	13,430	10,078	7,520	6,126	20,950	16,204
Lengthwise ..... boxes..	10,300	1,041	50,500	5,795	650	65	23,600	2,432	5,400	594	......	......	500	50	16,350	1,700	74,600	8,277	90,950	9,977
Medium scaled .. boxes..	192,610	23,662	117,700	16,341	54,000	7,440	184,229	25,103	31,300	4,382	47,000	6,580	89,600	11,757	277,910	35,484	438,529	59,781	716,439	95,265
No. 1 .... boxes..	......	......	11,700	1,164	2,000	200	9,900	975	1,300	118	......	......	5,200	453	3,300	318	26,800	2,592	30,100	2,910
Total	209,710	29,853	184,200	26,905	62,280	11,833	220,949	31,031	39,000	5,894	47,000	6,580	95,300	12,260	310,990	47,580	547,449	76,776	858,439	124,356
Herring, pickled .... bbls..	1,572	7,116	3,800	12,550	200	800	100	250	......	......	40	120	......	......	1,772	7,916	3,940	12,920	5,712	20,836
Secondary products:																				
Oil .... galls..	......	......	200	44	......	......	......	......	......	......	......	......	......	......	......	......	200	44	200	44
Pomace .... tons..	......	......	6	48	......	......	......	......	......	......	......	......	......	......	......	......	6	48	6	48
Refuse fish ...... bbls..	......	......	360	107	......	......	456	61	......	......	......	......	795	154	......	......	1,611	322	1,611	322
Total	......	......	......	199	......	......	......	61	......	......	......	......	......	154	......	......	......	414	......	414
Total value of products...	......	36,969	......	39,654	......	12,633	......	31,342	......	5,894	......	6,700	......	12,414	......	55,496	......	90,110	......	145,606
1894.																				
Herring for smoking .hds.	2,608	14,113	2,602	11,594	2,151	10,572	3,030	12,531	605	2,261	571	1,751	1,093	2,825	5,364	26,946	7,296	28,701	12,660	55,647
Herring for pickling .hds.	326	1,854	866	4,289	23	81	68	267	......	......	23	69	......	......	349	1,935	957	4,625	1,306	6,560
Total	2,934	15,967	3,468	15,883	2,174	10,653	3,098	12,798	605	2,261	594	1,820	1,093	2,825	5,713	28,881	8,253	33,326	13,966	62,207
Manufactured products:																				
Bloaters .... boxes..	11,113	7,519	8,050	5,960	18,726	15,701	18,231	12,902	1,000	500	......	......	300	175	30,839	23,720	26,581	19,037	57,420	42,757
Lengthwise ..... boxes..	38,922	3,333	73,750	5,515	14,215	1,100	41,988	3,464	7,000	619	16,000	1,280	1,250	104	60,137	5,052	132,988	10,363	193,125	15,415
Medium scaled .. boxes..	246,435	19,990	191,150	16,348	137,275	12,283	260,903	24,552	64,700	5,986	52,850	4,815	111,900	10,244	448,410	38,259	616,803	55,959	1,065,213	94,218
No. 1 .... boxes..	......	......	16,000	955	7,260	383	7,200	434	2,800	158	200	14	2,200	168	10,060	541	25,600	1,571	35,660	2,112
Total	296,470	30,842	288,950	28,778	177,476	29,467	328,322	41,352	75,500	7,263	69,050	6,109	115,650	10,691	549,446	67,572	801,972	86,930	1,351,418	154,502
Herring, pickled .... bbls..	1,428	4,190	3,303	9,259	100	250	275	1,038	......	......	95	312	......	......	1,528	4,440	3,673	10,609	5,201	15,049
Secondary products:																				
Oil .... galls..	......	......	300	46	......	......	......	......	......	......	......	......	......	......	......	......	300	46	300	46
Pomace .... tons..	......	......	12	108	......	......	......	......	......	......	......	......	......	......	......	......	12	108	12	108
Refuse fish ...... bbls..	......	......	745	214	......	......	570	70	......	......	......	......	1,120	209	......	......	2,435	493	2,435	493
Total	......	......	......	368	......	......	......	70	......	......	......	......	......	209	......	......	......	647	......	647
Total value of products...	......	35,032	......	38,405	......	29,717	......	42,460	......	7,263	......	6,421	......	10,900	......	72,012	......	98,186	......	170,198

NOTE.—"Tucktails," being limited in quantity, are not shown separately in the tables, but are included with the regular grades of smoked herring.

