BUREAU OF FISHERIES

REPORT

OF THE

UNITED STATES COMMISSIONER OF FISHERIES

FOR THE FISCAL YEAR 1920

WITH

APPENDIXES

HUGH M. SMITH
Commissioner

WASHINGTON
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National Oceanic and Atmospheric Administration

Report of the United States Commissioner of Fisheries

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REPORT

OF THE

COMMISSIONER OF FISHERIES.

DEPARTMENT OF COMMERCE,
BUREAU OF FISHERIES,
Washington, September 15, 1920.

SIR: I have the honor to present herewith a report which gives an outline of the major operations of the Bureau of Fisheries during the fiscal year ending June 30, 1920. The Bureau's functions are comprehended under eight captions, namely, relations with the fishery industries, biological investigations, propagation and distribution of food fishes, artificial propagation of fresh-water mussels, Alaska fishery service, Alaska fur-seal service, minor fur-bearing animals of Alaska, and general administration considerations, for each of which there follows a brief discussion. A number of special reports covering the Bureau's various activities have been issued and may be consulted by those who desire details.

It may be noted that the Bureau has reached the fiftieth year of its existence, having been established in February, 1871. Its growth from a mere commission charged with investigatory functions has been phenomenal, and the half century closes with the Bureau occupying a larger sphere of usefulness than ever before and prepared to render a more important service to the fishing industry and to the general public, but with its powers curtailed by a grossly underpaid staff and by inadequate appropriations for essential features of the work.

FISHERY INDUSTRIES.

GENERAL CONSIDERATIONS.

The general condition of the American fisheries may be characterized as unsettled. While the world-wide cry has been for increased food production, and the fisheries have responded to the cry, there has been an underconsumption of fish in the country at large, and millions of pounds of food fish have been wasted or put to economic uses of lesser importance. While the prices of foodstuffs almost without exception were rising during the past year, in at least one of the great fisheries, namely, the New England vessel fisheries, there was a falling off in prices received by the fishermen as compared with the previous year.

The Bureau, through its division of fishery industries, has rendered meritorious service in reducing waste, in effecting improvements in methods of preservation and distribution, in securing larger production of aquatic products, and in increasing the public appreciation of and demand for fish as food. The Bureau is in position to render still further and much-needed service in various fields. It has the equipment, the directing personnel, the conception of the problems, and the knowledge of the best ways of approach. The chief requirement is an adequate appropriation.

The past year has been noteworthy for the increasing attention given to the commercial possibilities of the fishery industries, to providing means for increasing production, to effecting improvements in preparation of the products for market, and to the saving of the by-products of the fisheries for use in the arts and industries. This widespread interest has resulted in increasing the demands upon the Bureau for trustworthy and detailed information regarding the fisheries, products, and processes; for the conduct of technological investigations which properly come within its sphere of operations; and for guidance and assistance in the upbuilding of certain fisheries without endangering the harvests of the future. Because of its limited appropriations it has been unable to meet many of these demands in the manner they deserve. This is especially true of the calls for various technological investigations to solve difficulties encountered in the preservation or utilization of certain fishery products and for educating the public as to the merits of fish as food, particularly the little-known varieties. For lack of such work large quantities of valuable protein food, the high-priced element of our diet, are being wasted at a time when there is particular need for the practice of economy and saving.

The Bureau has conducted a number of important investigations, as, for example, a study of the basic principles governing the preservation of fish with salt, experiments in the recovery of old brine and salt for reuse, development of methods of canning the Pacific mackerel and other abundant but neglected fishes of the west coast, preliminary studies of some features of freezing fish in brine, and the possibility of producing pearl essence from the scales of native fishes. Practical application of the results of its investigation in the salting of fish have been made and canners have been supplied with information gained in its temporary canning laboratory at San Pedro, Calif. Material aid has been given in the development of certain fisheries, such as those for sharks and porpoises; in increasing the use of by-products of the fisheries; in extending the production of fish oil, scrap, meal, leather, etc.; in determining to what uses various products are best suited; and in supplying information regarding sources of supply and possible markets for the finished products. A study of foreign methods of preserving nets has been made and a paper has been prepared for publication for the use of our fishermen in effecting economies in their expenditures for nets. Encouragement has been given to determining the practicability of using seaplanes in locating schools of fish, and arrangements have been made through the Navy Department for sending out planes for this purpose to enable those in the industry to determine their value as a commercial undertaking.

In the collection and dissemination of statistical information regarding the fisheries more has been accomplished than in any recent year. The Bureau has completed a canvass of the coastal fisheries of the South Atlantic and Gulf States for the calendar year 1918 and has prepared for publication detailed statistics of fisheries of the Gulf States for that year and of the fisheries of the Great Lakes for 1917, together with the results of canvasses of the shad fishery of the Hudson River and of the shad and herring fisheries of the Potomac River for 1919, completed during the year. The monthly returns of the quantities and values of the fish landed at Boston and Gloucester, Mass., Portland, Me., and Seattle, Wash., by American and Canadian vessels have been collected by local agents, tabulated, and published as monthly and annual bulletins for the use of the trade and to serve as a permanent record of the condition and trend of these important fisheries. Through the courtesy of the Health Department of the District of Columbia the Bureau has continued to receive daily reports of the quantity of fishery products received at the municipal fish wharf and market at Washington, D. C. These have been tabulated for the calendar year 1919 for publication. In addition a canvass of the fisheries of the New England States for 1919 has been begun.

A report of the work of this division for the calendar year 1919 containing a detailed account of investigations, the relations of the Bureau with the fisheries, and full statistical tables and discussions, has been prepared by the assistant in charge and issued as a public document entitled "Fishery Industries of the United States: Report of the Division of Statistics and Methods of the Fisheries for 1919." Persons desirous of obtaining such detailed information should consult this report.

UTILIZATION OF BY-PRODUCTS OF THE FISHERIES.

Inadequacy of supply of various nonfishery products has materially increased the demand for by-products of the fisheries possessing similar qualities. To this class belong fish oils for admixture with other drying oils in the manufacture of paints and varnishes, for purposes of hydrogenation and the like; fish scrap for use as an ingredient in fertilizer; meal for use as an animal feed; leather made from fish hides; and poultry grit from ground oyster shells. To meet these demands the Bureau has given a larger measure of attention to encouraging the saving of the by-products of the fisheries, to the solution of problems arising from efforts to put these products to new and more important economic uses, and to supplying information regarding sources of supply, methods of manufacture, uses, and markets.

Analyses have been made of the body and liver oils of various species of sharks and skates, albacore or tuna, and yellow-tail oils to determine more definitely their properties and possible uses. Samples of these oils were also furnished the educational bureau of the Paint Manufacturers' Association of the United States to determine their suitability for use in the manufacture of paints and varnishes. From drying tests of tuna oil made by the director of that association, it appears that this oil dries even more rapidly than linseed oil. The yield of oil from the tuna fisheries in southern California in 1919 is estimated at slightly in excess of 100,000 gallons. The oil of the yellow-tail (*Seriola dorsalis*) proved as satisfactory as menhaden oil but was not the equal of tuna oil for drying purposes.

Persons employed in the fisheries have been urged to convert unutilized stocks of fish waste into scrap for fertilizer, or preferably into fish meal, with the result that provision is being made for the more extended saving of this material. For example, until recently not more than half of the waste from the shrimp industry of the South Atlantic and Gulf States was saved, being converted into fertilizer which commanded a relatively low price. Feeding tests made by the Bureau of Animal Industry of the Department of Agriculture in cooperation with the Bureau of Fisheries indicate that shrimp bran, properly prepared, is fully the equal of fish meal for feeding hogs. This information has been brought directly to the attention of persons in the shrimp industry, and improved methods for the preparation of shrimp bran are being perfected, resulting in the saving of much larger quantities of this valuable material than formerly. From analyses it appears that shrimp meal may be expected to contain from 43 to 47 per cent of protein. There are indications that as feed it possesses other properties which tend to increase its value for such purposes.

As a direct result of these activities, in excess of 2,500 tons of menhaden meal and shrimp meal were produced in 1919, with prospects for a rapid annual increase in the output of these commodities in regions where heretofore they were unknown. In this field the Bureau has continued to receive effective cooperation from the Bureau of Animal Industry in the conduct of feeding tests of various kinds of fish meals, in deciding their suitability for feeding purposes, and in bringing to the attention of hog growers the value of these protein feeds. To properly safeguard the industry a number of additional feeding tests have been arranged for and will be started in the near future. These will include shrimp meal from drying platforms, shark meal, meal made from fish cuttings, and meals containing high percentages of oil or made from decomposed fish.

Satisfactory progress in the production of leather from fishskins and the establishment of fisheries for sharks and other unused aquatic animals are to be recorded, and provision has been made for determining more definitely the special properties of such leathers for the use of the trade. It is to be noted that the demand for dried shark fins, which the Bureau has stimulated, now exceeds the supply. The receipt of this commodity at San Francisco, the center of the industry on the Pacific coast, amounts to about 5 tons per month, much the larger portion being imported from the west coast of Mexico. Persons engaged in fisheries for sharks or fisheries in which sharks are incidentally taken are being urged to save all parts of these fishes and are furnished with detailed information on the subject

INVESTIGATION CONCERNING PRESERVATION OF FISH WITH SALT.

The preliminary investigation of the principles of preserving fish with salt has been completed and the results have been published (as Bureau of Fisheries Document No. 884) and made available to all persons interested in the subject. This work has been of material benefit in clarifying our knowledge of the factors influencing salting processes, and therefore in pointing the way to possible improvements in existing practices. Among other things it has shown that the purer salts, which contain only a fractional per cent of impurities such as lime and magnesium, penetrate the tissues of the fish more rapidly than salts containing a higher percentage of such impurities; and that salt penetrates fish packed in dry salt faster than if packed in brine, and through the flesh faster than through the skin, thus revealing the value of cutting or splitting the fish. As the blood spoils at a lower temperature than the flesh, it is important to thoroughly wash out the blood if the salting is attempted at high temperatures. The investigation was conducted on a laboratory scale, and did not include studies of the factors determining the length of time salted fish will keep or other important lines of research, such as determinations of the fat content of fish, the practicability of improving the general quality of salt fish, and means for increasing the demand for such products by the consuming public. Such investigations may be expected to reveal means for preventing or safeguarding against spoilage and in other ways render the industry material service.

One of the objects of the original investigation was to determine the practicability of salting fish at high temperatures, and therefore in warm climates. To give practical application to the results, the Bureau gave demonstrations of its methods to fishermen at points in Florida, where previous attempts at salting by the usual practices had resulted in failure through the spoilage of the product. For this work it employed a practical salter, with many years' experience in salting river herring, gave him careful training in its methods and objects, and detailed him to Florida to instruct fishermen desirous of salting river herring in this manner. As a result 80,000 fish were successfully salted, and brokers and dealers handling the product expressed themselves as highly pleased with its quality. As indicative of the importance of adhering rigidly to the method prescribed, it should be noted that every attempt of the packers to depart from that method resulted in the loss of the fish. The salting of the fish was so successful that the packers are preparing to engage in this new branch of the industry on a large scale, so as to make possible the shipment of fish in car lots.

PRESERVATION OF FISHERY PRODUCTS BY CANNING.

Since May, 1919, the Bureau has been conducting at San Pédro, Calif., experiments in the preservation of fishery products by canning. It has devoted its attention particularly to little used fishery products for which satisfactory canning methods have been lacking and to the establishment of standard methods which will yield standard packs. The mackerel (*Scomber japonicus*), an abundant fish but little esteemed on the California coast, has received more consideration than other species. Over 80 different packs of this fish have been put up and subjected to careful examination, with the result that a number of promising methods have been developed, several of which have been released for the use of the trade. Other species experimented with are bonito, barracuda, pilchard, sea bass, smelt, tunas, and yellow-tail, several hundred packs of the various species having been put up and held in storage for examination periodically. A number of special problems have been encountered in the course of this work which may require rather extended study before a solution is found, as, for example, the unpleasant odor and taste in canned bonito and the detinning of cans in packs of such fish as the barracuda. A vital desideratum of the Bureau, if it is to fulfill its functions and render the largest measure of service to the fisheries, is adequate provision in the matter of personnel and funds to enable it to render the canning industry of all sections aid in the preservation of crabs, shrimps, turtles, and certain fishes, and determining more definitely the possibility of applying newer methods in the case of staple canned fishery products. The need for accurate data in these fields is well shown by the large number of requests that the Bureau receives.

PRESERVATION OF FISH NETS.

Outside of Norway very little investigation or experimentation has been done on the preservation of fish nets. In that country considerable attention has been given to developing new methods and improving old ones. This important means of economizing in the expense of nets seems to have been neglected in the United States, where the only preservative employed to a considerable extent is tar, the use of which is confined to the coarser kinds of nets. As a basis for future investigative work and for the immediate benefit of the American fisheries, one of the Bureau's assistants has reviewed the literature on the subject, assembling important scientific data and tests for publication. Some of the more common and efficacious preservatives used for such purposes are catechu, quercitron, or other tanning extract, linseed oil, tar, and soap, followed by soaking in a solution of copper sulphate.

It may be pointed out that one of the important functions of the Bureau is to make available to fishermen the scientific and practical experiences of foreign countries. Through such studies of the foreign literature, results of great value may be obtained for direct use in the industry or as the basis for additional experimental work in our fishery products laboratory.

USE OF AEROPLANES IN THE FISHERIES.

The possibility of practical use of aeroplanes in various branches of the fisheries is one of the most interesting developments in aviation. The most obvious purpose that aeroplanes may serve is in the offshore fisheries in determining the location of whales and schools of surface-swimming fishes, like mackerel and menhaden, and in promptly communicating this information to fishing vessels or to shore stations. Other uses of aircraft in connection with the fishing industry will doubtless arise.

In April, 1919, it was suggested to menhaden companies operating in the Chesapeake Bay region and having vessels that frequent the grounds off the Virginia capes that seaplanes might be used advantageously in helping the fishermen find fish. Desirous of determining the practicability of the commercial use of aeroplanes in the fisheries, the Bureau was instrumental in bringing about an arrangement between the Naval Aviation Service and the menhaden fishermen whereby naval seaplanes were made available for observation flights in quest of menhaden. Subsequently radio apparatus was installed on two menhaden vessels and at a factory on Chesapeake Bay, so as to be able to communicate with the seaplanes; the offshore fishing grounds were blocked off in numbered squares on charts; and two naval seaplanes, each with a fisherman-observer, have been traversing the fishing areas and reporting the location of schools of fish. The early results have been satisfactory, as the seaplanes have readily found fish and acquainted the fishermen with their location and abundance, thus saving much time and expense that would ordinarily be required for cruising.

If this experiment continues to meet with the initial success, there is reason to believe that aeroplanes may take a permanent place in the menhaden fishery and doubtless in other branches. Inasmuch as the investment in planes and radio apparatus and the salaries of observers, pilots, and radio operators might be too burdensome for a single company to assume, it may be to the advantage of the industry for communities or groups of interests to provide for such service in common.

MISCELLANEOUS INVESTIGATIONS.

In addition to the technological studies already mentioned, the Bureau has supplied many inquirers with information and helpful suggestions regarding technological methods and processes, thereby rendering an important service in the upbuilding of the industry. The Bureau also has given attention to the development of methods for the recovery and reuse of salt and brine that have been employed in preserving fish; to an examination of possibilities of certain foreign methods of freezing fish in brine; to the methods of producing pearl essence from the silvery scales of native fishes, and to tests of the practicability of putting noncommercial sponges to commercial use. Pearl essence or liquid nacre ("essence d'orient") which is claimed to be superior to the imported product, of which large quantities are consumed in the United States, is now being made from the scales of river herring. The prices received by the fishermen are sufficiently high to induce them to save this hitherto waste product.

The equipment of the fishery-products laboratory in Washington has served the needs not only of the Bureau's own investigators but of other branches of the Government service. For example, use has been made of its brine-freezing plant by representatives of the Bureau of Plant Industry for freezing strawberries and cherries for comparison with the air-frozen product, and its air-freezing plant by the Bureau of Standards for the conduct of tests under various low-temperature conditions.

NEW ENGLAND VESSEL FISHERIES.

Through its local agents at Boston, Gloucester, and Portland, the Bureau has obtained and disseminated statistical and other information regarding the great vessel fisheries centering at those ports. These fisheries in 1919 were in a prosperous condition, although the number of trips and catch were not so large as in the previous year.

During the calendar year 1919 this fleet numbered 523 sail, steam, and gasoline screw vessels, including 25 American and 2 Canadian steam trawlers. These vessels landed at Boston 2,754 trips, aggregating 103,391,370 pounds of fish, valued at $4,713,350; at Gloucester 2,965 trips, aggregating 71,370,957 pounds, valued at $2,145,592; and at Portland 2,550 trips, aggregating 21,718,943 pounds, valued at $689,441. The total for the three ports was 8,269 trips, aggregating 196,481,270 pounds of fresh and salted fish, having a value to the fishermen of $7,548,383.

The foregoing total includes 39 trips, 26 at Boston and 13 at Portland, landed by nine Canadian fishing vessels, comprising 3,296,147 pounds of fresh fish, valued at $106,261. Of this quantity, 1,191,845 pounds, valued at $53,653, were landed at Boston, and 2,104,302 pounds, valued at $52,608, at Portland. There was a decrease of 12 vessels, 21 trips, and 2,306,602 pounds in quantity and $112,364 in the value of the products as compared with the previous year's status of this Canadian fishery. These fish were brought into our ports in accordance with an arrangement with the Canadian Government, as an emergency war measure granting reciprocal privileges to fishing vessels, by which Canadian fishing vessels were permitted to land their fares at American ports direct from the fishing grounds. Canadian fishing vessels began to utilize this privilege in April, 1918, and the arrangement is still in operation.

During the year 1919, 24 American fishing vessels made 29 trips with 434,486 pounds of fish at Canadian ports on the Atlantic coast, of which 8 trips by 8 vessels comprising 312,036 pounds were landed at Halifax, Nova Scotia. Incidentally, it may be noted that under the reciprocal arrangement 173 American fishing vessels landed 915 trips, amounting to 12,258,522 pounds, at Canadian ports on the Pacific coast, of which 889 trips by 154 vessels, aggregating 10,804-522 pounds, were discharged at Prince Rupert, British Columbia.

Compared with the previous year, there was a decrease of 481 trips, or 5.49 per cent, in the total number landed by the fishing fleet at Boston, Gloucester, and Portland, and of 9,019,883 pounds, or 4.38 per cent, in the quantity, and $2,983,165, or 28.32 per cent, in the value of the fish landed. The only important species showing an increase in catch over the previous year were haddock and halibut. The catch of haddock increased 16,044,644 pounds, or 24.06 per cent, in quantity, but decreased $405,338, or 12.66 per cent, in value, while the yield of halibut increased 333,657 pounds, or 18.73 per cent, in quantity and $84,911, or 28.09 per cent, in value. The production of cod decreased 6,450,007 pounds, or 8.98 per cent, in quantity and $1,034,024, or 28.58 per cent, in value; hake, 941,353 pounds, or 17.82 per cent, in quantity and $92,032, or 33.70 per cent, in value; pollock, 7,808,653 pounds, or 29.39 per cent, in quantity and $581,570, or 60.44 per cent, in value; cusk, 595,062 pounds, or 22.38 per cent, in quantity and $40,862, or 39.65 per cent, in value; mackerel, 4,445,271 pounds, or 43.75 per cent, in quantity and $641,682, or 53.97 per cent, in value; herring, 4,637,077 pounds, or 30.92 per cent, in quantity and $220,894, or 47.94 per cent, in value; swordfish, 151,364 pounds, or 14.63 per cent, in quantity and $10,824, or 4.84 per cent, in value; tilefish, 265,910 pounds, or 88.80 per cent, in quantity and $18,772, or 92.71 per cent, in value; and the various other species combined, 103,487 pounds, or 2.44 per cent, in quantity and $22,078, or 12.16 per cent, in value. The catch of Newfoundland herring decreased 2,885,047 pounds, or 45.17 per cent, in quantity and $142,090, or 42.81 per cent, in value. The quantity of tilefish landed at Boston was very small, amounting to only 33,510 pounds, valued at $1,474, as compared with 299,420 pounds, valued at $20,246, the previous year.

The products landed at Boston and Gloucester, Mass., and Portland, Me., by fishing vessels each year are taken principally from fishing grounds lying off the coast of the United States. In the calendar year 1919, 71.72 per cent of the quantity and 70.64 per cent of the value of the catch discharged at these ports by American and Canadian fishing vessels were taken from these grounds; 2.93 per cent of the quantity and 4.61 per cent of the value, consisting largely of herring, were taken from grounds off the coast of Newfoundland; and 25.33 per cent of the quantity and 24.74 per cent of the value from grounds off the Canadian Provinces. Newfoundland herring constituted 1.78 per cent of the quantity and 2.51 per cent of the value of the products brought in during the year. The herring were taken on the treaty coast of Newfoundland, and the cod, haddock, hake, halibut, and other species from that region were obtained from fishing banks on the high seas. All fish caught by American fishing vessels off the coast of the Canadian Provinces were from offshore fishing grounds.