4. Table showing the sources from which the herring were derived in 1893, 1894, and 1895.

Sources.	1893.		1894.		1895.	
	Hhds.	Value.	Hhds.	Value.	Hhds.	Value.
Quoddy Bay and tributaries.						
American weirs:						
Herring for sardines	6,412	$41,101	5,147	$23,470	3,707	$11,306
Herring for smoking	3,614	14,227	4,809	17,483	5,312	10,451
Herring for pickling	386	1,590	121	520	591	1,670
Total	10,412	56,918	10,077	41,473	9,610	23,427
Canadian weirs:						
Herring for sardines	22,910	143,027	28,804	131,061	32,724	102,970
Herring for smoking	3,267	18,120	4,642	22,329	4,363	15,477
Herring for pickling	328	2,146	362	1,971	1,208	4,559
Total	26,505	163,293	33,808	155,361	38,295	123,006
Machias Bay and vicinity.						
Herring for sardines	18	144	2	4	65	228
Herring for smoking	235	896	706	2,585	626	1,625
Herring for pickling	500	2,500	800	4,000	670	2,980
Total	753	3,540	1,508	6,589	1,361	4,833
Grand Manan.						
Herring for smoking	483	1,769	1,292	4,137	905	2,253
Herring for pickling	10	30	23	69	30	70
Total	493	1,799	1,315	4,206	935	2,323
Magdalen Islands.						
Herring for smoking	40	250	813	5,361	768	4,669
Newfoundland.						
Herring for smoking	146	914	398	3,752	174	1,740
Grand total	38,349	226,714	47,919	216,742	51,143	159,998

5. Table showing by localities the number and classification of persons engaged in the sardine industry in 1895.

How engaged.	Eastport.	Lubec.	North Lubec.	Robbinston, North Perry, and Pembroke.	Total.
Proprietors	28	14	13	9	64
Clerks, male	9		3	2	14
Clerks, female	1	1			2
Foremen	34	10	5	10	59
Tin-cutters, rimmers, benders, etc	87	38	31	16	172
Seamers, can-makers, and sealers	686	227	211	125	1,249
Cutters, male	338	53	54	97	542
Cutters, female	248	52	48		348
Flakers, male	72	37	51	17	177
Flakers, female	82			28	110
Bakers and helpers	20	12	11	5	48
Packers, female	418	178	151	103	850
Bathmen, testers, and nailers	84	32	24	11	151
General laborers	261	73	78	38	450
Boatmen	93	27	32	16	168
Total	2,461	754	712	477	4,404