Supremacy in the New England fisheries is usually assumed by the cod, with the haddock ranking second. In 1919, however, the haddock took first place, with 82,716,185 pounds, valued at $2,793,938. The yield of cod was 65,374,420 pounds, valued at $2,583,181. The next most important of the ground fish is the halibut, of which 2,114,661 pounds, valued at $387,191, were taken. Pollock showed a marked decrease from 1918; only 18,751,967 pounds, valued at $380,515, were secured, as against 26,560,620 pounds, worth $962,085, in the previous year. A noteworthy advance in production, indicating a growing demand, was in the catch of flounders, the increase over the previous year being over 77 per cent in quantity and 108 per cent in value. The total catch of mackerel was 53,992 barrels, a decline of more than 15,000 barrels from 1918. The catch of salt mackerel was only 7,000 barrels compared with over 13,000 barrels the year before. The total quantity of mackerel landed at the three ports was 5,713,196 pounds, valued at $547,242, of which 4,314,770 pounds, worth $427,104, were fresh. Both purse-seine and gill-net vessels in the southern mackerel fishery in 1920 had one of the best seasons on record. The fish caught weighed from 1½ to 3½ pounds, averaging about 2 pounds, and sold from 8 to 22 cents per pound, according to market conditions. In May there was a large body of mackerel off South Shoal Lightship, and the receipts at Boston landed by vessels were larger than for the same month in any recent year. The catch on the Cape Shore was disappointing; the weather was foggy, and the fish were well offshore, wild, and hard to catch. The total yield of mackerel up to July 1 was 60,842 barrels fresh and 3,357 barrels salted, compared with 38,787 barrels fresh and 6,452 barrels salted the previous year.

VESSEL FISHERIES OF SEATTLE.

The fishing fleet at Seattle, Wash., landed 670 trips during the year 1919, consisting of 13,651,020 pounds of fresh fish, having a value to the fishermen of $1,530,284, from fishing grounds along the coast from Oregon to Alaska. The largest quantities were taken from Grays Harbor grounds, Flattery Banks, west coast of Vancouver Island, Hecate Strait, and Yakutat grounds. The products included halibut, 11,110,720 pounds, valued at $1,422,519; sablefish, 1,553,600 pounds, valued at $74,290; "lingcod," 723,000 pounds, valued at $24,433; and rockfishes, 263,700 pounds, valued at $9,042. Compared with the previous year there was a decrease of 164 trips by fishing vessels, and of 20.13 per cent in the quantity and 18.93 per cent in the value of the products. The catch of halibut increased 8.46 per cent in quantity, but decreased 6.95 per cent in value. There was a large falling off in the catch of sablefish, "lingcod," and rockfishes, owing chiefly to a smaller demand than in the previous year.

The fishery products taken in Puget Sound and tributary waters and landed by collecting vessels during the year amounted to 11,809,450 pounds, valued at $983,819. This quantity included 10,387,703 pounds of salmon, valued at $902,717, and the remainder consisted of steelhead, pilchard, smelt, rockfishes, cod, flounders, crabs, and other species. Compared with the previous year, there was an increase in the products landed by collecting vessels of 11.35 per cent in quantity and 7.80 per cent in value.

SHAD FISHERY OF THE HUDSON RIVER.

According to a special canvass conducted by the Bureau, considerable improvement in the shad fishery of the Hudson River in 1919 is to be reported. The number of fish taken in recent years was as follows: 1915—15,855, value $8,643; 1916—9,287, value $5,465; 1917—12,015, value $6,540; 1918—67,403, value $48,184; and 1919—90,301, value $83,724. In 1919 there were 299 men engaged in the fishery, employing 158 boats representing a value of $6,700; 373 gill nets with a value of $15,269; 12 seines, valued at $1,700, and shore and accessory property valued at $7,920; a total investment of $31,589. The catch of 90,301 fish weighed 374,974 pounds, of which 76,501 shad or 301,306 pounds, valued at $60,690, were taken on the New York side of the river and 13,800 fish or 73,668 pounds, valued at $23,034, on the New Jersey side.

The Bureau plans to continue taking a yearly canvass of this fishery of the Hudson River where, in the absence of fish-cultural operations, dependence for the rehabilitation of the fishery rests on natural production and local protective measures.

SHAD AND ALEWIFE FISHERIES OF THE POTOMAC RIVER.

The Bureau has undertaken a yearly canvass of the shad fishery and the closely associated alewife or river-herring fishery of the Potomac River, a river in which extensive shad-cultural operations are being conducted. In 1919 the number of persons engaged was 789, employing 514 boats, valued at $80,685; using 306 pound nets, valued at $159,810; and 267 gill nets and one haul seine, valued at $26,761. The shore and accessory property was valued at $610, and the total investment was $267,866. The number of shad taken was 544,469, or 2,040,473 pounds, valued at $332,397. The number of alewives taken was 8,867,902, or 3,676,921 pounds, valued at $61,016.

The number and value of shad taken in this river for various years from 1896 to 1919 was as follows: 1896—684,063, $63,608; 1901—794,462, $119,366; 1904—372,647, $68,052; 1909—203,971, $53,732; 1915—182,402, $72,127; and 1919—544,469, $332,397. The added protection afforded these fish in recent years by restricting the distance from shore at which the fixed nets may be set, supplemented by active operations of the hatchery at Bryans Point, Md., has apparently been of direct benefit to the fishery, which is very intense, owing to the prevailing high prices.

FISHERIES OF THE GREAT LAKES STATES.

The Bureau's complete statistical canvass of the commercial fisheries of the Great Lakes during 1917 was duly finished, and the results were published in a form to show the fisheries by lakes. A regrouping of the figures has been made so as to set forth the fisheries by States.

The number of persons ascertained to be engaged in the fisheries of the Great Lakes was 9,221, of whom 3,183 are credited to Michigan, 1,909 to Wisconsin, 1,761 to Ohio, 683 to New York, 608 to Minnesota, 564 to Illinois, 446 to Pennsylvania, and 67 to Indiana. The investment in the fisheries in the different States arranged in order of importance was as follows: Michigan, $2,937,086; Ohio, $2,462,832; Wisconsin, $1,668,529; Illinois, $1,265,664; Pennsylvania, $919,919; New York, $793,371; Minnesota, $428,443; and Indiana, $79,825; total, $10,555,669. Arranged in the order of the value of the products, the States ranked as follows: Michigan, 29,737,355 pounds, valued at $2,035,889; Ohio, 26,442,993 pounds, valued at $1,570,230; Wisconsin, 24,042,103 pounds, valued at $1,320,162; Pennsylvania, 8,151,241 pounds, valued at $508,382; Minnesota, 10,041,846 pounds, valued at $429,667; New York, 3,481,236 pounds, valued at $268,215; Illinois, 1,356,294 pounds, valued at $87,375; and Indiana, 1,016,155 pounds, valued at $75,099; total output, 103,759,223 pounds, valued at $6,297,969.

Detailed tables and discussions of the fisheries of the Great Lakes and certain tributary waters and of Lake of the Woods and Rainy Lake are included in the report of the division of fishery industries for 1919.

FISHERIES OF THE GULF STATES.

A canvass of the coastal fisheries of western Florida, Alabama, Mississippi, Louisiana, and Texas for the calendar year 1918 was completed during the past fiscal year, and the detailed tables and discussions have been included in the divisional report.

In 1918 these fisheries gave employment to 14,888 persons, the total amount of capital invested was $6,537,859, and the products aggregated 130,923,583 pounds, valued at $6,510,310. Some of the more important products taken were mullet, including roe, 28,641,364 pounds, valued at $1,318,379; oysters, 23,754,465 pounds, or 3,393,495 bushels, valued at $1,106,725; shrimp, green and dried, 27,142,999 pounds, valued at $1,098,427; sponges, 452,188 pounds, valued at $725,155; red snapper, 9,429,802 pounds, valued at $609,312; squeteagues or "sea trout," 4,960,738 pounds, valued at $414,593; Spanish mackerel, 3,494,845 pounds, valued at $251,197; groupers, 5,935,825 pounds, valued at $235,406; redfish or red drum, 2,986,180 pounds, valued at $175,109; and menhaden 14,413,942 pounds, valued at $110,608.

Compared with the Bureau's returns for this region for 1902, there has been a decrease of 17.42 per cent in the number of persons employed, but an increase of 38.88 per cent in the investment, an increase of 15.15 per cent in the quantity of products, and an increase of 86.31 per cent in the value of the fisheries. Compared with the returns published by the Bureau of the Census for 1908, the increase in the catch amounted to 10.69 per cent in quantity and 33.95 per cent in value.

Partly at least as a result of the Bureau's efforts to extend the use of fishery products in the Gulf region, particularly neglected fishes or by-products, an increase in the catch and uses of such products is to be noted. For example, the yield of black drum in 1890 amounted to 136,053 pounds and in 1918 to 2,011,288 pounds; of groupers in 1890 to 427,781 pounds and in 1918 to 5,935,825 pounds; and of Spanish mackerel in 1890 to 700,459 pounds and in 1918 to 3,494,845 pounds. The yield of the by-products of the fisheries amounted to 17,409,496 pounds, valued at $310,682. This included more than 1,600 tons of fish scrap with a value of $119,384; over 109,000 gallons of oil, valued at $106,618; more than 6,000 tons of ground oyster shells for poultry grit, with a value of $61,177, and several items of minor importance.

The quantities and values of the products by States were as follows: West coast of Florida, 54,753,639 pounds, valued at $3,420,363; Alabama, 5,609,219 pounds, valued at $230,567; Mississippi, 20,592,089 pounds, valued at $762,770; Louisiana, 24,953,876 pounds, valued at $1,419,367; and Texas, 25,014,760 pounds, valued at $677,243.

FLORIDA SPONGE FISHERY.

The Bureau has continued to maintain in Florida a sponge-inspection service to give effect to the law regulating the size of commercial sponges from local waters that may be landed at American ports.

The Florida sponge fishery appears to be in a state of equilibrium between the natural supply and the catch, and if it can be so maintained no concern need be felt for the future. There is perhaps some surreptitious traffic in sponges of less than the legal minimum diameter of 5 inches, but the open and flagrant sale of such sponges which occurred some years ago has been suppressed. The cargoes of sponges on sale at the sponge exchanges sometimes contain a large proportion of sponges barely meeting legal requirements, and a number of persons engaged in the business express themselves in favor of an increase of the legal minimum to 5½ or even 6 inches. The superabundance of small sponges is attributed to the gradually returning productiveness of the beds in comparatively shallow water which were depleted by the spongers a number of years ago. There is no doubt that if the small sponges were permitted an additional year's growth these formerly exhausted beds would yield a larger quantity and, owing to the higher value of the larger sizes, a much greater financial return to the spongers.

BIOLOGICAL INVESTIGATIONS.

GENERAL CONDITION OF THE WORK.

In the field occupied by the Bureau's division of inquiry respecting food fishes and the fishing grounds, the fiscal year 1920 was marked by a reduction in activities as a necessary adjustment to the decreased appropriation for such purposes. The general policy adopted was to continue in progress the more important investigations, reducing the number of projects rather than the quality of the work.

During the preceding year several of the chief agencies of the Bureau's scientific activities were in the hands of the Navy Department, so that provision was required neither for the maintenance of certain stations or vessels nor for their normal activities. Just before the beginning of the fiscal year under report, or in the early part of that year, the Navy Department returned to the Bureau the Beaufort (N. C.) laboratory and the steamers *Albatross* and *Fish-Hawk*, and withdrew from the Woods Hole (Mass.) laboratory. It has been endeavored to put these agencies into effective operation again as far as practicable, but, owing to the necessity for extensive repairs to the Beaufort laboratory and its equipment, that station maintained during the fiscal year 1920 a minimum degree of activity.

This branch of the service has labored under the severe handicap of inability to maintain a full working staff. For several years the scientific personnel has been kept fairly complete, partly as a result of the reducing of entrance requirements to the lowest possible limit, and partly in consequence of the appeal of patriotic service during a national emergency. In the past year, however, scientific employees have gradually but steadily drifted out of the service, and qualified candidates for their places have failed to appear. Accordingly, the year closed with 32 per cent of the scientific positions vacant, among them some of high responsibility, and at the present date the number of vacancies has increased to 36 per cent, with other resignations in prospect. Unless radical changes can be promptly made in the salary scale and conditions of service, the efficient accomplishment of one of the Bureau's primary functions must depend upon the possibility of enlisting the services of men of independent means, inspired by patriotic purpose or zeal for the work, a condition which is both repugnant and unpromising.

STUDIES OF SALMONS AND TROUTS.

Notwithstanding the great amount of attention that has been given, over a long series of years, to the biology of the Pacific salmons, much remains to be learned regarding essential features of their life, growth, habits, etc., and the Bureau has continued to have highly qualified assistants devote themselves to these most important fishes. The efficiency of fish-culture operations and the intelligent application of protective measures require a secure foundation of knowledge of the several species at maturity, the life histories, migrations, and conditions favorable for existence. The studies necessary to establish this base of knowledge are highly technical, tedious, and time-consuming; nevertheless, material progress has been made in the interpretation of the age, early history, and possible races of the chinook salmon in the Columbia and Sacramento Rivers. Further consideration has been given to the capture of immature salmon in the open ocean, a commercial practice which threatens the future of the salmon industry, and a conclusive report may be expected shortly. Investigators have made significant studies of salmon in Alaska, the results of which will serve as a guide both in fish-cultural practices and in the administration of the salmon fishery in Alaskan waters.

There have been conducted anatomical studies and experiments with members of the salmon family which have brought to light conditions that bear directly upon the propriety and effect of certain fish-cultural practices, and that with further study and experiments at hatcheries are expected to lead to improvements in the manipulation of brood fish, and thereby promote efficiency and economy in the operation of trout stations.

The Bureau is also endeavoring by a series of studies, unavoidably technical in nature, to clear up the confusion existing as regards the relationships of the several members of the salmon family, a confusion which is not of theoretical interest alone, but which impedes the efficiency of practical work in the distribution of fishes, which should be based upon definite knowledge of the species propagated and distributed and of the natural range of these and related species. It is sometimes difficult to determine the results of the introduction of species of trout in new waters (as, for instance, the many disputes regarding rainbow and steelhead trouts) because definite criteria are wanting to identify the species propagated on different occasions, or the species found to have become established in the planted waters.

STUDIES OF OTHER FISHES.

A similar sort of obscurity with reference to the species of whitefishes and ciscoes, or so-called lake herrings, of the Great Lakes has been attacked, and there was brought to completion during the year the report of a thorough study of the whitefishes and related species in Lake Huron. The investigation will be extended to Lake Michigan in the course of the present year.

The investigations of smelts which have been pursued during a period of years are nearing completion, and the results will afford long-desired information regarding fishes that are esteemed for their value as human food and that are of even greater value as food of the larger food and game fishes.

The investigation of the paddlefish has been continued, but the species still baffles the most careful inquiry into its habits of breeding. The life histories of marine fishes are receiving persistent attention, and it is expected that substantial contributions in this field may be made at an early time.

In response to many inquiries regarding the possibilities for a sardine-packing industry on the northwest coast, the Bureau conducted a further inquiry into the occurrence of pilchards, or sardines, off the coasts of Washington and Oregon. It was ascertained that sardines occur in these waters irregularly, though abundantly at times, but, in view of the uncertainty of the runs, the difficulties of the fishery, and the general situation in the canning industry, the establishment of sardine canneries in the northwestern States at the present time is not recommended.

FISH-CULTURAL EXPERIMENT WORK.

The experimental work in the interest of fish culture, both public and private, which is pursued primarily in connection with the fisheries biological station at Fairport, Iowa, has been continued as far as permitted by the available means and personnel. The investigations of previous years have yielded results which it has been possible to apply in practice at several of the Bureau's fish-cultural stations, and the advantages to accrue from a more aggressive pursuit of fish-cultural experiment work are undoubted. It is therefore to be regretted that provision has not been made for the special personnel without which it is impossible to make adequate progress.

The experiments at Fairport, which relate to the propagation of bass, sunfish, catfish, and buffalofish in ponds, are supplemented by investigations of the plants and lower animals which live in the ponds and contribute directly or indirectly to the food supply of fish and to the yield of fish from the ponds. Results of special interest and value are regularly obtained, and if the observations could be more widely extended the Bureau would rapidly gain in ability to furnish just the sort of helpful information desired by the amateur fish-culturists in all parts of the country who are seeking to improve the conditions of home life on the farm by developing the fishpond as a source of food and a means of recreation.

MOSQUITO CONTROL BY THE USE OF FISH.

Previous reports have stressed the public service rendered by the Bureau in conducting investigations and practical operations in the employment of fish as a means of exterminating mosquito larvæ under conditions where other means of control are either impracticable or unnecessarily expensive. Renewed assurance of the value of this work was gained during the past year when the Bureau of Public Health Service urgently requested this Bureau to detail an assistant for full time in advising with Federal, State, and local health officers in the proper use of fish in the broad antimalaria campaign in the Southern States. There have also been several freely offered expressions of appreciation for the value of this service from State health officials.

The studies of fishes and other aquatic animals in relation to mosquito control have not been restricted to southern waters, but additional experiments have been conducted in Northern States, notably in the Interstate Palisades Park of New York and New Jersey.

STUDY OF FISH DISEASES.

While the Bureau was without a regular fish pathologist during the first half of the fiscal year, the study of the parasites and diseases of fishes was continued during most of that period by the aid of temporary employees. Diseases of fish in the St. Lawrence River and in certain fish hatcheries were investigated, and appropriate remedies were suggested when practicable. Later in the year systematic researches were directed at such special problems as the widely prevalent "white-spot" disease in salmonoid eggs and the mortality of pike-perch eggs which substantially lowers the efficiency of all pike-perch hatching operations.

SHELLFISH INVESTIGATIONS.

Oysters.—The problems of the oyster industry in some sections are critical and have received the fullest possible measure of attention. The problem of first importance is the failure of set during a period of years in Long Island Sound, and this has been attacked by methods of both biology and chemistry (in cooperation with the Bureau of Chemistry.) A foundation of facts is steadily being constructed, and some tentative conclusions as to the causes of trouble and the methods of alleviation are now possible. No claim can, however, be laid to a complete solution of the problem until further observations and experiments have been made. The inquiries have centered principally about Milford, Conn., and Sayville, N. Y.

It seems fairly clear that one of the disturbing factors, and possibly the chief cause of the failure of set, is the extensive pollution of inshore waters by sewage or industrial wastes, and proper attention is therefore being focused upon this aspect of the question.

Oyster studies have also been made in the Chesapeake Bay and in some waters of the State of Virginia. In the vicinity of Norfolk attention has been given to the damages to oysters resulting from the unlawful discharge of oil upon the waters of Hampton Roads. In the York River, Va., the investigation of conditions affecting unfavorably the growth of oysters has been brought to a close.

Fresh-water mussels.—In the propagation of fresh-water mussels the number of glochidia infected upon fish and liberated in the public waters was conspicuously greater than in the preceding year, and the unit cost was correspondingly lower. The results of artificial propagation are detailed elsewhere. In the experiments directed at the rearing of young mussels until they have attained a size (say half an inch in length) permitting of their being handled with convenience and planted deliberately upon suitable bottoms, notable results have been secured during the year. Before the past year a measurable degree of success had been attained with one species of mussel (the Lake Pepin mucket), but during the summer of 1919 two additional species (yellow sand-shell and river mucket) were reared in considerable quantities in small troughs.

At a conference in La Crosse, Wis., in January, 1920, participated in by representatives of the States of Wisconsin and Minnesota and by other interested persons as well as by assistants of the Bureau, consideration was given to the protection of mussel resources, and, acting upon authority provided by recent concurrent legislation in several States, it was determined to close against commercial shelling for a period of five years certain sections of the Mississippi River bordering the two States represented in the conference. The purpose is to allow opportunity for natural recuperation of the beds and to create favorable conditions for the artificial propagation of mussels. The proposed action, when taken, will represent the culmination of several years of earnest effort by various persons and agencies, in which the Bureau of Fisheries has played a leading part, to bring about the effective protection of the valuable mussel resources of the Mississippi Basin. Up to the present time, only four States which control the principal mussel-producing portions of the Mississippi River have enacted appropriate legislation. It is greatly to be desired that other States having jurisdiction over important shell-producing streams will join in this movement before the resources become too seriously depleted.

In the course of the fiscal year there was issued a document describing in detail the commercial fresh-water mussels, the implements and practices of the mussel fishery, and the machinery and methods of manufacture of buttons from the shells. There has also been completed and submitted for publication a general account of the natural history and propagation of the mussels. These papers are issued in response to a general demand for the varied information contained in them, and with a view to disseminating such knowledge of the resources and industries and of the conditions of their perpetuation as will stimulate the adoption of measures and practices whereby unnecessary waste may be avoided and the future as well as the present may be served.

MISCELLANEOUS STUDIES.

Investigation of the reddening of salt fish, which causes large annual losses to fish packers, has been continued and some definite conclusions are now possible. It has been ascertained that the discoloration is due to the growth of at least two organisms, one of which under appropriate conditions is characteristically red and the other pink. The simultaneous growth of these organisms results in the production of various shades of color. The organisms evidently have their origin in the imported sea salt which is so extensively used in the fishing industry. The conditions of growth of the causative agents have been pretty well determined, and experiments are under way to determine the means of eradication.

In response to solicitations from the trade that domestic sources be found for a vegetable gelatin such as is required for the satisfactory packing of certain fish products in cans, the Bureau has conducted an inquiry into the properties of gelatin derived from the seaweeds of the New England coast. A gelatinous extract from the common "Irish moss" of that coast, when properly prepared, was found to meet the requirements. It has been thought advisable to carry the investigation further and to ascertain the possibilities of developing domestic sources for agar-agar and other valuable gelatins of commerce now imported.

SCIENTIFIC WORK OF THE VESSELS.

The steamers *Albatross* and *Fish Hawk*, which had been surrendered to the Navy Department for the period of the war, were returned to service in the interests of the fisheries during the early part of the fiscal year.

For the present it is intended to retain the *Albatross* in the Atlantic, from which she has been absent for a period of more than 30 years. Her work up to the close of the fiscal year consisted in one cruise to the south as far as the Yucatan Channel and another cruise along the northeast coast and into the Gulf of Maine. Oceanographic studies and fishery trials were features of the cruises. The *Albatross* is now better equipped than ever before for practical fishing operations, and it is expected that as soon as the crew is properly trained and a suitable scientific staff can be found the vessel will make even more substantial contributions to the welfare of the fisheries than it has in the past.

The *Fish Hawk* has been engaged in an exploration of Chesapeake Bay to discover and record the seasonal conditions of salinites, temperatures, currents, and ultimate food supply of fishes, and to ascertain within the limits of feasibility all other conditions affecting the migrations and abundance of fish and shellfish. All of these data are essential for the most intelligent conservation and development of the important fisheries of this bay.

THE BIOLOGICAL LABORATORIES.

For the first time since the early part of 1917 the Bureau has had the full possession of all of its laboratories; but, while available for use, it has not been possible to operate all of them actively. The Woods Hole (Mass.) laboratory was rather fully engaged during the summer of 1919 with investigations in progress concerning oysters, the reddening of salt fish, gelatin from seaweed, and the habits, food, and parasites of fishes.

The Beaufort (N. C.) laboratory could not be put in shape for operation until late in the fiscal year, and deficiencies of funds and of personnel have rendered the station relatively inactive.

At the Fairport (Iowa) laboratory, studies of fresh-water mussels and experimental fish culture were pursued, with the use of the limited space afforded in the old temporary laboratory building. During the year, however, the excellent new building, fireproof in construction, pleasing in appearance, and admirable in design, was brought nearly to completion and its occupancy was expected at an early date in the following fiscal year.

Progress in the construction of the Key West (Fla.) biological station consisted principally in the installation of the necessary units of the pumping system and the construction of a concrete tank tower with storage for both fresh and salt waters. The water system is, therefore, complete and ready for use, and this is one of the most essential features of equipment of the station. The available laboratory space and other accommodations which it has been possible to supply from the appropriations hitherto made are inadequate for scientific work in the interest of the fisheries, except such as may be rendered by the permanent staff authorized. The station functioned usefully for a portion of the fiscal year, but since the loss of its scientific staff, about the middle of the year, it has remained idle and in the charge of a single employee as caretaker.

Too cordial an acknowledgment can scarcely be made of the loyal and devoted service of the men who have still remained in the service during these times when the most trying economic conditions have been and are yet bearing heavily upon them. The Bureau expresses also its appreciation of the services of those who have rendered their contribution to the work of the year, and left only under the compelling pressure of circumstances.

PROPAGATION AND DISTRIBUTION OF FOOD FISHES.

SUMMARY OF THE OPERATIONS.

The output of the hatcheries during the fiscal year 1920 fell short of the results in 1919, when a record was established. The aggregate production was 4,770,355,000, of which 3,872,218,000 were fry, 267,388,000 were fingerlings, yearlings, and adults, and 630,749,000 were fertilized and viable eggs. Important species whose output was larger than in the previous year were catfish, buffalofish, whitefish, chinook salmon, chum salmon, steelhead salmon, rainbow trout, blackspotted trout, grayling, crappie, sunfish, and cod. There was a reduction in the output of shad, cisco, pike perch, yellow perch, pollock, and winter flounder. The net decrease in output was about 1,105,000,000, of which about 1,050,000,000 represented the winter flounder.

Untoward conditions that influenced the fish-cultural work were the partial disorganization of the field force, the increased cost of operations with no increase in available funds, and unfavorable weather during the egg-laying periods. A very serious epidemic among brook trout in New England hatcheries materially reduced the output of that species.

Following is a summarized statement by species showing the number of eggs, fry, and adults, yearlings, and fingerlings distributed during the fiscal year 1920:

SUMMARY, BY SPECIES, OF THE DISTRIBUTION OF FISH AND FISH EGGS DURING THE FISCAL YEAR ENDED JUNE 30, 1920.

Species.	Eggs.	Fry.	Fingerlings, yearlings, and adults.	Total.
Catfish			76,286,060	76,286,060
Carp		37,800,000	6,999,310	44,799,310
Buffalofish		174,585,000	2,616,575	177,201,575
Shad		56,558,270		56,558,270
Alewife		115,000		115,000
Whitefish	111,830,000	278,535,000		390,365,000
Cisco	90,200,000	76,005,000		166,205,000
Silver salmon		5,835,700	2,892,050	8,727,750
Chinook salmon	11,267,000	1,265,770	37,505,500	50,038,270
Sockeye salmon	3,000,000	50,950,000	47,857,615	101,807,615
Humpback salmon		307,200		307,200
Chum salmon		7,318,100	5,733,150	13,051,250
Steelhead salmon	891,600	173,200	3,053,235	4,118,035
Atlantic salmon		1,550,000	225	1,550,225
Landlocked salmon	497,105	1,054,525	90,275	1,641,905
Rainbow trout	2,607,600	64,200	4,200,015	6,871,815
Blackspotted trout	722,600	2,021,500	1,315,700	4,059,800
Loch Leven trout			101,965	101,965
Lake trout	2,960,000	29,140,000	800,785	32,900,785
Brook trout	821,400	3,160,285	6,034,270	10,015,955
Grayling		1,165,000		1,165,000
Pike and pickerel			510,350	510,350
Freshwater drum			29,955	29,955
Crappie			35,897,805	35,897,805
Largemouth black bass		586,500	978,465	1,564,965
Smallmouth black bass		171,000	41,375	212,375
Rock bass			61,035	61,035
Warmouth bass			14,650	14,650
Sunfish			30,879,120	30,879,120
Pike perch	89,625,000	154,900,000		244,525,000
Yellow perch		162,590,100	616,050	163,206,150
White perch			1,500	1,500
White bass			46,070	46,070
Striped bass		16,474,000		16,474,000
Cod	160,992,000	489,175,000		650,167,000
Pollock		557,685,000		557,685,000
Haddock	155,335,000	159,953,000		315,288,000
Flounder		1,603,080,000		1,603,080,000
Miscellaneous			2,824,960	2,824,960
Total	630,749,305	3,872,218,350	267,388,065	4,770,355,720

A gratifying feature of the year's distributions was the increased number of fishes planted as fingerlings. The advance over 1919 in this respect exceeded 100,000,000. The most noteworthy factor in this increase was the Pacific salmons, of which over 97,000,000 were carried to the fingerling stages before being liberated as against 78,421,000 in the previous year.

HATCHING STATIONS OPERATED.

During 1920 the Bureau operated about 60 permanent hatcheries, 5 temporary hatcheries, and a large number of field, auxiliary, and collecting stations. No new hatcheries have recently been authorized by Congress, but the Bureau, in order to serve a public demand and meet existing needs, has established auxiliary stations at several points, and in 1920 such auxiliaries were operated at Lewis River, Wash., for chinook and chum salmons; Washougal River, Wash., for steelhead salmon; Paris, Idaho, for whitefish; Bay City, Mich., for pike perch; Willamette River, Oreg., for shad; Weldon, N. C., for striped bass; La Crosse, Wis., for brook trout and pike perch; and Atchafalaya, La., for buffalofish.

In the following list there are shown fish hatcheries, auxiliaries, and rescue stations operated in 1920, arranged alphabetically by States, together with the species handled at each.

MAIN AND AUXILIARY FISH-CULTURAL STATIONS OPERATED DURING THE FISCAL YEAR 1920.

State and locality.	Species handled.
Alaska:	
Afognak	Sockeye salmon.
Yes Bay	Do.
Arkansas: Mammoth Spring	Largemouth and smallmouth black bass, rock bass.
California:	
Baird	Chinook salmon.
Battle Creek	Do.
Mill Creek	Do.
Colorado: Leadville	Blackspotted, rainbow, Loch Leven, brook, and lake trouts.
District of Columbia: Central station	Shad, whitefish, cisco, chinook salmon, pike perch, yellow perch.
Georgia: Cold Springs	Largemouth black bass, crapple, sunfish, catfish.
Idaho: Paris [1]	Whitefish.
Illinois:	
Cairo [2]	Rescued fishes.
Meredosia	Do.
Quincy	Do.
Iowa:	
Fairport	Do.
Manchester	Brook and rainbow trouts, smallmouth black bass, rock bass.
Bellevue	Rescued fishes.
North McGregor	Do.
Kentucky: Louisville	Largemouth black bass, smallmouth black bass, rock bass, sunfish, yellow perch.
Louisiana: Atchafalaya	Buffalofish.
Maine:	
Boothbay Harbor	Haddock, pollock, winter flounder, alewife.
Craig Brook	Atlantic, landlocked, and humpback salmons, brook trout.
Green Lake	Landlocked salmon, brook trout.
Grand Lake Stream	Do.
Maryland: Bryans Point	Shad, yellow perch.
Massachusetts:	
Berkshire	Brook trout.
Gloucester	Cod, haddock, pollock, winter flounder.
Woods Hole	Cod, winter flounder.

[1] Auxiliary of Springville (Utah) hatchery. [2] Auxiliary of Louisville (Ky.) hatchery.

MAIN AND AUXILIARY FISH-CULTURAL STATIONS OPERATED DURING THE FISCAL YEAR 1920—Continued.

State and locality.	Species handled.
Michigan:	
Northville	Brook and rainbow trouts, landlocked salmon, cisco, smallmouth black bass, sunfish.
Bay City	Pike perch.
Charlevoix	Lake trout, whitefish.
Minnesota:	
Duluth	Lake and brook trouts, whitefish, pike perch.
Homer	Largemouth black bass, pike perch, rescued fishes.
Mississippi:	
Tupelo	Largemouth black bass, crappie, sunfish.
Friars Point	Rescued fishes.
Missouri: Neosho	Largemouth black bass, smallmouth black bass, rock bass, crappie, sunfish, yellow perch, rainbow trout.
Montana:	
Bozeman	Blackspotted, rainbow, and brook trouts, grayling.
Glacier Park	Do.
New Hampshire: Nashua	Brook and rainbow trouts, smallmouth black bass.
New York: Cape Vincent	Brook, lake, and rainbow trouts, whitefish, cisco, yellow perch.
North Carolina:	
Edenton	Shad, largemouth black bass, sunfish.
Weldon	Striped bass.
Ohio:	
Put in Bay	Whitefish, pike perch, yellow perch.
Port Clinton	Carp.
Oregon:	
Clackamas	Chinook, chum, and steelhead salmons, brook, rainbow, and blackspotted trouts.
Applegate	Silver and steelhead salmons.
Rogue River	Chinook and steelhead salmons, rainbow trout.
Upper Clackamas	Chinook and steelhead salmons, brook trout.
Willamette	Shad.
South Carolina: Orangeburg	Largemouth black bass, crappie, sunfish.
South Dakota: Spearfish	Blackspotted, rainbow, brook, and Loch Leven trouts.
Tennessee: Erwin	Largemouth and smallmouth black bass, rock bass, sunfish, carp, brook and rainbow trouts.
Texas: San Marcos	Largemouth black bass, crappie, rock bass, sunfish.
Utah: Springville	Blackspotted, rainbow, and brook trouts.
Vermont:	
St. Johnsbury	Landlocked and steelhead salmons, brook and rainbow trouts, smallmouth black bass, yellow perch, white perch.
Holden	Brook and lake trouts, steelhead salmon.
Swanton	Yellow and pike perches.
Virginia: Wytheville	Largemouth and smallmouth black bass, rock bass, sunfish, crappie, brook and rainbow trouts.
Washington:	
Baker Lake	Sockeye and steelhead salmons.
Birdsview	Humpback, silver, and steelhead salmons, blackspotted and rainbow trouts.
Duckabush	Chum, humpback, silver, and steelhead salmons.
Quilcene	Chum, silver, and steelhead salmons.
Quinault	Chinook, silver, and sockeye salmons.
Sultan	Chinook, silver, and steelhead salmons.
Big White Salmon[1]	Chinook salmon.
Lewis River[1]	Chinook and chum salmons.
Little White Salmon[1]	Chinook, chum, silver, and sockeye salmons.
Washougal River[1]	Steelhead salmon.
West Virginia: White Sulphur Springs.	Smallmouth black bass, rock bass, sunfish, brook and rainbow trouts.
Wisconsin: La Crosse	Brook trout, pike perch, rescued fishes.
Wyoming:	
Saratoga	Blackspotted, rainbow, Loch Leven, and brook trouts.
Yellowstone National Park[2]	Blackspotted trout.

[1] Auxiliary of Clackamas (Oreg.) hatchery. [2] Auxiliary of Bozeman (Mont.) hatchery.

DISTRIBUTION OF THE OUTPUT.

The output of the Bureau's hatcheries and collecting stations has reached every State, together with Alaska, District of Columbia, and Hawaii. Individual applications, indorsed by Senators and Representatives in Congress, for fish for public and private waters were filled to the number of more than 8,000, in addition to which about 1,000 special plants of fish were made in public waters of the various States on the initiative of the Bureau's local representatives.

In making distribution from the hatcheries and collecting stations the Bureau's cars traveled 91,525 miles, and detached messengers in charge of baggage-car shipments of live fish and fish eggs covered approximately 400,000 miles.

Two new steel railway cars, especially constructed and equipped for the transportation of live fishes, were put in commission during the year. These cars were built by the American Car & Foundry Co., of Wilmington, Del., and cost, including boilers and pumps, $29,416 and $29,733, respectively. In each car is embodied the most approved methods of railway-car construction, and the equipment includes some specially designed aerating apparatus not previously used, which has resulted in a material saving of fuel. The noteworthy economy effected in the distribution of the Bureau's output has been brought about by the increased carrying capacity of the new cars, which amounts to nearly 35 per cent over that of the other cars now in use. Formerly the distribution cars were equipped with an independent steam plant to supply the air needed for the safe conveyance of live fishes. The new cars are provided with an apparatus whereby the necessary air is obtained from the "train line," thus resulting in a material saving of fuel. A further saving in air has been accomplished by discarding the specially made hard-rubber air-liberator holders formerly used, and substituting one-eighth inch galvanized tees. The hard-rubber holders cost about $1 each and were subject to frequent breakage. The tees cost 5 cents each and will wear indefinitely, at the same time adequately meeting all requirements. The size of tubing used in conveying air to the fish has also been reduced from three-eighths to one-fourth inch.

RELATIONS WITH THE STATES.

Closer cooperative relations now exist between the Bureau and the State fishery officials than at any previous time. Each year adds to the number of field stations operated jointly by the Bureau and the States under an arrangement that reduces expense, increases the output, and promotes the efficiency of the work of both parties.

Acknowledgment is made of the valuable assistance rendered to the Bureau by various State fishery authorities during the year. In some instances the material aid proffered by the States has made possible the conduct of extensive fish-cultural enterprises that otherwise would have been greatly curtailed. The ever-increasing cost of labor and materials has taxed the Bureau's appropriations to the limit, but by means of State assistance it has been possible to carry to a successful outcome several important projects.

In only comparatively few cases have the States failed to respond to the Bureau's desire to establish mutually helpful relations. In one instance the Bureau has been constrained to abandon well-matured plans for the extension of fish-cultural operations in behalf of a State because of what appeared to be the intention of the local authorities to set aside the essential provisions of a law that afforded some protection during the spawning season to the fishes in whose artificial propagation and distribution the Bureau was spending many thousands of dollars.

During the year 1920, 24 State fish commissions received from the Bureau assignments of fish and fish eggs aggregating 232,137,000 eggs, 3,016,000 fry, and 660,000 fingerlings. The eggs were mostly of commercial fishes of the Great Lakes and Pacific coast, furnished to State hatcheries for incubation, with the intention of having the resulting young planted by the State officials in suitable local waters. The fingerlings were for the most part fishes secured in rescue operations in the Mississippi Valley. The details of this State cooperative work are as follows:

ALLOTMENT OF FISH AND FISH EGGS TO STATE FISH COMMISSIONS DURING THE FISCAL YEAR 1920.

[All figures are for eggs unless otherwise indicated. Fingerlings are designated *a* and fry *b*.]

State and species.	Number.
Arkansas: Rock bass	[a]3,000
California: Chinook salmon	4,235,000
Idaho:	
Blackspotted trout	25,000
Chinook salmon	30,000
Illinois:	
Black bass	[a]600
Catfish	[a]261,200
Crappie	[a]14,300
Pickerel	[a]270
Yellow perch	[a]450
Sunfish	[a]158,500
Brook trout	[a]500
Rainbow trout	40,000 [a]3,000
Iowa: Rainbow trout	98,400
Maine: Landlocked salmon	417,105
Maryland:	
Pike perch	1,500,000
Rainbow trout	93,000 [a]3,200
Massachusetts: Chinook salmon	[a]7,500
Michigan:	
Lake trout	1,000,000
Whitefish	20,150,000
Lake herring	2,000,000
Landlocked salmon	25,000 [b]16,600
Pike perch	55,125,000
Minnesota:	
Black bass	[a]15,550
Catfish	[a]20,405
Crappie	[a]2,500
Sunfish	[a]9,950
Lake trout	200,000
Steelhead salmon	25,000
Montana:	
Blackspotted trout	247,600
Lake trout	50,000
Rainbow trout	1,540,000
Nevada:	
Brook trout	78,400
Rainbow trout	106,600
New Hampshire:	
Lake trout	25,000
Whitefish	400,000
Pike perch	2,500,000
New Jersey:	
Pike perch	1,000,000
Rainbow trout	22,000
New York:	
Lake herring	87,700,000
Whitefish	2,800,000
Lake trout	1,600,000
Landlocked salmon	30,000
Ohio: Whitefish	50,000,000
Oklahoma: Rainbow trout	[a]4,380
Oregon:	
Blackspotted trout	105,000
Chinook salmon	7,002,000
Rainbow trout	100,000
Sockeye salmon	3,000,000
Steelhead salmon	700,000
South Dakota: Brook trout	[a]2,400
Utah:	
Brook trout	[a]10,000
Rainbow trout	[a]98,000
Vermont:	
Lake trout	25,000 [a]2,000
Landlocked salmon	20,000
Steelhead salmon	25,000
Pike perch	24,000,000
Yellow perch	[b]3,000,000
Washington:	
Blackspotted trout	150,000
Lake trout	25,000
Steelhead salmon	75,000
Wisconsin:	
Black bass	[a]9,550
Catfish	[a]16,750
Crappie	[a]5,000
Sunfish	[a]10,350
Yellow perch	[a]700
Whitefish	13,680,000
Wyoming:	
Blackspotted trout	100,000
Lake trout	20,000
Rainbow trout	48,000
Total	232,137,505 [a]660,055 [b]3,016,600

There appears to be no evidence that the State of Maryland intends to meet the conditions imposed by Congress in the matter of the reopening and operation of the hatchery at the head of Chesapeake Bay, near Havre de Grace. This hatchery was closed by order of the Secretary of Commerce on January 27, 1917. The condemnation and sale of the property should be considered.

In making original plants of nonindigenous fishes in the waters of any State, the general policy and practice of the Bureau are to defer to the recommendations of the State fishery officials. Individual applications are referred to the State commissioners, and no applications are filled without their consent. Being impressed with the importance of safeguarding State waters from the damage that may result from the introduction of unsuitable fishes, the Bureau has, for a number of years, in cooperation with the States concerned, sought to discourage the planting of basses, perches, pikes, and other fishes of known predatory habits in the Pacific States, because of the injury that may be done to the young salmon and trout, which already have enough natural enemies with which to contend. This policy meets with some opposition from sportsmen and from persons who wish to stock private or small public waters with fishes that are different from those occurring locally. It is well known that there exist in the Pacific States numerous waters not inhabited by salmon and trout in which basses and other spiny-rayed fishes would thrive, but it appears unwise to make exceptions, because there is always the possibility of the introduced fishes escaping at times of flood or becoming established by other means in trout or salmon waters. The results that would be liable to follow are such that the Bureau would not wish to share any responsibility therefor, and its proper course undoubtedly is to continue refusing to entertain applications of that character even if State officials should be inclined to yield to strong importunities.

PROPAGATION OF PACIFIC SALMONS.

While the egg collections at the Pacific salmon stations for the year showed a decrease of approximately 7,000,000 as compared with 1919, the net results of the year's work must be regarded as satisfactory. There has been no abatement of the serious handicap imposed on this work by the excessive cost of materials and the scarcity and cost of labor. Increased appreciation of the Bureau's work by the extensive commercial interests in the salmon fishery is indicated by their requests for its further extension and by the cooperative assistance they have rendered.

At the Afognak station the spawning season of the sockeye salmon began July 26, and by August 22 eggs to the number of 73,133,000 had been laid down in the hatchery, filling all available space. A further collection of approximately 6,000,000 eggs was made on September 8, and installed for incubation in boxes of gravel in accordance with the method developed by A. Robertson, at the Harrison Hot Springs hatchery in British Columbia, bringing the total egg collections to 79,178,000.

Unusually favorable conditions prevailed during the spawning season, the Litnik River and its tributaries being at a stage to permit of the easy ascent of fish and at the same time allow the installation of the racks. The winter was also mild, with but little snow, and communication between the station and the village was rendered simple by the absence of ice in the bay and snow on the tramroad. The egg collections exceeded those of the previous year, and it was estimated that the fish taken for artificial propagation did not represent more than 50 per cent of the spawning salmon that entered the lake. After the completion of the egg collections, the racks were removed in order that the remaining fish might have free access to the natural spawning beds, and as late as September 18 green fish in considerable numbers were observed at the mouths of creeks tributary to the lake. The run of salmon in Litnik River has shown a steady increase since the volcanic eruption in 1912, at which time it was practically destroyed.

During October 10,000,000 eyed sockeye eggs were forwarded to Seattle, Wash., arriving there in excellent condition. From that point 7,000,000 were diverted to the Quinault Lake hatchery and 3,000,000 were consigned to the State Fish and Game Commission's hatchery at Bonneville, Oreg. In March a lot of 3,300,000 eggs whose development had been retarded as much as possible was transferred by a steamer of the Pacific American Fisheries Co., to Ikatan, Alaska, in charge of an employee of the Afognak station. The eggs were incubated on trays in one of the buildings belonging to the company, and the resulting fry were liberated in May in tributaries of Ikatan Lake.