6. Table showing by localities the extent of the sardine industry in 1895.

Designation.	Eastport.		Lubec.		North Lubec.		North Perry, Robbinston, and Pembroke.		Total.	
	No.	Value.	No.	Value.	No.	Value.	No.	Value.	No.	Value.
Investment:										
Canneries	17	$134,800	7	$49,200	7	$46,000	5	$20,500	36	$250,500
Vessels, boats, and lighters	53	21,112	13	5,350	12	3,275	10	2,700	88	32,437
Cash capital	....	275,100	....	59,000	....	63,500	....	28,500	....	426,100
Total	....	431,012	....	113,550	....	112,775	....	51,700	....	709,037
Materials, wages, and fish:										
Shooks for cases	367,584	26,101	146,676	10,229	111,300	7,968	58,300	4,095	683,859	48,483
Plain tin...boxes	34,365	116,226	12,410	42,474	9,757	32,427	5,800	19,625	62,332	210,752
Oil tin (decorated), boxes	12,856	66,020	4,024	20,868	3,193	16,520	2,066	10,743	22,139	114,151
Mustard tin (decorated)....boxes	2,328	23,403	1,598	15,720	1,152	11,396	342	3,485	5,420	54,004
Pig tin........lbs	415,924	61,210	154,641	23,376	129,481	19,566	76,101	11,615	776,147	115,767
Pig lead......do	602,856	22,382	232,660	8,514	184,981	6,555	105,410	4,217	1,125,907	41,668
Soldering fluid, lbs	126,635	2,099	66,000	1,138	36,500	609	20,500	343	249,635	4,189
Cotton-seed oil, galls	248,638	72,173	89,833	26,875	68,953	20,842	46,200	13,937	453,624	133,827
Mustard....galls	63,735	8,644	50,352	7,016	29,630	4,035	9,700	1,370	153,417	21,065
Vinegar....galls	3,684	370	6,500	553	13,304	1,035	1,300	112	24,788	2,070
Spices........lbs	225	14	....	....	839	73	....	....	1,064	87
Kerosene oil.galls	60,857	5,352	14,000	1,290	13,400	1,100	4,050	365	92,307	8,167
Wood......cords	258	694	167	452	103	264	117	281	645	1,691
Coal.........tons	1,814	6,348	557	1,958	448	1,678	226	965	3,045	10,949
Coke.........tons	85	522	135	775	98	620	35	233	353	2,150
Soldering coppers, cases	223	4,245	96	1,823	62	1,203	41	790	422	8,061
Nails.........lbs	75,200	2,195	20,350	587	17,900	522	9,900	326	123,350	3,630
Salt...........lbs	1,814,815	6,305	640,050	2,194	490,800	1,688	237,400	797	3,188,565	10,984
Barrels for Russian sardines	413	153	813	389	....	....	100	55	1,326	597
Wages	....	306,448	....	104,677	....	93,690	....	51,625	....	556,440
Herring....hhds	18,937	61,671	8,129	23,585	5,988	18,298	3,440	10,950	36,496	114,504
Total cost of preparation	....	792,665	....	294,493	....	240,149	....	135,929	....	1,463,236
Manufactured products.										
Sardines in oil:										
Quarters..cases	275,863	686,828	89,823	224,874	67,453	167,853	46,200	112,050	479,339	1,191,605
Halves...cases	1,215	5,703	....	....	1,000	4,650	....	....	2,215	10,353
Sardines in mustard:										
Quarters..cases	5,668	16,853	....	....	3,000	8,250	....	....	8,668	25,103
Three-quarters, cases	80,035	177,147	56,852	121,779	38,844	83,214	12,100	25,290	187,831	407,430
Sardines in spices:										
Three-quarters, cases	1,896	4,312	....	....	1,000	2,500	....	....	2,896	6,812
Plain herring:										
One pound round, cases	1,151	3,223	....	....	....	....	....	....	1,151	3,223
Russian sardines, bbls	413	978	813	2,187	....	....	100	225	1,326	3,390
Total	....	895,044	....	348,840	....	266,467	....	137,565	....	1,647,916
Secondary and waste products:										
Oil.........galls	14,891	2,175	....	....	425	63	2,475	346	17,791	2,584
Pomace......tons	910	8,825	....	....	35	280	180	1,775	1,125	10,880
Refuse fish..bbls	10,194	878	6,400	640	5,400	560	500	75	22,494	2,148
Refuse tin....lbs	41,200	406	39,000	195	21,591	111	6,000	15	107,791	727
Refuse coppers, lbs	14,361	675	3,875	180	4,129	165	1,350	54	23,215	1,074
Copper filings, lbs	4,510	191	1,570	65	3,200	130	575	22	9,855	408
Solder dross..lbs	19,342	806	11,515	392	12,734	338	1,400	45	44,991	1,581
Total	....	13,451	....	1,472	....	1,647	....	2,332	....	18,902
Total value of products	....	908,495	....	350,312	....	268,114	....	139,897	....	1,666,818