The total destruction of the retaining rack at Yes Bay by the heavy drift brought down by the high water of September 17, the sixth day of the spawning season, reduced the collection of sockeye-salmon eggs at that station to the lowest point in its history, only 9,752,000 being secured. After the destruction of the rack, seining in the river was continued up to September 24, but with unsatisfactory results, as with no barrier to stop them the majority of the fish passed upstream. The eggs obtained were of good quality and hatched with a loss of less than 4 per cent. The output of the station, including 8,628,000 fingerling fish carried over from the previous year, amounted to 12,678,000 sockeye-salmon fingerlings, and at the close of the fiscal year 5,355,000 fish were still in the station ponds.

In addition to the fish-cultural operations outlined, a considerable amount of construction and repair work essential to the proper maintenance of the station was undertaken. The importance of these repairs has been apparent for several years, but because of their extensiveness it has not been possible to set aside from the appropriation for salmon propagation a sufficient amount to meet the requirements without curtailing seriously the fish-cultural part of the work. The unsafe condition of the water-supply flume has long been the cause of much worry, and as it appeared to have reached the full limit of endurance at the end of the fiscal year 1919, it was decided to use the regular allotment for installing a pipe line, a right of way having already been surveyed, and thus give the station a water supply for present needs, with ample reserve for future expansion of the hatchery, and at the same time furnish power for a lighting plant. Six thousand feet of woodstave pipe were obtained, and 2,300 feet of trestle for carrying the pipe were constructed. The available funds were not sufficient to carry the work to completion because of the prevailing high prices of all material and labor, but the importance of finishing the project and of making other essential repairs at the earliest possible date is indicated by the collapse during the winter of more than 100 feet of the old flume. Because of the small number of troughs required to accommodate the light collection of eggs, no loss of eggs was occasioned, though the hatchery was without an adequate supply of water for several hours. On account of the decayed condition of floor timbers and foundation posts, a number of hatching troughs were overturned earlier in the season by the support on which they stood breaking through the floor. No loss occurred, but had the hatchery been filled with eggs or fry, as would have been the case in a normal season, either of these incidents could not have failed to result in a large loss of stock. The trestle, constructed primarily to carry the new pipe for water supply, is built to accommodate a tramcar, thus making available for the convenient use of the station a large amount of timber suitable for fuel and also for lumber. Other important work accomplished by the station employees, with material already on hand and without additional expense, was the replacing of 1,600 feet of plank walk about the station grounds, completing new foundation for the superintendent's residence, constructing 1,320 feet of tramway from the hatchery to the boathouse on the lake shore, and equipping it with 12-pound iron rails. This completes the tramway, extending from tidewater to the hatchery, over which all supplies reach the station.

From the stations in the Washington field, not including Quinault, the total output for the year amounted to 29,956,700 eggs, fry, and fingerlings, these figures including 125,000 eyed steelhead-salmon eggs supplied to applicants. While this output was somewhat below the previous season's, the falling off is attributable to a series of untoward circumstances rather than to a decrease in the run of salmon, and a gratifying increase in the yield of sockeye and silver-salmon eggs is to be recorded.

On July 21, 1919, all the buildings and equipment at the Baker Lake station were destroyed by fire. As immediate action was necessary to safeguard the eggs available from the sockeye salmon already entrapped there, funds intended for use in other fields were diverted for this more important purpose. As a consequence operations had to be discontinued for the year at Darrington, Day Creek, and Illabot Creek, at each of which points traps, flumes, and other equipment had suffered damage from floods and ice during the winter, and funds were not available for making repairs.

Low water in Grandy Creek and Skagit River during the spawning season of the humpback and chinook salmons curtailed egg collections for the Birdsview station. The run of humpbacks was light, but chinooks were in evidence in the river, though beyond the reach of traps or seines and unable to attain the spawning grounds in the tributaries. The number of eggs taken was 74,000 of humpbacks and 54,000 of chinooks. Conditions were better during the silver-salmon run, and 2,198,000 eggs were secured. This stock was augmented by the transfer of 2,418,000 eggs from the Baker Lake collections. Steelhead-salmon eggs to the number of 255,000 also were taken at Birdsview.

The largest run of sockeye salmon recorded during the past 10 years occurred at the Baker Lake station. The first fish entered the trap at the lake outlet on July 1, and the run continued until August, during which period 7,800 fish were taken and transferred to the retaining inclosure for ripening. At spawning time 3,835 of the number on hand—about 49 per cent—were females, which yielded 11,150,000 eggs of good quality. Approximately 200 of the female brood fish escaped from the retaining inclosure during a sudden rise in the lake, the racks at either end of the inclosure being somewhat out of repair; material for repairs to these racks was destroyed by the fire already mentioned and could not be replaced in time. A large run of silver salmon also occurred in Baker Lake, but the river stages were low during the early part of the fall, and fish did not ascend to the lake until November, when the heavy rains in progress caused a rise of 12½ feet above normal, overflowing the trap and permitting many of the fish to escape. The total collection of 2,600,000 eggs was transferred to Birdsview immediately after being eyed. The sockeye eggs passed through the incubation period with only nominal losses, and 10,250,000 advanced fry were returned to Baker Lake.

After the fire of July 21, which destroyed the hatchery, mess house, blacksmith shop, oil house, foreman's cottage, and other small buildings, with all tools and hatchery equipment, it required the most energetic efforts on the part of the station personnel to complete arrangements in advance of the spawning season in September for handling the large numbers of eggs it was expected to collect from the brood fish on hand. The task was especially difficult because of the location of the station with regard to transportation facilities, the nearest railroad station being 18 miles distant and accessible only by pack horses. The first eggs were placed in eight troughs constructed from lumber salvaged from the fire. By October 6 a new sawmill was in operation, and 40 new troughs had been constructed from lumber manufactured on the grounds. In equipping the troughs to receive eggs and fry, more than a thousand trays of three-fourths inch strips covered with wire mesh were required. Early in November the special appropriation of $50,000 provided by Congress for the reconstruction of the station became available, when the station force was augmented by the employment of temporary labor. The sawmill machinery was housed by a building 50 by 80 feet, a temporary shelter was erected over the hatching troughs, and the work of cutting timber, clearing the grounds of wreckage from the fire, and operating the sawmill was pushed as rapidly as possible. The sawmill and construction work had to be suspended during the winter, as ice in the lake prevented the movement of logs to the mill, but it was resumed by March 20, and at the close of the fiscal year the lower frame for the new hatching building had been completed. This building is 56 feet wide and 130 feet long, with 12-foot walls. It will contain 150 standard salmon troughs, and with the contemplated tray system it will have a capacity for handling approximately 40,000,000 eggs and fry to the feeding stage.

Although climatic and other conditions were unfavorable at the Duckabush station, the egg collections exceeded those of several years past. The summer run of chum salmon was very good, and 5,450,000 eggs were obtained. The fish were taken in trap and seines at the mouth of the river, and transported by autotruck a distance of 3 miles to the hatchery without washing, this method having proved the most satisfactory in making transfers of green eggs of the chum salmon. The "water-hardening" process is delayed by permitting the eggs to remain unwashed in the milt, and experiments conducted last season indicate that eggs reaching the hatchery within an hour after being taken suffer little loss, while those held for a longer period invariably show a serious mortality. An excellent run of steelhead salmon occurred at this point, but because of high water the egg collections were not large, aggregating only 405,000. Another unfavorable feature was the necessity of transferring male fish from the Quilcene station, as the run in the Duckabush River appeared to be largely made up of females.

At the Quilcene station the numbers of all species of salmon reaching the racks were small, and as a consequence the egg collections were not as large as last season. This section of Hoods Canal is subjected each year to active fishing by purse seines, and the high prices of recent years have been an added incentive to such operations. While the law prohibits the use of seines within a certain specified distance of the mouths of all salmon streams, a large number of spawning fish are taken directly in the mouths of certain streams entering the canal, to the detriment of the Bureau's work and the future supply. The eggs taken at Quilcene station during the year were 2,200,000 chum, 1,130,000 silver, and 460,000 steelhead. In addition, 2,402,000 chum-salmon eggs were transferred from the Brinnon collecting station. At Sultan, where the year's work in fish culture compares favorably with that of other years, there were taken 3,167,000 silver, 185,000 chinook, and 92,000 steelhead eggs. Practically all of the silver salmon were taken during the period between November 1 and December 15, when commercial fishing is restricted at the mouth of the Snohomish River, and but few eggs were secured after the beginning of commercial operations.

The collection of sockeye-salmon eggs at the Quinault station—8,035,000—exceeded the take of the preceding year by over 60 per cent. During October this station was supplied with 7,000,000 sockeye eggs from the Afognak station. This shipment was made with two objects in view, namely, to relieve the crowded condition of the Afognak station, where more eggs had been taken than could be cared for locally, and to maintain the sockeye salmon in Quinault Lake, this lake and Baker Lake being the only places in the United States outside of Alaska where important spawning grounds of the sockeye salmon exist. When the first eggs were taken, on October 28, and up to November 14, spawning operations were rendered difficult by the low water, but on November 15 a rise of more than 13 feet occurred in Quinault Lake, overflowing the racks in all streams and permitting many salmon to escape. Fishing was resumed on November 19 and continued until December 16, when there was a second rise, followed by the escape of many more spawning fish. In connection with the sockeye operations, 750,000 silver-salmon eggs were taken. Notwithstanding that the run of this species appeared to be in excess of last season's run, the egg collection was much smaller, this being one consequence of the prevailing floods. It is a characteristic of the silver salmon to enter spawning streams in the largest numbers in times of high water, and many fish passed the retaining racks while they were submerged. Chinook-salmon eggs to the number of 40,000 were secured. During December the station experienced a period of the coldest weather ever recorded in that region, the thermometer registering for a time just above the zero mark. This occasioned the loss of a number of sockeye-salmon fry in the rearing ponds and necessitated the immediate liberation of others in the lake.

Experiments were conducted to ascertain the value of seal liver as food for young salmon as compared with other foods in general use. At the close of the year there was no appreciable difference in the size or condition of the fish receiving the seal-liver diet, as compared with other lots feeding on pork liver and fresh fish.

The usual work of rescuing salmon and trout fingerlings from pools that become dry during the summer was taken up in July and August, and upward of 10,000 fingerlings of the silver salmon and blackspotted trout were taken and returned to deep waters. At the close of the fiscal year there remained on hand at the station 1,500,000 sockeye fingerlings.

An outstanding feature of the salmon work in the Oregon field was the successful rearing of an increased number of chinook salmon to the fingerling stage. The output of chinook fingerlings from the Columbia River stations, including 75,000 retained at the end of the year for marking, exceeded 29,000,000, all of them being of Nos. 2, 2½, and 3 fingerling size. Another interesting point in connection with this work was the very satisfactory outcome of experiments in the use of frozen salmon eggs for fish food. Approximately 13,000 pounds of the immature spawn of salmon taken by commercial fishermen were purchased from local canneries at 5 cents per pound and held in cold storage at Portland for use as needed. In preparing it for feeding to the young salmon, the frost was extracted by submerging it in cold water for a few hours, after which it was cooked in a double boiler for two and one-half hours, being stirred at frequent intervals while cooking. Salmon fry receiving a regular diet of this material, with an occasional meal of beef spleen, made more rapid growth, were more vigorous, and suffered less mortality than any lot of fish previously reared in this region. The cost of the eggs is more than that of salted flesh of the spawned-out salmon, which has been used so extensively at all of the Pacific coast stations, but its demonstrated superiority as a food for young fish would seem to warrant its purchase in larger quantities during the year 1921.

Notwithstanding that the very active commercial fishery conducted in the Columbia River each year was augmented last season by an increased number of drift-net and trap-net fishermen, chinook-salmon eggs in excess of 20,000,000 were taken at the Little White Salmon station, the spawning season being from September 19 to October 15. The operations were not altogether favorable, as both the Columbia and Little White Salmon Rivers were at low stage throughout the period the fish were running. The chum and silver salmons, until recently practically ignored by Columbia River fishermen, were sought during the past season as eagerly as the chinook. Collections of eggs of these species amounted to 204,000 chum and 27,000 silver. Transfers of eyed chinook eggs were made to provide room for the feeding of fry and also for the purpose of improving the run of the species at other points. The Clackamas station received 2,110,000, Upper Clackamas 800,000, and the State hatchery at Bonneville 4,000,000. With the exception of 750,000 advanced fry which were retained in the wide water above the rack, all the fish resulting from the eggs remaining at the station were reared to fingerling sizes Nos. 2 and 3, and more than 11,250,000 were returned to the river.

The operations at the Big White Salmon proved successful in every respect, 16,000,000 chinook-salmon eggs being collected during the spawning season, as against 10,665,000 last year. Nearly half of the eggs collected were obtained from fish taken in Spring Creek, thus seemingly furnishing direct evidence of the efficacy of the hatchery and in support of the "parent-stream" theory, as the natural conditions that existed at the mouth of this stream prior to the Bureau's work were such as to preclude the ascent of salmon; the fishway provided to make this stream accessible to the fish proved satisfactory in all respects. Fish entered the stream in such large numbers that at one time it was feared the natural flow of water would be insufficient to hold them without loss. To guard against this, a flume of temporary construction was laid along the bank, with spillways at frequent intervals to insure more thorough aeration of the water. The advantages gained from this work are that Spring Creek is adjacent to the hatchery, and eggs taken therefrom are of a much better quality than those secured from the Big White Salmon River. Eggs from Spring Creek are in the hatching baskets before hardening has taken place, whereas several hours must elapse before eggs taken from the river reach the hatchery. It is frequently necessary to transport the eggs by boat in the rough water of the Columbia, which has a tendency to increase the loss. Of the eggs collected 3,000,000 were shipped in the eyed stage to other stations, and from the remainder 11,600,700 large vigorous fish were liberated in the Columbia River tributaries. The loss on eggs and fish throughout the season was very light.

The usual preparations were made for the collection of chinook-salmon eggs at the Rogue River station, the only modification of the work being the installation of the head rack early in April. By this means some of the early-run fish were stopped. The slight increase in the egg collections from the river may be attributed to this cause, as very few fish are able to reach the upper portions of the stream after commercial fishing begins on April 15. It is expected that favorable action will be taken by the next legislature on a bill to shorten the fishing season, and it is believed that the results of this action and of the new fishway in the Ament dam will be manifested in an increasing number of eggs taken another season. Chinook-salmon eggs to the number of 1,362,000 were collected; these, with 1,020,000 received from the State hatchery, were successfully hatched, resulting in an output of 2,306,700 No. 2 fingerlings.

At the Applegate Creek station the destruction by flood, during the winter of 1918–19, of the irrigation dam by means of which the station secured its collection of eggs necessitated new construction. As the principal egg collections occur during winter, frequently when the river is at flood stage, it was necessary to construct a barrier of a permanent nature, and a fin rack anchored to cement piers, with traps at the shore line, was thrown across the stream. The structure has operated successfully and withstood the floods of last winter without damage. In undertaking this work it was necessary to wait for low water, which occurred during October and November. It was impossible to complete the structure in time to stop the run of silver salmon, which was light, and lasted but two days. As at the Rogue River station, low water prevented the main body of the fish from reaching the spawning grounds, and the collection of steelhead-salmon eggs was reduced fully 50 per cent from this cause. The season's take was 2,086,000 steelhead eggs, of which 600,000 were forwarded to the Rogue River station and 700,000 to the State hatchery at Butte Falls. The remainder were hatched and the resulting fry liberated in Applegate Creek and other near-by tributaries of the Rogue River.

Acknowledgment is made of the cordial assistance received from the Oregon Fish and Game Commission and the local cannery interests. Without their cooperation the extensive feeding of salmon which was conducted in the Oregon field would not have been possible.

The drought, adversely affecting fish-cultural work in southern Oregon, extended to California, the past winter being unusually mild and almost without rain. The reduced egg collections in California are attributed partly to that cause. The racks installed in the McCloud River during the latter part of the fiscal year 1919 resulted in the collection of 1,350,000 eggs of the spring-run chinook salmon. These were incubated without undue loss, and the fry were reared to fingerlings. During the incubation period the gravity flume was without water, and the hatchery was supplied by pumping from the McCloud River. The racks were removed after the spring run of fish was over, as the fall run of fish at this point has never been sufficiently large to warrant the expense involved in taking eggs. The racks have again been installed for the 1920 season for the spring run of salmon, but the indications are that the effort will meet with failure. The conditions existing at the irrigation dam at Redding have not been remedied, and this, in connection with the protracted drought, has prevented salmon from ascending the Sacramento River. Notice was served on the responsible persons by the California Fish and Game Commission to construct a fishway in accordance with the laws of the State, and plans of a suitable structure were furnished, but this notice was ignored. The matter is now in the hands of the legal authorities, who should take prompt action to compel compliance with the law.

At Battle Creek the collections totaled 4,078,000 eggs, as against 5,384,000 the preceding year. The usual shipments were made to the State hatchery at Sisson, and from those kept at the station 3,619,000 No. 1½ fingerlings were produced. Some further work was performed on the pond system established last season, and the pipe line and supply ditch were completed. The decrease in the number of eggs collected at the Mill Creek station is larger than at Battle Creek, 6,358,000 being the total for 1920, while 17,284,500 were secured last season. Shipments to the number of 4,000,000 were transferred to the Sisson State hatchery in the eyed stage, and 2,122,000 fingerlings were produced from the remainder.

The stack-tray system of handling eggs and fry was tried at stations in this field, with as satisfactory results as have been derived from that form of apparatus at other salmon stations.

PROPAGATION OF COMMERCIAL FISHES OF THE GREAT LAKES.

Climatic conditions during the spawning seasons of the principal fishes of the Great Lakes were extremely variable and on the whole very unfavorable in 1920. The lakes in fall, early winter, and spring are subject to severe storms and sudden variation in temperature. It is at the spawning season that the commercial fishermen obtain their principal catch, and the Bureau is dependent almost entirely on the results of their efforts for its supply of eggs for artificial propagation. It follows that the outcome of any season's work depends largely upon the extent to which the fishermen are able to ply their trade. There are, of course, other factors that make for the success or failure of the work, but the weather conditions are the governing factor.

Collections of whitefish eggs were made in each of the five Great Lakes, and there were taken 420,425,000 eggs against 550,868,000 for last season, the largest numbers, as usual, from Lake Erie. The decrease was not ascribable to any falling off in the number of fish on the spawning grounds. On the contrary, there was an excellent run of fish, fully equaling, if not exceeding, that of last season. The outcome was due entirely to unfavorable weather that prevailed throughout the egg-collecting period.

The field work in Lake Erie yielded 317,360,000 whitefish eggs, the most productive points being Port Clinton, Middle Bass Island, Put in Bay, Monroe, and Isle St. George. While the collections were 25 per cent less than in the previous year, the eggs were of excellent quality and the percentage of healthy fry was the highest ever attained at the Put in Bay station. Transfers of eggs were made to the Ohio, Michigan, and Minnesota fish commissions and to the Bureau's hatcheries at Duluth and Charlevoix. The eggs that were retained produced 200,000,000 fry, which were planted in local waters. The mean incubation period was 133½ days, 10 days longer than in the previous season, with the mean water temperature 2° F. lower.

Acceding to the urgent requests of persons interested in the commercial fishery for carp in tributaries of Lake Erie, the artificial propagation of this species was resumed in the spring of 1920. A battery was set up at Port Clinton and the same methods of manipulation that proved successful last season were employed. The results were satisfactory, 47,250,000 eggs being obtained from fish taken in seines by the commercial fishermen and 37,800,000 fry produced and liberated. The first eggs were taken on June 2 and hatched on the fifth day after being placed in the jars, the eye spots appearing on the third day. Eggs taken later in the season eyed on the second day and hatched on the third, in a mean temperature of 74½° F. The collections of last season amounted to 28,500,000 eggs. The local fishing interests are in the heartiest accord with this work and have rendered valuable assistance by furnishing a building, men, and equipment.

The collection of whitefish eggs was undertaken for the Charlevoix hatchery at the usual points in Lakes Michigan and Huron. Rough weather so interfered with fishing operations that the take of eggs was reduced to approximately one-half of last season's, only 17,680,000 being obtained, but all were of unusually high quality and produced healthy fry. Because of the widely separated points at which the whitefish fishery is conducted, the establishment of a field station, provided with suitable crates for holding the fish for ripening, located at some central point on the north shore of Lake Michigan, should be considered.

Just prior to the whitefish spawning season on Lake Ontario arrangements were made with the Dominion and Ontario provincial fishery authorities for the cooperative collection of eggs in the Canadian waters of Lake Ontario. Under this arrangement it was agreed that the first 30,000,000 eggs obtained by American spawn takers in Canadian waters should be delivered to the provincial hatcheries, but that all collections in excess of that number were to be sent to the Cape Vincent station. It later developed that the provincial hatchery required only 21,800,000 eggs, and that was the actual number furnished. The plans outlined early in the season provided for collecting stations at Deseronto, Bygotts Point, and along the shore near South Bay, Ontario. A severe storm during the first week of operations precluded any collections, and when the weather improved the season was well advanced. At this time the market price of whitefish dropped to 6 cents per pound, which resulted in the practical abandonment of the fishery at Deseronto. Still another incident that had the effect of further handicapping the fish-cultural work at this point was the opposition by fishermen to the recent action of Dominion and provincial fishery authorities in closing certain sections of the upper reaches of the Bay of Quinte to commercial fishing. This feeling was reflected in the failure of many of the fishermen to lend assistance. Only 6,300,000 whitefish eggs were obtained in the Deseronto field, but there is reason to believe that by establishing better relations with the local fishermen, and with favorable weather, this point can be extensively developed as a collecting station. At Bygotts Point and South Bay the fishermen were in hearty accord with the work and rendered valuable assistance. However, the weather was a serious drawback, and egg collections at both points suffered therefrom. At South Bay, for example, the total take of whitefish eggs for the season was 39,805,000, of which number 25,000,000 were taken in two nights of favorable weather. Bygotts Point station yielded 30,560,000 eggs. Each of these fields is comparatively new, being occupied for the second time only, but promises to be very productive when fully developed. On the grounds near Cape Vincent 8,800,000 eggs were secured, bringing the grand total for the season to 83,665,000 eggs. In addition to those turned over to the Province of Ontario, 2,800,000 eggs were shipped to the New York Conservation Commission, 2,500,000 eyed eggs were planted in Lake Ontario, and small lots of eyed eggs to the number of 1,900,000 were shipped to Central Station, the New York Aquarium, and Warren, N. Y. The remainder were retained at the station and the resulting fry returned to the waters of Lake Ontario.

In the lake herring or cisco work on Lake Ontario no new fields were entered in 1920. Collections of eggs from the catches of the fishermen were made at Sodus Point, Fairhaven, and Cape Vincent to the number of 181,150,000. The eggs, which were of remarkably good quality, were disposed of in various ways: Some lots were sent to the Michigan Fish Commission, the New York Aquarium, and Central Station, and 87,700,000 were consigned to the New York Conservation Commission. The remainder, approximately 90,000,000, were retained at the Cape Vincent hatchery and yielded 73,505,000 fry, which were planted in suitable local waters.

The hatching of lake trout in 1920 was on about the same scale as in 1919. During the spawning season in Lake Superior the employees of the Duluth station collected eggs at points on the north shore of the lake and at Isle Royale, Mich. A few eggs of the early run were taken between September 23 and October 20, but the largest collections were secured later. The season closed in the last week of November with a total take of 21,079,000 eggs. The results were disappointing, as from the number of fish on the grounds where commercial fishing is conducted along the north shore there was reason to believe that a very successful season from a fish-cultural standpoint was assured. Because of the destruction of nets by storms, the collections exceeded those of last year by only a small margin. Conditions on the south shore were even more unfavorable, and this field was abandoned shortly after November 1.

For the Michigan stations lake-trout eggs were obtained at the usual points in Lakes Michigan and Huron. A large body of fish appeared during the spawning season, but the fishermen were able to operate their nets only at irregular intervals. A total of 31,733,000 eggs were secured, most of which were of an average quality, though at certain points where only inexperienced help was available the quality was inferior. As indicative of the changing condition of the lake fisheries, it is interesting to note that while for a number of seasons past enough lake-trout eggs were not obtainable to justify the expense of operations at the Alpena hatchery on Lake Huron, more eggs of that species were taken during 1920 in the vicinity of Alpena than at any other point on the lakes. If this situation continues, the advisability of resuming regular operations at this point may be worthy of consideration. Practically all of the lake-trout eggs collected in Michigan waters in recent years have been obtained from the fisheries in the vicinity of Charlevoix and Beaver Island, Lake Michigan.

As in other parts of the Great Lakes region, the work of the Cape Vincent station in Lake Ontario suffered from stormy weather. Lake-trout eggs were sought at Pigeon and Stony Islands, but only a few days were suitable for fishing during the time the fish were on the spawning beds. While the run did not appear to be as large as last season's, the total number of eggs taken from both points—941,000—was more than 200,000 in excess of last year's collection.

The season's pike-perch operations on the Great Lakes and on Lake Champlain were on a much less extensive scale than in 1919. The winter of 1919–20 was severe, and very heavy ice formed on Lake Erie; nevertheless by the end of March the lake was free of ice and the pike-perch fishermen were able to set their nets earlier than usual. During the first days of the season the take of fish was very large, and a successful season in pike-perch hatching was anticipated. There followed a period of cold weather, with snow and heavy winds, that had the effect of destroying many nets and of breaking up the schools of spawning fish. Operations for this species were continued longer than usual in the belief that a change in the weather would bring a return of the fish, but the season closed on May 10 with a total collection of only 116,950,000 eggs. With the exception of 1,000,000 shipped to Central Station, all the eggs were incubated at Put in Bay and the fry liberated in Lake Erie.

The success attending the experiments in connection with the propagation of pike perch in Saginaw Bay last season made it advisable to resume the work this year. Some difficulty was experienced in finding a suitable location for the establishment of a battery where a water supply free from chlorine was available. Such a place was eventually found at Bay City, and a battery of 100 jars was installed. Last season the sterilized water from the city supply proved entirely unsuitable for fish-cultural purposes, and practically all the eggs retained at Bay City were lost from this cause. In the spring of 1920 large numbers of spawning pike perch entered Saginaw Bay, but because of certain difficulties in transportation the express company at Bay City on several occasions placed an embargo on shipments of fresh fish. As suitable storage facilities were not available, the fishermen were forced to suspend operations during the time the embargo was in force. Under these conditions only 95,700,000 eggs were obtained, and because of the intermittent operations they were not of the best quality. Of the number taken, 40,575,000 were placed in the jars at Bay City for incubation, and the remainder were delivered to the Detroit hatchery of the Michigan Fish Commission. The excellent facilities for pike-perch work in Saginaw Bay would seem to justify the establishment of a permanent station equipped to handle the large numbers of eggs that seem to be obtainable under favorable conditions. There is a strong public sentiment in favor of such an establishment.

In continuance of the arrangement made last season for the collecting of pike-perch eggs in Turtle River in cooperation with the Minnesota Game and Fish Department, 32,000,000 eggs were obtained as the Bureau's share and were hatched under the direction of the Duluth station. At the hatchery on Lake Champlain 171,450,000 pike-perch eggs were secured, as against 245,350,000 in 1919. The quality of both eggs and fry was superior in 1920, as a result of improved facilities and methods. Although the eggs were taken during a period of 15 days, yet within 48 hours after hatching began the incubation of all eggs on hand was completed. One-third of the eyed eggs were delivered to the Vermont Department of Fisheries and Game under an agreement whereby a part of the expense of the Swanton hatchery is borne by the State.

In order to meet a demand and also to take advantage of opportunities for increasing the supply of food fishes, the Bureau has continued to hatch yellow perch at Put in Bay, Cape Vincent, and Swanton, the last-named station having the largest output. At that place 30,000,000 eggs were collected, and 27,800,000 fry were hatched therefrom. After a suitable number of fry had been returned to local waters, the remainder were distributed to applicants in New York and New England.

The value of the Bureau's fish-cultural work addressed to the commercial species of the Great Lakes is very generally recognized, and that it should be extended as fully as possible is the opinion of all persons having an interest in the important industry. The Bureau is constantly being urged to undertake the further expansion of its activities, but is prevented from doing so by lack of the necessary funds. There are points in various sections of the Great Lakes region where profitable collecting stations may be developed that will produce many millions of ripe eggs that at present are a total loss because they are sent to market in the fish. There is little reason to doubt that the annual output of whitefish, cisco, lake trout, pike perch, and yellow perch can be very materially increased in all the Great Lakes if sufficient funds for the establishment and operation of new field stations can be obtained.

CULTIVATION OF FISHES OF MINOR INTERIOR WATERS.

The active and increasing demand for fishes for lakes, ponds, and interior streams has in general been met by the various stations devoted to the trouts, landlocked salmon, basses, crappies, sunfishes, etc. As a rule, the applications for such fishes can be promptly filled, but the production of smallmouth black bass has never been equal to the demand, and the regular output of brook trout has had to be supplemented by the purchase of large numbers of eggs from private fish-culturists.

The stations in the Rocky Mountain region in Montana, Wyoming, Utah, Colorado, and South Dakota have handled the native trouts and two introduced trouts, together with grayling, and the season's output was of average volume.

In the Montana field, with the Bozeman station as headquarters and with hatcheries in Yellowstone National Park and Glacier National Park as auxiliaries, the varied operations have been successful. The collections of rainbow-trout eggs in Madison Valley, aggregating 3,812,000, were only a little below the record take of the previous year, and grayling eggs to the number of 700,000 were obtained in the same field.

At the hatchery on Yellowstone Lake, in Yellowstone National Park, some of the eggs of the blackspotted trout taken from wild fish are incubated and the resulting young are deposited in park waters, while limited consignments of eyed eggs are made to the Bozeman hatchery and to the fish commissions of the States of Montana, Wyoming, Idaho, Oregon, and Washington. During the season of 1920, which involves the end of the fiscal year 1920 and the beginning of the fiscal year 1921, about 6,500,000 eggs were taken. In the summer of 1919 the Commissioner made a personal inspection of the fish-cultural work in the park, and made arrangements for extending and augmenting the hatching operations in view of the very heavy drain on the fish life occasioned by the greatly increased number of anglers now resorting to the park. The superintendent of the park has extended every facility for making the hatchery effective and for enabling the Bureau to maintain and improve the supply of fish in the park waters.

The auxiliary hatchery in Glacier National Park, constructed for the National Park Service, but operated by the Bureau of Fisheries, has already justified its establishment. Encouraging reports are being received as to the results of this pioneer work, and it is believed that in a short time noteworthy collections of eggs may be obtainable from waters entirely devoid of fish life previous to the Bureau's entry into this field. The fiscal year's hatching operations in the park extended from July 1 to September 30, 1919, and from April 29 to June 30, 1920. The eggs handled consisted of 300,000 brook trout from the Leadville station, 310,000 rainbow trout from the field station in Madison Valley, 500,000 grayling obtained through the courtesy of the Montana Fish and Game Commission, and 200,000 blackspotted trout from Yellowstone National Park. From these eggs 1,369,000 fry and fingerlings were hatched and planted in selected waters in Glacier Park.

Until funds become available for the development of a number of promising outlying fields, the output of the Saratoga station in Wyoming must be somewhat limited. Brood fish on hand produced during the last fiscal year 96,000 eggs of brook trout and 297,000 eggs of rainbow trout, while collections from wild fish, made under difficult conditions, yielded 31,000 eggs of brook trout and 408,750 eggs of rainbow trout. The hatchery supply was augmented by 430,000 eggs of blackspotted trout and 406,000 eggs of brook trout from other stations.

At the Springville (Utah) hatchery the brook rainbow and blackspotted trout have remained in excellent condition, but the eastern brook trout have deteriorated. Fish Lake continues to be the most prolific source of eggs. The lake is operated jointly by the Bureau and the State game and fish department, and the Bureau's share of the collections in 1920 was 1,035,000 brook-trout eggs and 1,330,000 rainbow-trout eggs. Special attention is being given to the maintenance of the fish supply in Fish Lake, as its value as a source of eggs is recognized.

The work of the Leadville hatchery and its field stations in Colorado was quite successful, especially as regards the propagation of eastern brook trout, of which 5,909,900 eggs were obtained by parties stationed on eight lakes. In an attempt to develop a new field station for collecting eggs of rainbow and blackspotted trouts at Antero Reservoir, two apprentice fish-culturists detailed to make investigations and locate spawning grounds were mysteriously drowned.

Owing to lack of suitable help and to the abnormally large expense that would have been required, no attempt was made at the Spearfish (S. Dak.) station to obtain eggs from wild fish as heretofore. Brood stock held at the hatchery produced 107,000 eggs of eastern brook trout and 130,000 eggs of rainbow trout, which were supplemented by 947,000 eggs of brook trout purchased from dealers and by the transfer from other fields of 419,000 eggs of blackspotted trout and 25,000 eggs of lake trout. The water supply at this station has long been unsatisfactory and at times precarious. During the protracted winter of 1919–20, the flow of water was at one time reduced to 22 gallons per minute for all hatchery purposes, and three 12-foot troughs each containing from 25,000 to 40,000 eyed trout eggs were given only 2½ gallons per minute, which amount was not increased and the numbers of eggs and fry were not reduced until the feeding stage was reached. By an agreement recently made with the municipal authorities of Spearfish, the Bureau is to have the use of the overflow from the newly constructed city reservoir. By means of a separate pipe line, water of desirable quality will become available without cost, and for the first time the hatchery and ponds will have an adequate supply for present and prospective needs.

In the New England trout hatcheries there was a serious epidemic, which greatly curtailed the production of brook trout. At the Berkshire hatchery the malady, known as the "white-spot" disease, was particularly severe and reduced the output to insignificant proportions. Even under favorable conditions the yield of brook trout at the Bureau's hatcheries is unequal to the demand, and resort must be had to private hatcheries for some millions of eyed eggs that are required each season. The price paid for these eggs has risen from 30 to 40 cents per thousand in 1912 to 75 and 80 cents per thousand in 1920, with every indication that it will advance still further. This supply is uncertain and frequently of inferior quality, owing to the fact that many commercial trout breeders engage in the work with the main object of supplying fish for the market, the production of eggs being incidental. In these establishments the fish are put on the market after their first spawning, and it is well known that eggs taken from young fish are never equal in quality to those obtained from 3 to 5 year olds. From every standpoint it is highly desirable that the Bureau should have a source from which brook-trout eggs in sufficient numbers may be obtained to meet all requirements and relieve it of dependence on the high prices and inferior stock of the commercial dealers. After a consideration of this subject, York Pond, in the White Mountain National Forest Reserve, N. H., was selected as a site for the development of a source of supply for brook-trout eggs. A camp was established and preliminary work on the project undertaken during June, 1920, and allotments of fingerling trout were planted in the pond during that month. With the cooperation of the State of New Hampshire by the enactment of legislation giving the Bureau control of the pond, which is approximately 19 acres in area, and of the Forest Service in maintaining roads, it is expected that the full development of this body of water will enable the Bureau to produce large numbers of brook-trout eggs of a high quality and at reasonable cost.

Landlocked-salmon propagation, conducted principally from the station at Green Lake, Me., and its subsidiary at Grand Lake Stream, was rather more successful than in the previous year. The output was 1,641,905 eggs, fry, and fingerlings. Green Lake, one of the sources of eggs, was at an unusually low level, and the fish were unable to ascend the tributary streams for spawning. The eggs secured at this point were from fish caught in pound nets in the lake. Of the eggs distributed 417,105 went to the State of Maine, in fulfillment of the agreement by which the eggs taken by the Bureau on the Fish River Lakes are to be eyed at the Caribou State hatchery, and one-half the net collections become the property of the State. The work in this field suffered from lack of competent employees.

The group of stations at which both salmonoid and pond fishes are handled includes those at Wytheville (Va.), White Sulphur Springs (W. Va.), Erwin (Tenn.), Neosho (Mo.), and Manchester (Iowa), where the output is derivable almost entirely from brood fish maintained from year to year in artificial ponds. The aggregate production of these stations in 1920 was, in round numbers, 3,225,000 brook and rainbow trout and 240,000 bass, while there remained on hand at the close of the year 234,000 fingerlings available for distribution and for increasing the breeding stock. While a number of untoward conditions have tended to curtail the yield of these stations, considerable progress has been made in improving their physical condition and in securing a better quality of brood fish. The output of both brook and rainbow trout at White Sulphur Springs was the largest in the history of the station; the Manchester station largely increased its production of rainbow-trout eggs; and by improved methods of handling the fertility of rainbow-trout eggs at the Neosho station increased 40 per cent.

The 1920 output of smallmouth black bass was slightly less than in 1919. At nearly every station where this species is propagated the same adverse weather conditions prevailed, resulting in a retarded spawning, the loss of many of the eggs in the first spawning, the abandonment of nests by the parent fish, and the killing of eggs in later layings by sudden fluctuations in temperature. The only station at which an increased production of smallmouth black bass occurred is Louisville, which distributed over 100,000 fry and fingerlings, and had its most successful season.

The propagation of largemouth black bass was adversely influenced by the same conditions that affected the smallmouth species, although the aggregate output was larger than in the previous year. Both the Orangeburg (S. C.) and the San Marcos (Tex.) stations had an especially successful season, and the latter had the best year in its history. From Orangeburg the production of largemouth bass was 241,765, notwithstanding a considerable loss of fingerlings from cannibalism, owing to the inability to secure capable assistance in promptly removing the young fish from the ponds containing adults. As an innovation in the distribution of pond fishes, 5,400 sunfish were held through the winter at Orangeburg without undue loss, made an excellent growth, and were planted in spring. In response to the large demand for sunfish in the Southern States, an effort is being made to increase the output of this species as fast as possible. The bluegill—the largest, and in many localities and in many respects the most desirable of the sunfishes—is being substituted as brood stock for the other and smaller species.

In Texas there has been a call for pond fishes in excess of the production of the one station operated in the State. To meet this demand, plans were made to increase the production of fish of the species most called for. With this in view, the lease of a parcel of land, desirable for pond construction and conveniently located for the distribution of the output, was secured from the city of New Braunfels. The lease included a supply of water from the city reservoir. About two years ago, following a period during which the San Marcos station was closed, the Texas Legislature enacted a law giving suitable protection to bass, crappie, and other food and game fishes during their spawning period. The absence of such a law in the State was the important consideration in connection with the closing of the station. By a ruling of the attorney general of the State this law was practically annulled during 1920, and the fishes propagated by the Bureau are again left without adequate protection at a time when such protection is most urgently needed, viz, their period of mating, nesting, egg laying, and guarding the young. Any effort to increase the output of artificially reared fishes under these circumstances seems ill advised.

The value and importance of vegetation in pond culture have long been recognized, and much time and effort have been devoted to the production of luxuriant growths of aquatic plants in fish ponds. The intelligent control of this growth is also of importance, and this can not be successfully accomplished without more exact knowledge of the natural food of young bass and other warm-water species. It is of the utmost importance in connection with the subject to know what plants enter directly into the dietary of the fish or contribute indirectly to the support of the smaller animal forms that furnish food for fish. In order that information might be gained on this subject, which appears to have been generally neglected by fish-culturists, a special assistant was employed to make a study of the conditions as they existed at the Neosho station during the winter of 1919–20. More extensive work along similar lines has been done by the same specialist under the supervision of the division of scientific inquiry, and much information of value and interest to fish culture has been gathered. When this is assembled and made available for practical application to the work of the stations, there is reason to believe that beneficial results will follow. The natural food supply for pond fishes is of particular importance, since it is very difficult to induce these fish to accept the various artificial foods that are taken readily by the trouts and salmons.

The Bureau has continued its experiments looking to the development of a satisfactory food for young salmonoid fish at a reasonable cost for replacing the meat products in general use, the price of which has advanced in proportion with all other commodities. Perhaps the most notable results have been from the use of salmon eggs as food for young salmon. These are the immature eggs taken from salmon secured in commercial fishing operations, and are held in cold storage until needed. Canned seal liver, a by-product of the fur-seal islands, gave satisfactory results at a western station, the test indicating that it compares favorably with pork liver. A product sold under the name of "dried flies," the exact nature of which has not been learned, was obtained from a New York importing firm and tried as a food for trout at a number of stations, with unsatisfactory results in every instance. Fishotein, a slaughterhouse preparation, and clam meal have been used with some success, but neither of these products appears suitable unless employed in conjunction with meat. The results of all experiments thus far made, with the exception of frozen salmon eggs, leave beef heart and beef liver at the top of the list as the most desirable foods for young salmonoid fish. Not only do they produce a more rapid growth, but the mortality is much less. Of these two foods the heart seems more desirable for the early feeding stages, while the liver is better for the more advanced fingerling sizes.

PROPAGATION OF RIVER FISHES OF THE ATLANTIC SEABOARD.

Fishes of the Atlantic coast streams which receive attention at the Bureau's hatcheries are the salmon, the shad, the yellow perch, and the striped bass.

For a long period of years the Bureau has been conducting, at its hatchery at Craig Brook, Me., operations addressed to the Atlantic salmon. The scene of this work is the Penobscot River, which is the only New England stream that now has a run of salmon, and even the Penobscot maintains its salmon in the face of serious physical and other handicaps. It seems to be well established that the perpetuation of the salmon fishery in Maine depends largely, if not chiefly, on artificial propagation. The work, however, meets with scant local support, and the fishermen, who are the principal beneficiaries, show little disposition to cooperate. They have demanded full market price for the brood salmon collected by the Bureau and held for the ripening of their eggs, and, in addition, they have asked for a bonus for delivering the fish in good condition. The cost of the brood salmon some seasons has ranged from $6 to $7 apiece, and other features of the work have also been expensive. The fishermen have of late shown a tendency to ask higher and higher prices for fish and a larger premium for careful handling. A proper spirit of cooperation would seem to impel the fishermen, in their own interests, to supply brood salmon to the hatchery at a nominal price and to waive the charge they have been making for proper handling. The wisdom of continuing this work under existing conditions is questionable.

From the Atlantic salmon obtained during the last fiscal year there remained on hand at the spawning time in October 227 fish, which yielded 797,610 eggs. This number was supplemented by 1,000,000 eggs obtained from the fishery authorities of Canada in exchange for trout eggs. Both of these lots of eggs were incubated with normal loss, and the resulting young, to the number of 1,550,000, were planted in the Penobscot and other important streams of Maine.

Shad hatching has been conducted as usual at the stations on the Potomac River and Albemarle Sound. At both points the work was prosecuted under very trying weather conditions. The spawning season at Bryans Point began April 18 and continued until May 18, during which 42,570,000 eggs were obtained from the fishermen, and 38,161,000 fry of excellent quality were hatched and planted. The run of shad into Chesapeake Bay in the spring of 1920 was said to be the largest in a number of years, and specially good catches were made on both sides of the lower bay, but the number of fish reaching the spawning grounds was limited.

At the Edenton station the first spawning fish were found on April 1, and the season ended on May 12 with a collection of 21,667,000 eggs. The incubation period was marked by sudden and extreme fluctuations in air and water temperatures, and rather heavy losses of eggs and fry resulted. The output of young shad was 16,286,000. The shad catch in the section of Albemarle Sound accessible to the hatchery was the smallest for many years, the effects of the light run being augmented by inclement weather, embargo on express shipments, and low prices, which caused many of the fishermen to withdraw their nets early in the season. The fullest cooperation was accorded by the fishermen to the hatchery, and mainly to this fact must be attributed the degree of success that was attained under most discouraging circumstances.