7. Table showing by localities the products of the sardine industry in 1893 and 1894.

Designation.	Eastport.		Lubec and South Lubec.		North Lubec.		North Perry, Robbinston, and Pembroke.		Total.	
	No.	Value.	No.	Value.	No.	Value.	No.	Value.	No.	Value.
1893.										
Herring utilized....hhds..	15,180	$89,662	7,556	$45,629	5,179	$39,206	1,425	$9,775	29,340	$184,272
Manufactured products:										
Sardines in oil—										
Quarters ....cases..	200,842	684,175	93,075	326,123	50,875	206,008	21,050	73,250	374,752	1,289,556
Halves ....cases..	3,700	6,161	......	....	500	2,435	......	....	4,200	8,596
Sardines in mustard—										
Quarters........cases..	5,907	20,267	......	....	1,600	5,600	......	....	7,507	25,867
Three-quarters .cases..	63,900	177,597	41,597	114,393	33,008	93,460	3,450	10,313	141,955	395,763
Sardines in spices—										
Three-quarters.cases..	800	2,480	......	....	500	1,375	......	....	1,300	3,855
"Sea trout" (herring)—										
Three-lb. ovals .cases..	119	357	......	....	......	....	......	....	119	357
Plain herring—										
One-lb. round...cases..	210	588	......	....	......	....	......	....	210	588
Russian sardines..bbls..	509	1,507	301	954	......	....	......	....	810	2,461
Total	......	893,132	......	441,470	......	308,878	......	83,563	......	1,727,043
Secondary and waste products:										
Oil ....galls..	11,000	2,278	827	177	400	80	950	190	13,177	2,725
Pomace...........tons..	680	6,328	58	486	25	213	65	640	828	7,667
Refuse fish ....bbls..	5,710	484	5,850	585	4,900	490	300	60	16,760	1,619
Refuse tin ....lbs..	25,700	127	39,316	173	5,600	28	......	....	70,616	328
Refuse coppers .....lbs..	10,773	533	3,040	220	3,186	147	750	30	17,699	930
Copper filings ......lbs..	1,600	81	1,943	107	2,484	118	300	12	6,327	318
Solder dross........lbs..	13,684	619	9,350	376	6,450	248	1,250	38	30,734	1,281
Total	......	10,450	......	2,124	......	1,324	......	970	......	14,868
Total value of products..	......	903,582	......	443,594	......	310,202	......	84,533	......	1,741,911
1894.										
Herring utilized....hhds..	18,547	85,619	7,208	33,450	5,103	21,171	3,095	14,295	33,953	154,535
Manufactured products:										
Sardines in oil—										
Quarters ....cases..	264,004	799,542	81,001	261,296	59,324	196,022	42,350	124,788	447,279	1,381,648
Halves ....cases..	3,040	15,316	......	....	500	2,435	......	....	3,540	17,751
Sardines in mustard—										
Quarters ....cases..	9,233	30,476	......	....	1,600	5,600	......	....	10,833	36,076
Three-quarters.cases..	71,911	188,358	46,265	122,778	28,843	80,103	10,050	26,100	157,069	417,339
Sardines in spices—										
Three-quarters.cases..	1,871	4,992	......	....	500	1,375	......	....	2,371	6,367
"Sea trout" (herring)—										
Three-lb. ovals .cases..	208	624	......	....	......	....	......	....	208	624
Plain herring—										
One-lb. round...cases..	1,187	3,167	......	....	......	....	......	....	1,187	3,167
Russian sardines..bbls..	235	570	446	1,406	......	....	40	100	721	2,076
Total	....	1,043,045	......	385,480	......	285,535	......	150,988	....	1,865,048
Secondary and waste products:										
Oil ....galls..	14,130	2,238	......	....	950	148	2,180	356	17,260	2,737
Pomace...........tons..	918	8,263	......	....	65	520	163	1,605	1,146	10,388
Refuse fish ....bbls..	9,472	932	6,300	630	3,800	380	425	85	19,997	2,027
Refuse tin ....lbs..	37,950	358	39,300	181	8,400	42	4,000	10	89,650	591
Refuse coppers .....lbs..	16,121	656	2,903	178	1,700	74	800	39	21,524	942
Copper filings ......lbs..	1,995	92	1,697	76	1,330	60	325	13	5,347	241
Solder dross........lbs..	23,474	836	8,928	302	7,400	287	400	15	40,202	1,440
Total	......	13,375	......	1,362	......	1,506	......	2,123	......	18,366
Total value of products..	......	1,056,420	......	386,842	......	287,041	......	153,111	......	1,883,414