At the striped-bass hatchery, operated on the Roanoke River in North Carolina as an auxiliary of the Edenton station, the 1920 season was successful. Between May 1 and 15, fish caught for market by the commercial fishermen yielded 19,358,000 eggs, which produced 16,474,000 fry, all of which were planted in local waters.

The Bryans Point hatchery has continued to render efficient service in keeping up the supply of yellow perch in the Potomac River. From March 15 to 24, during which very wintry weather at times prevailed and ice formed about the nets, brood fish to the number of 13,411 were obtained from the fishermen. Spawning occurred from March 25 to April 5, after which the 12,811 adult fish on hand were released. The eggs deposited naturally by the fish while being held in live cars numbered 129,544,000. About 2,500,000 eggs were sent to another station; the remainder produced 119,240,100 fry that were deposited on the local spawning grounds.

The recently established field hatchery on the Atchafalaya River in Louisiana was operated for buffalofish in the spring of 1920, and had its most successful season. The hatchery had been enlarged in anticipation of an increased take of eggs, and additional hatching jars to the number of 260 were installed, making 440 jars in all. The first eggs were secured on February 23 and the last on April 4. The collections from the fishermen's nets aggregated 236,420,000 eggs, or more than 100,000,000 in excess of the previous year's production. The plants numbered 174,585,000.

MARINE FISH HATCHING.

Four species of marine food fishes are hatched at the Bureau's three seaside stations in Maine and Massachusetts, namely, the winter flounder, the cod, the haddock, and the pollock. The extreme severity of the winter interfered with all branches of the work and reduced the egg collections by about 800,000,000.

The winter flounder, which now supports extensive shore fisheries that annually contribute many million pounds of excellent food to the markets of the New England and Middle Atlantic States, is handled at the three hatcheries and is the species produced in largest numbers. At the Boothbay Harbor station 792,853,000 eggs were secured and incubated without undue loss, the fry being deposited in the local bays. At the Gloucester hatchery 155,810,000 eggs were obtained. The season's output for the Woods Hole station was the smallest for five years, owing to weather conditions. In the Waquoit field 611,570,000 eggs were obtained under great difficulty, and 16,616,000 eggs came from Hadley Harbor and Quisset Harbor. Later operations in Narragansett Bay yielded 238,318,000 eggs. The aggregate collections for the Woods Hole station in all fields were 866,504,000 eggs of fair quality. With the exception of 35,000,000 eyed eggs and fry consigned to Jamaica Bay, N. Y., the local waters received the plants of fry. The total deposits of flounder fry from the three hatcheries were 1,603,080,000.

Cod eggs for hatching purposes, obtained from the fishermen's catches in the case of the Gloucester station and from brood fish in the case of the Woods Hole station, numbered 570,740,000 and 223,-465,000, respectively, the latter number being produced by 2,825 adult fish held in the cistern under the hatchery. The boats of the Gloucester haddock fishermen, visited by spawn takers from the local hatchery, yielded 303,800,000 eggs during the period from January 14 to April 30. In a similar way, during November, December, and January, 954,800,000 pollock eggs were gathered from fish on their way to market. The quality of the eggs was poor and a rather heavy mortality occurred in hatching; 557,685,000 fry were planted.

The Bureau has taken up in a tentative way the matter of salvaging the enormous numbers of ripe eggs of cod, haddock, and other ground fish that are annually wasted in the New England fisheries. The experiment, first tried in 1919, of placing spawn takers on fishing vessels for the purpose of taking, fertilizing, and planting the eggs contained in fish caught for market, was continued in 1920. Five spawn takers between February 26 and April 26 made 14 trips, 8 on otter-trawl vessels and 6 on trawl-line vessels, and afforded further information as to the feasibility of attempting this work on a sufficiently large scale to make it worth while. Upward of 220,000,000 eggs, about equally divided between cod and haddock, were thus obtained and deposited in the natural spawning grounds, under conditions that closely simulate nature. The experience gained in the two seasons' trials indicates that it is entirely practicable to conduct these operations on a gigantic scale at a comparatively low cost, and it is the belief of the Bureau that it may be desirable to initiate the work in cooperation with the owners, masters, and crews of fishing vessels. The saving of a few hundred millions of eggs might not mean a great deal in view of the magnitude of the fisheries and the extent of natural spawning, but the annual saving of some thousands of millions of eggs might be expected to produce an appreciable effect on the supply of marketable fishes.

RESCUE OF STRANDED FOOD FISHES.

No feature of the Bureau's work in fish conservation has had a more rapid development in recent years than the rescue of fishes from the overflowed lands along the Mississippi River. The fishes that are salvaged comprise practically every useful species of the region. The importance of and necessity for the work arise from the fact that when the floods come many of the fishes are in spawning condition and deposit their eggs far from the river. On the recession of the flood waters the resulting young are left behind and eventually become permanently landlocked. Under such conditions the fish inevitably perish as the cut-off ponds and sloughs gradually become dry during summer or are quickly frozen on the advent of winter. The toll of valuable food fishes that is thus taken is enormous, and the opportunity to prevent a part of the annual waste and add to the food supply is most appealing.

The simplicity of the operations, the low cost, and the certain results of great magnitude are the outstanding features. In 1920, as heretofore, headquarters were established at favorable points in the Mississippi Valley, from which seining crews visited the landlocked waters, removed the fish, and planted them in the open waters of the river. The principal centers of the work were Homer and La Crosse, Wis.; Bellevue and North McGregor, Iowa; Quincy and Cairo, Ill.; Clarksville and Canton, Mo.; and Friars Point, Miss.

During the year ending June 30, 1920, but principally in the summer and early autumn of the calendar year 1919, the aggregate number of fish salvaged was 156,659,500. This output exceeded by about 100,000,000, the record that was established in the previous fiscal year.

From Homer, Minn., the work began on August 1 and continued until cold weather and ice made further operations impracticable. From this point five seining crews were employed throughout the season, collecting 37,073,812 miscellaneous fishes, of which 37,007,590 were returned to the river. The season at La Crosse extended from August 13 to November 8. This field includes the territory extending from Dresbach, Minn., to McDonald Dam, below Lynxville, Wis., and seining crews worked from La Crosse, Genoa, Ferryville, and Lynxville, Wis. The territory about Lynxville is one of the most prolific and is capable of much greater development and productivity whenever funds for the purpose are available.

The crews with headquarters at North McGregor were engaged from August 4 to November 10, operating from North McGregor and Guttenberg. The collections amounted to 27,565,287 fish. This field is also capable of further development, a promising territory existing between Clayton and Dubuque, Iowa. From Guttenberg southward no rescue operations have ever been attempted, and reports from the chief game and fish warden of the State of Iowa indicate that this field contains opportunities for rescue work not excelled at any point on the river.

The station at Bellevue, Iowa, produced 39,549,952 rescued fishes during the season, the work extending from August 11 to November 13. Two crews were employed, one operating from Bellevue, and the other from a houseboat, covering the territory from Dubuque to within 7 miles of Bellevue. Further possibilities for rescue work exist in this vicinity. From Savanna, Ill., and points farther south seining crews could be profitably employed.

The operations on the Ohio River, in the vicinity of Cairo, Ill., reached greater proportions than in any previous year. The number of fish taken was 5,830,410, of which crappie and catfish predominated. There was a noticeable decrease in the number of black bass this season, not only in the Cairo field, but at all other points, the cause being attributed to the low stage of the river during the spawning season of the black bass in May and early June, the rise not occurring until after the fish had spawned.

There was a satisfactory increase in the number of fish taken in the rescue work in the vicinity of Friars Point, Miss., under the supervision of the superintendent of the Tupelo station. The work in that section began July 16 and continued to November 14, during which time 847,328 fish, chiefly buffalo fish, catfish, and sunfish, were taken by the seining crews. Of these, 40,630 were distributed to applicants, while the remainder were returned to their native waters.

The usual operations along the Illinois River, at Meredosia, Ill., were conducted, continuing from July 1 to December 4, and resulted in the conservation of 1,340,427 fish. Similar work tried for the first time at Clarksville and Canton, Mo., and other points of minor importance, under the supervision of the director of the Fairport (Iowa) station, produced 1,552,087 rescued fishes.

It is to be noted that the average cost per thousand fish rescued in 1920 was less than 20 cents; and while in certain fields where the output was not large the cost was somewhat higher, more than 75 per cent of the fish were rescued and returned to their native waters at a cost of only 13 cents per thousand.

A small percentage of basses, catfishes, and other species rescued is used in supplying applicants, most of whom are in the States of the Mississippi Valley. This diverted output serves a very useful purpose but is not so great as to constitute a depletion of the Mississippi. In

1920 the rescued fishes that were not restored to the Mississippi but were sent to other waters numbered 983,784, or less than seven-tenths of 1 per cent of the entire number handled.

This public service in immediate aid of the local States but indirectly of value to the entire country has been voluntarily assumed by the Bureau because there has been a strong local demand for it and because of the conviction that it is vastly more important and productive of direct results than are the combined operations of many fish-cultural stations. The work is receiving the approbation of State fish commissioners, commercial fishermen, and the general public. The possibilities of greatly extending its scope and magnitude are believed to be almost unlimited, and the only obstacle that presents itself is lack of funds. In the estimates of appropriations for the Bureau for the fiscal year 1922, there is provision for a very modest increase in the general funds for fish culture in order that the rescue work, among other branches, may receive fuller consideration. No money appropriated by Congress for any purpose can be relied on to yield more certain and more direct economic results.

ACCLIMATIZATION.

Noteworthy enrichment of the aquatic food resources of various parts of the country has resulted from the acclimatization of desirable animals from other sections. Among the well-known instances of successful acclimatization are the transfer of the Atlantic shad and striped bass to the Pacific coast; the Pacific steelhead salmon to the Great Lakes and to minor lakes in New England and elsewhere; the western rainbow trout, the eastern brook trout, and other trouts to numerous States in which they were not indigenous.

The most recent success of this kind is the case of the Pacific humpback or pink salmon in Maine. Following plants of young salmon in streams in the eastern part of the State, runs of adult fish appeared during a number of years. The fish occurred in greatest abundance in the early autumn of 1919, when there were large runs in Dennys and Pembroke Rivers, and smaller runs in Penobscot, Machias, St. Croix, and Magaguadavic Rivers, the last-named stream being in New Brunswick. Weirs in Passamaquoddy and Cobscook Bays took considerable numbers of the new fish which were disposed of locally or shipped to Boston and New York. Accurate information regarding the amount of the catch was difficult to obtain, as the fishermen were in fear of the local law which prohibits the taking of salmon at the only time when the humpback is available, this law having been enacted with sole reference to the Atlantic salmon; but it is within bounds to state that several thousand adult humpbacks were caught and either shipped to market or consumed locally.

The most interesting feature of this case is that the Bureau's fish-culturists, sent to Dennys and Pembroke Rivers during the period of the migration, took and fertilized 499,300 humpback-salmon eggs that were sent to the Craig Brook hatchery.

From the evidence at hand there seems no reason to doubt that the humpback salmon can maintain itself in certain New England rivers and will prove a valuable addition to the local fish supply. The only condition of success that should be safeguarded is that a proper proportion of the run of adult fish should be allowed to reach the stretches in the lower parts of the streams, where suitable spawning grounds exist. The matter is wholly in the hands of the State authorities and involves the maintenance of adequate fishways over the relatively low dams that cross almost every stream of importance.

The introduction of the eastern brook trout into Colorado and other Western States has been a conspicuous success. The establishment of brook trout, rainbow trout, lake trout, European brown trout, and Loch Leven trout in selected waters of the Yellowstone National Park has been a noteworthy accomplishment, and similar service in the Glacier National Park is now in progress.

One of the best, most adaptable, and most widely transplanted of the native trouts is the rainbow, which now affords excellent fishing in practically every State having waters of suitable temperature. As with the eastern brook trout in Colorado and elsewhere, the acclimatized wild rainbow is now supporting extensive fish-cultural operations in various States. Field stations for the collection of rainbow trout eggs in Montana and Wyoming have proved very productive. Meadow Creek, a tributary of the Madison River in Montana, operated as an adjunct of the Bozeman station, has yielded nearly 4,000,000 rainbow trout eggs of the best quality during each of the last two seasons. Sage Creek, a tributary of the North Platte River in Wyoming, has afforded the Saratoga station excellent opportunities for taking large numbers of eggs, even with the crude equipment that has been available; and the superintendent estimates that with proper appliances this field will yield 10,000,000 eggs annually.

ARTIFICIAL PROPAGATION OF FRESH-WATER MUSSELS.

The usual work in mussel propagation was conducted in the field in suitable sections, as heretofore, under the general direction of the fisheries biological station at Fairport, Iowa. A total of 183,021,720 glochidia in a condition of parasitism on fishes were liberated in public waters as compared with 136,907,365 liberated last year, an increase of 46,114,355.

Infection of rescued fishes in the vicinity of Minneiska, Minn., on the Mississippi River and at various points as far south as Dakota, Minn., was accomplished in cooperation with the rescue work of one of the fish-cultural crews operating under the direction of the Homer, Minn., station. The number of fishes rescued in connection with the propagation of mussels was 907,995, of which 36,442 were adults. Of the total number of fishes rescued, 22,567 were infected with glochidia before being restored to the rivers.

Three species of commercial mussels were propagated, the leading one being *Lampsilis luteola*, commonly known as the Lake Pepin mucket. The infected fish hosts were liberated in the Mississippi River off Fairport, Iowa; in Lake Keokuk, Iowa, and Ill.; in the Mississippi River at New Boston and Oquawka, Ill.; in the Mississippi River at Lake Pepin, Minn. and Wis.; at various points along the Mississippi River, between Minneiska and Dakota, Minn.; in Lake Pokegama, Minn.; and in the White River in the vicinity of Newport, Ark.

Small numbers of mussels reared at the Fairport station were planted in public waters at the following places: Lake Keokuk, Iowa and Ill.; Roanoke River at Salem, Va.; Shenandoah River at Elkton, Va.; and Potomac River at Harpers Ferry, W. Va.

The cost of mussel distribution during the fiscal year 1920 was considerably less than in the previous year, being at the rate of $0.0562 per thousand as compared with $0.0689 per thousand in 1919. The decreased cost was due to the larger output of glochidia, notwithstanding the fact that the cost of labor, equipment, and material was greater than in the preceding year. This computed cost of mussel propagation includes overhead charges and depreciation of buildings, boats, and nets calculated at $0.0198 per thousand.

FRESH-WATER MUSSEL PROPAGATION IN 1920, SHOWING NUMBER OF EACH SPECIES PLANTED AND POINTS OF DEPOSIT.

Locality.	Mucket.	Lake Pepin mucket.	Pocketbook.	Total.
Lake Pokegama, Minn.		60,694,250		60,694,250
Mississippi River at Lake Pepin		82,044,350		82,044,350
Mississippi River between Minneiska and Dakota, Minn.			11,234,995	11,234,995
Mississippi River at Fairport, Iowa	1,878,100			1,878,100
Mississippi River at New Boston, Ill		5,060,250		5,060,250
Mississippi River at Oquawka, Ill	5,000	795,500		800,500
Mississippi River at Lake Keokuk, Iowa and Ill		19,807,675		19,807,675
White River at Newport, Ark	1,501,600			1,501,600
Total	3,384,700	168,402,025	11,234,995	183,021,720

ALASKA FISHERIES SERVICE.

GENERAL CHARACTER OF WORK.

Enforcement of the fisheries laws and regulations constitutes the chief feature of the Bureau's work in connection with the general fisheries of Alaska. Other important duties include the collection and dissemination of statistical information, the marking of stream mouths, inquiries and investigations as to aquatic resources, the study of conditions with respect to proposed fisheries legislation, the inspection of private salmon hatcheries, and the holding of hearings to determine the advisability of further restrictions upon fishing operations.

Details in respect to the work of this service are published in an annual document issued under the title "Alaska Fisheries and Fur Industries." This comprehensive report will give full details in regard to all important phases of the matter involved.

EXTENT AND CONDITION OF THE FISHERIES.

The salmon fishery of Alaska, which reached such enormous proportions in 1918, showed a marked decline in 1919. So serious was the falling off that a prediction may be freely made that, unless most drastic steps are taken to further curtail operations, the industry may suffer almost irreparable damage and may before many years cease to be of paramount commercial importance. As compared with 1918, there were declines in 1919 of 16 per cent in value and 42 per cent in the catch of salmon.

The remedy lies in more adequate legislation, and there is urgent need for revision of the salmon laws now operative. The laws were good enough when passed 14 years ago, the industry then being comparatively undeveloped, but the laws fail to meet the present situation. Last winter much time and effort were devoted to the drafting of a new fishery bill by a committee representing the Bureau, the Governor of Alaska, and the commercial interests. The bill as drafted was not submitted to Congress for the reason that there were certain fundamental differences of opinion as to several important features. The Governor of Alaska desired that practically all money derived from taxation of the fisheries should revert to Territorial uses not connected with the fisheries. There was disagreement also as to rates of taxation and other features. The difficulty in securing proper legislation for the fisheries of Alaska arises chiefly from the divergent views among different interests and the apparent inability to appreciate the seriousness of the situation. This lack of harmony seems to have impressed Congress, which has for many years refused to pass bills that have received approval of committees. Not only is a new fishery law demanded, but there is grave need for increased appropriations, added personnel, more vessels, more hatcheries to enable the Bureau to do its part in safeguarding the fisheries of Alaska.

General statistics collected by the Bureau show that in the calendar year 1919 the total investment in the Alaska fisheries was $74,181,560, an increase of $430,771 over 1918. The salmon industry absorbed approximately 92 per cent of this amount. Employment was given to 28,534 persons, or 2,679 less than in 1918. The total value of the products in 1919 was $50,282,067, a decrease of $8,872,792 from 1918, or approximately 15 per cent. The reduction in the pack of salmon caused nearly the whole of this decrease.

The salmon-canning industry gave employment to 25,499 persons and produced 4,583,688 cases, valued at $43,265,349. There were 134 canneries in operation. The salmon mild-cure industry gave employment to 133 persons and produced 4,490,600 pounds, valued at $916,800. The fresh-salmon trade employed 34 persons and handled a product of 5,208,327 pounds, valued at $356,688. Other products of the salmon industry were pickled salmon, 1,622,000 pounds, valued at $195,447; frozen salmon, 1,552,480 pounds, valued at $130,355; dry-salted salmon, 212,244 pounds, valued at $17,601; dried and smoked salmon, 415,000 pounds, valued at $43,000; oil, 966 gallons, valued at $966; and fertilizer, 724,000 pounds, valued at $18,680.

The halibut industry produced 7,783,179 pounds of fresh halibut, valued at $880,433; 6,495,372 pounds of frozen halibut, valued at $670,147; and 240 pounds of canned halibut, valued at $25. The herring industry yielded 6,357 cases of one-half pound cans and 95,448 cases of one-pound cans, valued at $40,395 and $811,366, respectively; 7,718,985 pounds of pickled herring, Scotch cure, valued at $451,240; 2,216,120 pounds of pickled herring, Norwegian cure, valued at $147,634; 169,374 gallons of oil, valued at $110,800; and miscellaneous products, valued at $114,735. The cod industry had products valued at $825,990, the chief output being 9,829,343 pounds of dry-salted cod, valued at $773,297. The whaling industry yielded miscellaneous products to the value of $1,027,200. Other fishery outputs were as follows: Clams, $184,363; trout, $13,155; sablefish, $35,-485; red rockfish, $1,414; crabs, $160; shrimps, $21,000; and miscellaneous fresh fish, $1,639.

ENFORCEMENT OF FISHERY LAWS.

The patrol for the enforcement of the fishery laws and regulations was actively carried on in the season of 1919 and was renewed for the season of 1920. Six of the patrol vessels were owned by the Bureau, and a like number was chartered. The work was made more effective by the employment of a number of temporary assistants as stream watchmen. Their chief function is to prevent violations of the law by their presence at points where extensive fishing in the streams is more likely to occur. The success of this work has been clearly demonstrated during the current season. Owing to limited appropriations, it has not been possible to carry on this phase of the work to the extent that it is desirable, but more active operations are contemplated another year. It is the purpose to employ a larger number of vessels and increase the number of stream watchmen at the more important fishery centers in all sections of Alaska.

It is hoped that the active cooperation of the Navy Department may be secured through the detail of at least 10 subchasers to be at the disposal of the Bureau of Fisheries for the enforcement of the fishery laws and regulations during the active salmon-fishing season, extending from about the first of June until approximately the end of September. Two subchasers were on duty in southeastern Alaska in the season of 1920. One of these rendered excellent service.

The closing to salmon fishing of practically all of the salmon streams of Alaska, together with certain areas outside their mouths, resulted in requests that the Bureau indicate the closed waters by suitable markers. The erection of markers was accordingly begun in the season of 1919, and the work was carried on more extensively in 1920. It will be continued as rapidly as possible, but several seasons will probably be required to complete the work.

The stealing of salmon that have been caught in traps, which has been referred to locally as piracy, developed to a considerable extent in 1919, and in 1920 was again the source of serious loss and annoyance to cannery operators in southeastern Alaska. Several naval vessels in the district had instructions to aid in suppressing this lawlessness, but it was not entirely stamped out. It would seem that there has been some exaggeration at times of losses thus sustained, and the practice would soon come to an end if purchasers of salmon made certain of the source of fish offered for sale and refused to accept stolen fish. The Bureau's agents have cooperated in efforts to suppress this traffic.

As a result of activities of the Bureau's representatives there were numerous convictions for violation of the fishery laws and regulations.

SCIENTIFIC INVESTIGATION OF THE ALASKA FISHERIES.

In the summer season of 1919 an investigation of the spawning grounds of the Copper River was made by Dr. Henry B. Ward, who spent about seven weeks studying conditions in that field. His report has been published in "Alaska Fisheries and Fur Industries in 1919." Another investigation was made by Dr. C. H. Gilbert and Mr. Henry O'Malley of fishery conditions in central and western Alaska. With the exception of Chignik, visits were made to all the most important fishing districts. Their report also is incorporated in the general report referred to.

The controversy which arose as a result of salmon-canning operations at the Yukon River led to the Bureau's undertaking in 1920 a special investigation of the whole fishery situation on the Yukon. The work was assigned to Dr. C. H. Gilbert and Mr. Henry O'Malley, who proceeded to the Yukon region early in the season of 1920. The results of the investigation will determine the future course of the Bureau in regulating the salmon fishery in that stream.

FISHERY RESERVATIONS.

In accordance with the regulations issued jointly under the terms of the Executive order of March 3, 1913, two additional permits were issued for fishing operations in the Aleutian Islands Reservation. At the end of the fiscal year 1920 there were 26 such permits in force. Fishery matters in the Afognak Reservation have received proper attention. The usual patrol of the fishing grounds was maintained, and permits were granted to natives to take salmon in the reservation. In order to prevent drain upon the supply of salmon for the Afognak hatchery, Litnik Bay was closed at all times to commercial fishing except for silver salmon, which species runs late in the season. The commercial catch of salmon in the reservation was 113,163, a slight decrease from the previous season.

PRIVATE SALMON HATCHERIES.

The private salmon hatcheries operated in Alaska have been inspected, as required by law. In 1920 only two such hatcheries were in operation. One of these, on Naha Stream, in the fiscal year 1920 liberated 17,070,000 red-salmon fry. The other hatchery, on Hugh Smith Lake, planted 11,357,000 red-salmon fry in the same year. Upon the basis of the output of these hatcheries the operators thereof were entitled under the law to a remission of taxes upon canned salmon at the rate of 40 cents a case to the amount of $11,370.80. The Territorial Fish Commission also did fish-cultural work chiefly at Juneau, where a small hatchery is maintained.

WOOD RIVER SALMON CENSUS.

As the result of an investigation made in 1919, Dr. C. H. Gilbert, a recognized authority on the Pacific salmons, recommended the discontinuance of the counting of red salmon at Wood River, which has been carried on each season from its inception in 1908 through 1919, with the exception of the year 1914. Dr. Gilbert felt that the work could be more advantageously conducted elsewhere in Alaska, preferably at Chignik or at Karluk, where the runs would represent distinct races. The determination of the direct ratio between the catch of salmon and the escapement as tallied in either of these streams would be much more important and conclusive than at Wood River, for the reason that the commercial catch on Bristol Bay below the mouth of Wood River is made up of salmon headed for several streams.

REVISION OF REGULATIONS FOR SALMON FISHERIES.

The need of further restrictions upon salmon-fishing operations generally in Alaska being apparent, two hearings were held at Seattle in November, 1919, for the purpose of eliciting information for use in guiding the Department's action in the matter. Following these hearings an order was promulgated by the Secretary of Commerce under date of December 23, 1919, effective January 1, 1920, which had application to a large portion of all the streams flowing into the Pacific Ocean and Bering Sea between Cape Dixon, in southeast Alaska, and Cape Newenham, Bering Sea. The text of the order is as follows:

Hearings having been given at Seattle, Wash., November 20, 1919, and November 25, 1919, respectively, after due notice in accordance with law, for the purpose of determining the advisability of limiting or prohibiting fishing in certain waters in Alaska, and to amend or modify the order of December 21, 1918, and all persons having had full opportunity to be heard, it is hereby ordered, by virtue of the authority vested in me by section 6 of "An act for the protection and regulation of the fisheries of Alaska," approved June 26, 1906, that until further notice all fishing for salmon, or other fishing in the prosecution of which salmon are taken or injured, in all hereinafter-described waters of Alaska be and is hereby made subject to the following limitations and prohibitions in addition to the general restrictions already applicable by virtue of existing laws and regulations:

1. Waters east of the longitude of Cape Spencer:

(*a*) All fishing is prohibited in all salmon streams and their tributaries and lakes.

(*b*) All fishing, except with purse seines and drift gill nets, is prohibited within 500 yards of the mouths of all salmon streams.

(*c*) All fishing with purse seines and drift gill nets is prohibited within 200 yards of the mouths of all salmon streams, and all fishing with purse seines and drift gill nets as well as with all other apparatus is prohibited within 500 yards of the mouths of Chilkat River, Chilkoot River, Anan Creek, Hetta Creek, Sockeye Creek, and Naha Stream.

2. All fishing is prohibited in all salmon streams, their tributaries and lakes, and within 500 yards of the mouths of such streams flowing into the Pacific Ocean or Bering Sea between Cape Spencer and Cape Newenham, except as follows:

(*a*) Fishing is permitted in Bering River below a line extending at right angles across Bering River from a point approximately 800 feet northwesterly from the mouth of Gandil River.

(*b*) Fishing is permitted in Copper River and its tributaries in accordance with the terms of the order promulgated December 20, 1918, which order is continued in full force.

(*c*) Fishing is permitted at Karluk beyond the zone 100 yards outside the mouth of Karluk River where it breaks through Karluk Spit into Shelikof Strait.

(*d*) Fishing is permitted in Ugashik River below a line extending at right angles across the Ugashik 500 yards below the mouth of King Salmon River.

3. The driving of salmon downstream and the causing of salmon to go outside the protected area at the mouth of any salmon stream are expressly prohibited.

4. This order does not apply to persons taking salmon with rod, hand line, or spear for their personal or family use and not for sale or barter.

5. The waters of the Afognak Reservation are covered by presidential proclamation of December 24, 1892, and the regulations promulgated by authority thereof are not modified or affected by this order but remain in full force.

6. All previous orders of the Secretary of Commerce imposing limitations or prohibitions upon fishing in the waters covered by this order, except as hereinbefore indicated, are hereby superseded.

7. This order became effective January 1, 1920.

On May 22, 1920, announcement was made of a hearing to be held at Seattle on November 23, 1920, at which it is proposed to elicit information in respect to what further restrictions, if any, should be placed on salmon fishing in the Yukon River.

Under date of May 25, 1920, announcement was made of a hearing to be held at Seattle on November 30, 1920, for the purpose of securing information as to whether restrictions in addition to those already imposed by law should be placed upon fishing in the Kuskokwim River.

Request having been made for a reconsideration of the existing salmon-fishery regulations for the Copper River, announcement has been made of two hearings, one at Cordova, Alaska, October 5, and one at Seattle, Wash., November 18, 1920.

ALASKA FUR-SEAL SERVICE.

GENERAL ACTIVITIES.

The scope of the Bureau's work in connection with the Pribilof Islands is far more extensive than is generally realized. Major activities include the administration of affairs pertaining to the fur-seal and fox herds, with annual products now averaging between $2,000,000 and $3,000,000, and the welfare of the native inhabitants, numbering upward of 300 persons, who in a sense are wards of the Government. The work thus not only covers the management of a large commercial enterprise but involves civic and municipal duties under conditions unlike those existing elsewhere in the world.

The natives of the Pribilof Islands are essential for carrying on the fur-seal industry. Without them it would be practically impossible under present conditions to conduct the laborious operations connected with the killing and skinning of seals and the curing and shipping of the pelts. The natives perform their work faithfully for the most part and take a keen interest in securing the best results. In return for their efforts, the natives are allowed certain cash compensation for fur-seal and fox skins taken, and in addition are supplied with food, clothing, fuel, shelter, and medical attention. The distribution of supplies is prorated in accordance with the size of families. Suitable schools are maintained for the native children. Housing conditions are unsatisfactory, but this situation is being remedied as rapidly as possible with the funds available. Most of the dwellings were built 40 or 50 years ago and are badly in need of replacement. Recently a model concrete house was completed for native use. If after a season's occupancy this type proves satisfactory, as it is believed it will, further buildings of the same kind may be constructed. On March 31, 1920, the number of natives resident on St. Paul Island was 188 and on St. George Island 128, a total of 316.

On December 31, 1919, the Commissioner of Fisheries had in his custody, as trustee for certain of the natives, the sum of $3,093.57. These funds are kept on deposit with the Washington Loan &

Trust Co., Washington, D. C., and draw interest at the rate of 3 per cent per annum, calculated on monthly balances. Liberty bonds purchased by the natives through the Bureau of Fisheries had, at the end of the fiscal year 1920, been forwarded to their owners or disposed of in accordance with their wishes.

The purchase of supplies for the Pribilof Islands has been a large undertaking. In 1919 the goods were assembled at Seattle, Wash., whence transportation was afforded to the Pribilof Islands chiefly by the U. S. S. *Nanshan*, through the cooperation of the Navy Department. Certain supplies in excess of the *Nanshan's* capacity were forwarded by commercial steamer to Unalaska. In 1920 the Navy Department again cooperated by shipping supplies on the the U. S. S. *Saturn*, which vessel also acts as tender for the Alaska naval-radio stations.

The Coast Guard, through its vessels detailed for Alaska service, has from time to time rendered valuable assistance in the transportation of supplies and persons in connection with the Bureau's work at the Pribilof Islands.

The *Eider*, a vessel with carrying capacity of from 40 to 50 tons, purchased last year by the Bureau for use as local tender at the Pribilofs and for trips between there and Unalaska, the nearest port, 250 miles distant, has proved of great value. It is noteworthy that the *Eider* made a trip from Unalaska to the islands in the middle of winter. No vessel had ever before visited the islands at that time.

Among more notable improvements at the islands in the past year have been the construction of two new salt houses for curing sealskins, the erection of a garage to house the four tractors and two trucks in use on St. Paul Island, the construction of two new native dwellings, one of concrete, and improvements to the landings both on St. George and St. Paul Islands. The four tractors sent to St. Paul Island in the fall of 1919 have been of great value in hauling sealskins from killing fields to the salt houses, and in moving seal carcasses from the fields to the by-products plant.

The Navy Department has continued the maintenance of radio stations on St. Paul and St. George Islands. They have been of incalculable value in affording communication with the outside world at all times of the year.

Attention is invited to the necessity of augmenting the personnel of the Pribilof Islands. The best interests of the Government require that the present staff be increased by a biologist or naturalist to give sustained consideration to the scientific problems involved in the fur seals, foxes, and other life on the islands, and by several technical assistants.

THE FUR-SEAL HERD.

The census of the seal herd as of August 10, 1919, showed 524,235 animals of all ages in the herd, an increase of 27,803 over the corresponding figure for 1918. The tentative figures for the census of 1920 indicate 548,473 seals as of August 10, 1920, or an increase of slightly over 24,000 in the year. The increases from year to year are net, the seals killed in the period between the censuses having been deducted. The census in 1920 was again taken under the immediate supervision of Dr. G. Dallas Hanna.

In the calendar year 1919 there were taken on St. Paul Island 24,053 sealskins and on St. George Island 3,768, a total of 27,821. Of these skins, 2,513 were from seals 6 years of age and 5,218 from seals 7 years of age and upward, in an effort to reduce the number of old surplus bulls. In 1920 there were taken through August 10, 21,936 skins on St. Paul Island and 4,042 on St. George Island, a total of 25,978. The take for 1920 will be increased somewhat by fall killings to provide food for the natives.

The provisional quota of seals to be killed at the Pribilof Islands in the calendar year 1920 was fixed at 35,000, of which 31,000 were to be taken on St. Paul Island and 4,000 on St. George Island; but as the sealing season progressed it became apparent that the surplus adult males, which constituted about 25 per cent of the contemplated quota, were not present in the expected numbers. On the recommendation of the responsible agents of the islands telegraphic authority was given to take, in addition to the numbers previously determined, 3,000 3-year-olds and 1,000 4-year-olds, these classes of seals being present in sufficient abundance on St. Paul Island to fully warrant the increased killings.

The different elements of the fur-seal herd, as determined by recent observations, now closely approximate the proper proportions in respect to the various age classes. The efforts of the past two seasons to reduce the excess of breeding males have been successful, as indicated by the fact that the average number of cows per harem increased from 30 in 1919 to 41 in 1920.

Experimental work in the season of 1920 may lead to the adoption of marked changes in methods of handling fur-seal skins, but final decision must await the outcome of the dressing and dyeing. The experiments have included an improved method of salting the skins; the washing of the pelts before salting, in order to remove blood and dirt; and, in addition, there have been extensive practical tests of the advisability of removing blubber from the pelts before salting.

In the fiscal year 1920 three sales of Pribilof Islands fur-seal skins were held at St. Louis. At the first sale, September 10, 1919, 9,055 skins were disposed of at the bid price of $827,112.50. At the second sale, February 2, 1920, 9,100 skins were sold for $1,282,905. At the third sale, May 10, 1920, 5,752 skins brought $424,166. The total number of sealskins sold during the fiscal year was, therefore, 23,907, at the aggregate price of $2,534,183.50. The high prices received are indicative of the excellent quality of the skins, which prior to sale are dressed, dyed, and machined at the modern plant located in St. Louis. The output of this plant unquestionably surpasses anything of the kind ever produced heretofore in Europe or elsewhere.

As a net result of the sales of fur-seal skins in the fiscal year 1920 there was deposited in the Treasury of the United States the sum of $1,457,790.57. This amount represents, in part, some of the skins sold in previous fiscal years for which returns did not come in until 1920. In addition to the amount stated the sum of $271,894.48 was set aside for payment to Great Britain and Japan of the shares to which those nations are entitled under the North Pacific Sealing Convention of 1911.

Pursuant to the provisions of the fur-seal convention, there have been received by the United States 111 sealskins from the Japanese herd on Robben Island. This number represented the 10 per cent share of the United States of the take of 555 skins in each of the years 1918 and 1919. These skins, which had been taken and cured in an excellent manner, were forwarded in March, 1920, to the Department's agents in St. Louis for sale.

BY-PRODUCTS OF THE SEAL INDUSTRY.

Shipments in the fiscal year 1920 of commodities prepared at the by-products plant on St. Paul Island aggregated 20,568 pounds of animal meal, or fertilizer, and 3,000 gallons of oil. The amount received from the sale of fertilizer was $771.30, and for the oil $3,640. An excellent grade of oil was produced. The plant was again operated in the season of 1920, but shortage of labor and fuel limited operations, with the result that 29,000 pounds of fertilizer and 1,800 gallons of oil were produced. An expert was employed for the operation of the plant. It is expected that hereafter the work will be conducted along more extensive lines.

FOXES AND REINDEER.

The blue-fox herds on the Pribilof Islands as a source of revenue to the Government are largely dependent on the sealing industry. Without the food provided from seal carcasses the fox herds would disappear as a commercial proposition. St. George Island is a far more prolific producer of fox pelts than St. Paul. On St. George there has been developed a method of control that has not yet been adopted on the other island. The animals are fed regularly through the winter with seal meat preserved from killings of the preceding summer, and they are captured in specially constructed traps which permits the release of an adequate and healthy breeding reserve.

In the season of 1919–20 there were taken on St. Paul Island 155 blue-fox pelts and 33 white-fox pelts, and on St. George Island 746 blue-fox pelts and 4 white-fox pelts, a total of 901 blue pelts and 37 white pelts. This was the largest production in many years. The yield of both islands in the preceding season was 667 blue skins and 30 white skins. The white fox on the islands represents a color phase of the blue fox, and, as it is far less valuable, every effort is made to eliminate it from the herds. It is expected that over 1,000 blue-fox skins may be taken in the coming winter.

The blue and white fox skins taken at the Pribilof Islands in the winter of 1918–19, with the exception of two withheld for exhibition purposes, were sold at public auction at St. Louis on September 10, 1919. Six hundred and sixty-five blue pelts and 30 white pelts made up the sale. The blue pelts brought $130,274.50, an average of $195 each, and the white pelts $1,660, an average of $53.33 each.

According to the best available figures, there were 164 reindeer on St. Paul Island and 123 on St. George Island at the end of the year 1919. This is a net increase of 18 over the year before. During 1919, 36 reindeer were used for food, thus affording a welcome change in diet. The herd is in a flourishing condition, having increased to its present proportions from the original stock of 40 animals introduced on the islands in 1911.

MINOR FUR-BEARING ANIMALS OF ALASKA.

VALUE OF FURS PRODUCED.

The value of the furs shipped from Alaska in the year ending November 15, 1919, exclusive of those from the Pribilof Islands, was, according to statistics compiled by the Bureau, $1,379,347.66. The corresponding figures were $1,305,421.16 for 1918 and $1,028,719.05 for 1917. The principal furs shipped in the last year were 7,723 red-fox pelts, valued at $270,305; 4,575 white-fox pelts, valued at $210,450; 28,040 mink pelts, valued at $252,360; and 113,652 muskrat pelts, valued at $215,938.80. The statistics of fur shipments were collected as in previous years by requiring shippers to report all consignments of furs from Alaska. The Post Office Department continued its cooperation in having postmasters report all shipments of furs by mail. As a check on reports of furs from Alaska made otherwise than by mail, the records of the customshouse at Juneau are available for examination.

REGULATIONS AND VIOLATIONS.

No change was made during the fiscal year in the departmental regulations for the protection of fur-bearing animals in Alaska, except that the close season on sea otters was extended for an additional period of five years, or until November 1, 1925. While it appears that the numbers of sea otters in Alaska are increasing somewhat, it seems highly desirable to continue in the inshore waters the protection that is afforded offshore by international agreement.

A considerable number of seizures of unprime furs was made during the year. The regulations forbid the taking of unprime furs at all times. A very important seizure was that made in July, 1919, of marten and beaver pelts, which had been mailed in Alaska, the killing of beaver and marten being prohibited throughout the year in Alaska. The seizure was made through search warrants acquiesced in by the Post Office Department and consisted of 714 marten skins and 699 beaver skins. The right of the Government to seize and hold these skins was contested, and at the end of the year the matter was still undecided by the courts.

FUR FARMING IN ALASKA.

On December 31, 1919, five islands were under lease to individuals or firms for the propagation of foxes and other fur-bearing animals—viz, Chirikof, Long, Marmot, Little Koniuji, and Middleton. The annual rental received was $200 or $205 for each island.

Fur farming continues to be carried on by a number of persons in Alaska. Operations are concerned chiefly with the breeding of foxes. Whether intensive fox farming will prove in the end successful can not be foreseen at present. In all probability the raising of foxes on islands where the animals are permitted to run at large will continue to be profitable to those who are so situated as to take advantage of conditions.

TRANSFER OF JURISDICTION.

The act making appropriations for the Department of Agriculture for the fiscal year 1921, approved May 31, 1920, contained a provision that the jurisdiction heretofore exercised by the Secretary of Commerce over land fur-bearing animals in Alaska, the Pribilof Islands excepted, be transferred to the Secretary of Agriculture. This transfer has for several years been advocated by the Bureau of Fisheries. The act further provides that jurisdiction in the matter of leasing certain islands in Alaska for the propagation of foxes and other fur-bearing animals be also transferred from the Secretary of Commerce to the Secretary of Agriculture. At the same time the jurisdiction over walruses and sea lions previously vested in the Secretary of Agriculture was transferred to the Secretary of Commerce.

MISCELLANEOUS.

APPROPRIATIONS.

The regular appropriations for the support of the Bureau of Fisheries for the fiscal year 1920 aggregated $1,206,190. The specific purposes for which the appropriations were made and the amount thereunder were as follows:

Salaries	$434,190
Miscellaneous expenses:	
Administration	11,000
Propagation and distribution of food fishes	400,000
Maintenance of vessels	120,000
Inquiry respecting food fishes	45,000
Statistical inquiry	15,000
Protecting sponge fisheries	3,000
Protecting seal and salmon fisheries of Alaska	125,000
Officers and crew of vessels for Alaska fisheries service	26,000
Special appropriations:	
Cape Vincent (N. Y.) fish hatchery, general repairs	8,000
Duluth (Minn.) fish hatchery, foreman's cottage	4,000
Wytheville (Va.) fish hatchery, general improvements to water supply	5,000
Fairport (Iowa) biological station, additional amount for rebuilding laboratory	10,000

The following deficiency appropriations, amounting to $132,500, became available during the year:

Maintenance of vessels	$5,000
Inquiry respecting food fishes	500
Protecting seal and salmon fisheries of Alaska	2,000
Baker Lake (Wash.) hatchery, replacing buildings destroyed by fire	50,000
Woods Hole (Mass.) station, replacing machine shop and power plant	70,000
Fairport (Iowa) biological station, equipment	1,000
Wytheville (Va.) station, improvement to water supply	4,000

In accordance with law, a detailed statement of the expenditures under the regular and deficiency appropriations will be duly submitted.

BUILDINGS AND IMPROVEMENTS.

The special appropriation for the construction of a foreman's cottage at the Duluth, Minn., station has not been used. Proposals were received from a number of contractors for the work, but none of a satisfactory nature within the limits of the appropriation were received.

At the Cape Vincent, N. Y., station there has been satisfactory progress in making the improvements contemplated. The most important items are the general remodeling of the interior of the hatchery building. This involves new windows, floors, and floor joists, the reinforcing of the stone walls of the building, and the general rearrangement of the hatching batteries, pumps and heating plant, all making for economy in space and convenience in operation. A 10-inch suction pipe from the end of the dock to the pumps has been laid and a new pump installed. Concrete piers, to serve as a foundation for an 18,000-gallon wood-stave tank supported on a steel tower, material for which has been ordered under contract, were in place at the close of the year, and the construction of a whitefish battery of an improved type, together with a building to shelter the fry tanks, was under way.

The special appropriation of $50,000 for the reconstruction of buildings at the Baker Lake station, which were destroyed by fire on July 21, 1919, became available in November and work was immediately undertaken. A new frame hatchery 56 by 130 feet, equipped with 150 standard salmon-hatching troughs with a capacity for at least 40,000,000 sockeye-salmon eggs and fry will be ready for occupancy during the 1920 spawning season. In addition, a temporary shelter containing 40 hatching troughs was completed in time to successfully handle the large egg collections made in the fall of 1919. All the lumber used has been cut on the grounds by means of a sawmill purchased and installed for the purpose. This mill will be a valuable permanent adjunct to the station.

The special appropriation for the improvement of the water supply at the Wytheville (Va.) station has been used in the installation of approximately 4,000 feet of 14-inch wood-stave pipe. The work involved the construction of a cement dam in Tates Run, from which point the water is taken, the excavation of a ditch 3 feet deep by 2 feet wide and 4,000 feet long, 500 feet of which were blasted from solid rock, and the construction of a dam and four bulkheads of cement where the line crosses the creek. The complete installation increases the water supply by approximately 1,500 gallons of water per minute. The laying of this line necessitated the purchase of a right of way across intervening land.

The new biological laboratory at Fairport, Iowa, to take the place of the one destroyed by fire, is practically completed and was ready for occupancy in the summer of 1920. The building is of concrete, stone, and brick construction, and is designed to be fireproof. The outside dimensions are 101 feet 8 inches by 54 feet 6 inches. The main floor comprises two office rooms, four biological laboratories, and a chemical laboratory, besides a room of two compartments for embedding and microtome work, a stock room and a museum with adjoining work room. On the second floor are a large and well-lighted library, 2 laboratories, 10 bedchambers, 3 bathrooms, and linen closets. The third floor, which is completed only over the center or main portion of the building, comprises 10 rooms which may serve as required for bedchambers, storage, and other appropriate purposes. In the basement there are a boiler room, a coal vault, dynamo room, two storage rooms, packing room, dining room, pantry, and kitchen, and finally two large rooms for tanks and an aquarium. The floors are concrete except in the library. Marble terrazzo is employed for floors in bathrooms, in first and second story public halls and corridors, and on main stairways. The building is equipped with electric lights and with conduits for an intercommunicating telephone system. It is steam heated, provided with hot and cold water, and is piped for gas in the principal laboratories.

Plans for a boiler and engine house and machine shop at the Woods Hole (Mass.) station, to replace the wooden structure, which was burned in March, are completed and the contract will be let at an early date.

VESSEL SERVICE.

At the beginning of the fiscal year the steamer *Albatross* was at Baltimore fitting out and being put in order for the Bureau's needs after her use by the Navy. Considerable additions were made to her equipment, including a powerful modern dredging winch and an otter trawl. She sailed October 27 for a cruise in Florida and Cuban waters to initiate fishery investigations to serve as a basis for further operations by the ship during the next two years. Biological and physical oceanographic stations were occupied on four sections across the Gulf Stream between Cape Henry and Key West: Across Florida Strait, between Key West and Habana; from Habana to Cape San Antonio at the western end of Cuba; across the Yucatan Channel to Cape Catoche; and from Cape Catoche to Dry Tortugas. The vessel returned to Baltimore on January 1, 1920.

On February 16 the *Albatross* sailed for Boston, arriving there February 24, and making this port headquarters for fishery and oceanographic investigations in the Gulf of Maine. This was a continuation of investigations conducted in the same waters by the *Grampus*, beginning in 1912. On the trip to Boston the vessel made three hauls with a 60-foot otter trawl in the vicinity of the 100-fathom curve, with the purpose of determining the occurrence of tilefish and other ground fish off the middle Atlantic coast; she also occupied a series of hydrographic stations on a line across Georges Bank. The work in the Gulf of Maine lasted until April 21.

On May 3 the *Albatross* started an inquiry regarding the spawning habits of the haddock in the Gulf of Maine. This work lasted until May 19, when the vessel returned to Baltimore, arriving May 20. A general survey of the ship was made on May 25. While she was found to be in generally good condition, certain repairs and improvements were authorized and were in progress at the end of the fiscal year.

Owing to the inability of obtaining satisfactory scientific assistants it was not possible to utilize the steamer *Fish Hawk* during the first half of the fiscal year, but on January 10 active operations were undertaken. A hydrographic and biological survey of Chesapeake Bay was commenced, to be carried out by a series of cruises, each of one to two weeks' duration, at approximately monthly intervals. This work is being continued with satisfactory results. The vessel is in excellent condition.

During the summer and fall of 1919 the steamer *Halcyon* was attached to the Gloucester (Mass.) station and assisted in fish-cultural work during the season. In January, February, and March she performed valuable service in keeping the channel in Gloucester Harbor cleared of ice, so that fishing vessels could enter and depart.

When the *Halcyon* was turned over to the Navy at the beginning of the war, she was not entirely completed and equipped. This need has been met, and the vessel has been put in condition for the Bureau's purposes. Some desirable alterations in her interior have been made, a heavy gun platform has been removed from the forward deck, her engine and machinery have been overhauled, and bilge keels have been built on. An electric-light plant has been installed, and a dredging winch with appropriate gear and apparatus has been provided. The work is practically completed, and the vessel is ready for service.

The auxiliary schooner *Eider*, purchased during the last fiscal year for service at the Pribilof Islands, left Seattle on October 26 for the islands with coal and other supplies and with several Government employees, reaching her destination on November 22. Headquarters for the winter were established at Unalaska, there being no harbor or suitable anchorage at the islands. During the year the vessel has been almost constantly employed as a tender, operating between the Pribilof Islands and Unalaska. Trips were made as the weather permitted in January, April, May, and June. The vessel has proved satisfactory for the service required.

The steamer *Osprey* was engaged as a fishery patrol boat in southeastern Alaska waters until August 6, 1919. She was then reported to be in an unseaworthy condition, and for the remainder of the year was laid up at Cordova. The *Osprey*, which is 25 years old, was purchased by the Bureau in 1912 for $13,000, and has given nearly eight years of hard service. She has now outlived her usefulness, and, as it was believed inadvisable to devote any large amount of money to put her in first-class condition, she has been condemned, and sale has been authorized.

The two small fishery patrol boats *Murre* and *Auklet* have performed excellent service, being constantly employed in southeastern Alaska waters during the entire year. From November 1 to March 31 the *Murre* was loaned to the Bureau of the Census for the use of census enumerators. This vessel has met with two accidents during the year. She caught fire on December 3, 1919, with the result of considerable damage to the vessel and loss of personal property of the crew. On April 1 she struck a rock and was beached in consequence. An investigation showed that both of these accidents were unavoidable and no blame has been attached to the personnel of the boat. She has already been repaired and is in active service.

The *Phalarope* and the *Gannet* have been engaged as usual in fish-cultural work, the former in connection with the Woods Hole (Mass.) and Bryans Point (Md.) stations, the latter at Boothbay Harbor, Me.

In addition to the vessels mentioned in the last annual report, there have been transferred to the Bureau by the Navy Department the motor boats *Raeo*, *Edithena*, and *Wachussetts*. The *Raeo* has been rechristened the *Kittiwake* and assigned to the Gloucester (Mass.) station for fish-cultural work, but no definite assignments have been made of the other two. It is believed that they will prove of value in some of the activities of the Bureau.

A new motor boat, the *Tern*, was constructed in April for use on the lower Yukon River and in the delta waters. The vessel is 38 feet long and is equipped with a 35–50-horsepower engine.

PUBLICATIONS AND LIBRARY.

The limitation imposed by Congress on the publications of the Bureau is proving a considerable drawback. Most of the Bureau's documents are intended to serve a definite public purpose, looking to the conservation, maintenance, or proper utilization of aquatic creatures. Such publications are therefore deserving of wide distribution within proper limits if their purpose is to be achieved. Many of the printed reports are the result of protracted inquiry or investigation and pertain to the welfare of important branches of the fisheries and fish culture in extensive areas where it may be desirable, if not necessary, to reach thousands of persons. In these circumstances, to restrict editions to 1,000 copies, regardless of their cost or regardless of the exigencies of the particular public fishery situations intended to be met, and to prohibit the issuance of reprints during the same year in which the original reports were published, may defeat the Bureau's efforts to render a service for which there is a great public demand. The major cost of publications is not in paper and presswork and may be not even in composition, but in the labors and expenses of investigators. It would, therefore, seem unwise in the case of many of the Bureau's documents to exercise economy only with regard to their least expensive feature.

The publications issued during the year have been carefully considered and designed in all cases to meet a public need. The free distribution of documents has been restricted and mailing lists have been revised. The series of economic circulars has been added to and continues to serve the useful purpose of supplying practical information on timely subjects at insignificant cost. The limitation on the size of editions acts as a special handicap in the case of these documents.

A noteworthy work accomplished by the librarian is the completion of an analytical subject bibliography of the Bureau's publications from 1871 to 1920. These publications constitute a library in themselves, and, without doubt, are the most complete and comprehensive collection extant on the fishery industries, fish culture, and aquatic biology and physics. More than 6,700 titles occur, and, in order to make the matter available for reference, intelligent compilation and classification are necessary. It is proposed to print this bibliography in convenient and inexpensive form, appearing opportunely at the close of the first half century of the Bureau's existence.

DISINTEGRATION OF THE PERSONNEL.

As the concluding section of this report, special attention is invited to the matter of fair compensation for the loyal and efficient employees of the Bureau in Washington, in the field, and afloat. It is hoped that affirmative action may be taken by Congress on pending relief measures that affect the force in the District of Columbia and that there may also be a readjustment of salaries throughout the field service.

A very serious situation confronts the Bureau because of the disintegration of the trained corps of specialists in all branches of the service, owing to the insufficient salaries allowed by Congress. With the cost of living increased at least 100 per cent in the past 10 years, the bonus provided by Congress, while most desirable and acceptable, must be regarded as a wholly inadequate, purely palliative, and manifestly temporary expedient. No bonus and no salary increase have been accorded an important part of the Bureau's personnel responsible for the wise planning and efficient direction of the work.

The Bureau has, therefore, been obliged to submit to the loss of valuable employees and the crippling of its technical staff that represent years of special training in order to equip them for the peculiar needs of the fishery service, because of the notoriously low compensation allowed by Congress and the much more attractive positions outside the Government. Unskilled laborers and low-grade mechanics are receiving wages that in many cases far exceed the compensation allowed by law for high-grade experts in the Bureau's service, while technical positions of responsibility and importance comparable to those in the Bureau command salaries in private life that are from two to four times those paid by the Government.

It is therefore not strange that the Bureau should have lost through resignations one-third of its scientific force and that other resignations therein are pending, resulting in the disorganization of a staff that has taken years to build up, will require years to reestablish under most favorable conditions, and can never be replaced so long as the Government offers no financial inducements. In the fish-cultural service, owing to low compensation, about two-thirds of the statutory positions in the lower grades have been either vacant or filled temporarily by old men and boys without qualifications, and in many cases even incompetent persons have refused to accept employment at the meager rates of pay offered by the Government. At one western station the superintendent and one other employee have been the only members of the statutory force for more than two years, while in other fields the work of important auxiliary stations has of necessity been put in charge of inexperienced, temporary men, or mere apprentices.

No private establishment would be expected to function under the conditions that have been confronting the Bureau for several years and have become more acute each year. Prompt and radical measures are now imperatively demanded if complete disorganization of the force is to be obviated.

Respectfully submitted.

H. M. Smith,
Commissioner of Fisheries.

To Hon. J. W. Alexander,
Secretary of Commerce.

THE FISHERIES BIOLOGICAL STATION AT FAIRPORT, IOWA

By R. E. Coker

Assistant in Charge of Scientific Inquiry
U. S. Bureau of Fisheries

Appendix I to the Report of the U. S. Commissioner of Fisheries for 1920

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THE NEW BIOLOGICAL LABORATORY BUILDING, COMPLETED IN 1920.

THE FISHERIES BIOLOGICAL STATION AT FAIRPORT, IOWA.

By R. E. Coker, *Assistant in Charge of Scientific Inquiry, U. S. Bureau of Fisheries.*

HISTORY AND FUNCTIONS.

The Fairport station was established by act of Congress in 1908. Its construction was begun in 1909, and with temporary equipment it began operations in June, 1910. The old laboratory, a frame structure of approximately the same dimensions as the present fireproof building, was constructed in 1912 and 1913. At the formal dedication of the building on August 4, 1914, unusual public interest was manifested by the attendance of 5,000 persons and by the congratulatory addresses delivered by men of prominence in public life and by scientific men of established repute. This building was unfortunately destroyed by fire on December 20, 1917. The office furniture and files and such scientific records as were retained in the office in original or duplicate form were saved; but records embodying results of tedious investigations were lost, together with the scientific equipment. A chief loss was the library, which, though not large, included a rare collection of separate papers and monographs, particularly such as related to fresh-water mussels of America and Europe.

Fortunately, the station comprised a great deal more than the laboratory building. The ponds and water system remained intact. The personnel of the station adapted itself readily to the changed conditions, and the important scientific and administrative work of the station was promptly resumed in the cramped quarters afforded by the old "temporary laboratory," a small one-story building just below the railroad, which had served a similar purpose in the first years of the station's history. For nearly three years valuable scientific work was carried on in these poor quarters, both by the permanent scientific staff and by a limited number of specialists in temporary association with the Bureau—men and women to whom personal convenience or comfort was secondary to the achievement of the objects to which the station was dedicated.

An appropriation of $80,000 was promptly made by Congress for the erection of a new and fireproof building. This, supplemented by two small additional appropriations, made it possible to build and partially to equip the present admirable building of brick, stone, and concrete. Experience gained during the occupancy of the old building, the resourcefulness and skill of the architect,[1] and the good spirit manifested by the constructing company, all combined to make the new building superior in available space, convenience, and serviceability, and an exceptional value in proportion to cost.

[1] Prof. James M. White, professor of architecture and supervising architect of the University of Illinois.

After unavoidable delays arising from the conditions of national emergency, the new laboratory was completed and occupied in August, 1920. Again there was a demand upon the Bureau for the observance of exercises of dedication, and these were set for October 7, in connection with a Conference Regarding the Application of Science to the Utilization and Preservation of the Resources of our Interior Waters (October 7 and 8). The occasion was made impressive, helpful, and inspiring through the whole-hearted cooperation of representatives of the Government, business men, and scientists from the leading American universities. Recognition of the national significance of this biological station for investigation of problems of fresh waters was attested by the presence of delegates from 22 universities and colleges and from two independent scientific organizations, representing 14 States, from California on the west to Massachusetts on the east, from Oklahoma and Florida on the south to Wisconsin and Michigan on the north.

The station serves as a base of operations for a large part of the scientific work of the Bureau of Fisheries in the Mississippi Basin. A primary activity is the propagation of pearly fresh-water mussels; but not less significant are its functions in experimental fish culture, in investigations of various fresh-water fishery problems, and in promoting both a fuller utilization of aquatic products and a broader interest in the protection of aquatic resources, in order that the future, as well as the present, may be properly served.

Through field parties the activities of the station have been extended into most of the States of the Mississippi Basin, and the results of work done go much further than the localities in which operations are conducted. The benefits of service to the mussel industries are felt not only where mussel fishing, or clamming, is practiced, but wherever mussels are manufactured into the finished products of commerce—in New York and Massachusetts, as well as in Wisconsin and Iowa; they are experienced, too, though unconsciously, by all who are consumers or utilizers of buttons. The demonstration at Fairport of the feasibility of propagating the channel catfish in ponds can be made useful for the increase of food supply in other parts of the United States. The propagation and distribution of some hundreds of millions of buffalofish fry in public waters each year is the direct result of experiments originally conducted at the Fairport station. The broader utilization of fishes formerly considered "coarse" or useless is in part the result of practical experiments in smoking fish, conducted during several years at this station. The varied services of the station will be described and illustrated more fully in later pages.

PERSONNEL AND EQUIPMENT.

Every station of the Bureau is regarded as an agency through which as complete a public service is to be rendered as conditions allow, but it is evident that the Fairport station combines in a somewhat unique way the functions of a fisheries biological station and a fish-cultural experiment station. This it does because of the provisions of personnel and equipment authorized by the Congress and because of the conditions of its location and origin.

There is attached to the station a small permanent staff of scientists, fish-culturists, and other employees necessary for continuous operation and uninterrupted experimental work. During some parts of the year, as may be desirable and practicable, the personnel responsible to this laboratory is much enlarged. The temporary associates or employees, comprising investigators skilled in special lines, scientific assistants, practical fishermen, or others, make it possible not only to increase the effectiveness of the station, but to broaden the territory of its operations.

About 60 acres of land, extending from the banks of the Mississippi, on a two-fifths of a mile front, to the brow of a hill a quarter of a mile back, afford ample space for the distribution of ponds and the suitable location of buildings. The slope of the ground is such as to assure proper drainage and to make it feasible to have a gravity flow of water from the storage reservoirs, located on or beneath the ground at suitable elevations, to the ponds and buildings.

There are in all 36 ponds, 14 of which are small and made of concrete, and 22 of which are dug out of the earth, simulating the conditions of natural ponds and varying in area from one-tenth of an acre to an acre or more. There are two water systems, the natural river water, pumped into a large storage reservoir and flowing thence to the several ponds, and filtered river water which is stored in low and high pressure cisterns and used for domestic and laboratory purposes. There is also a complete underground sewage and drainage system, which conveys the waste water and sewage into the river well below the source of supply.

The buildings comprise a main laboratory building, a small tank house, a boiler and pump house, a boat and seine shed, a storehouse and carpenter shop, a small shell-testing shop, and other necessary living houses and outbuildings. In some of these will be found pumping machinery for the two water-supply systems, machinery for cutting and finishing buttons in testing work, and such shop and field tools as are necessary to make the station as nearly self-contained as practicable.

The principal building, of concrete, stone, and brick, with ground dimensions of approximately 100 by 55 feet, has a fully finished basement besides two full stories and a finished third story over the center and larger portion of the building. The present laboratory accommodations for 16 investigators can be extended by conversion of other rooms into laboratories. A well-lighted library, chemical laboratory, photographic room, museum, tank, and aquarium rooms are features of the building essential to the efficient accomplishment of biological and chemical investigations of fishery problems. To afford necessary accommodations for temporary investigators at certain seasons, there are provided also a kitchen, a dining room, and a number of bed chambers which may be converted into laboratories as required. The building is lighted by electricity.

SERVICE RENDERED.

WHAT IS DONE FOR MUSSEL INDUSTRIES.

The services of the Fairport station to the pearly mussel industries have consisted in the propagation of mussels, the survey of mussel resources, the investigation of mussel problems, and the promotion of the protection of mussels.

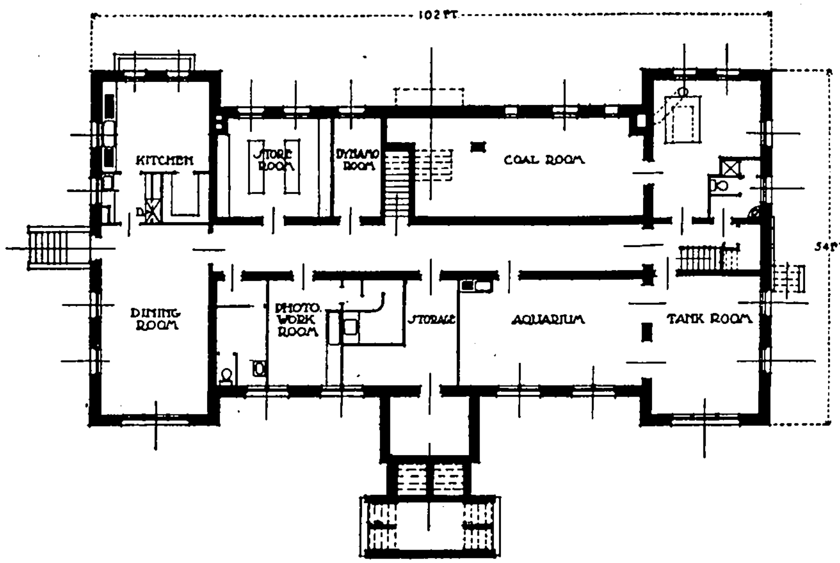

FIG. 1.—The biological laboratory, ground floor plan: D, ice box.

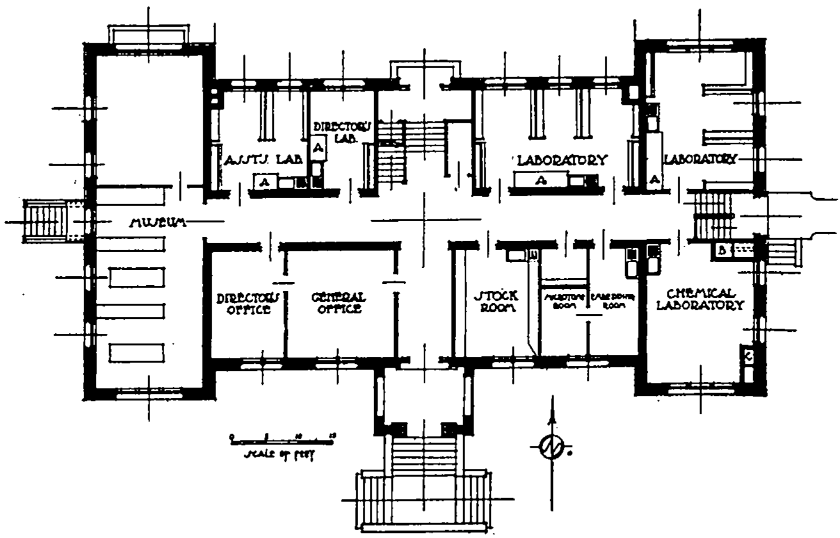

FIG. 2.—The biological laboratory, first floor plan: A, tank table; B, chemical hood; C, balance slab.

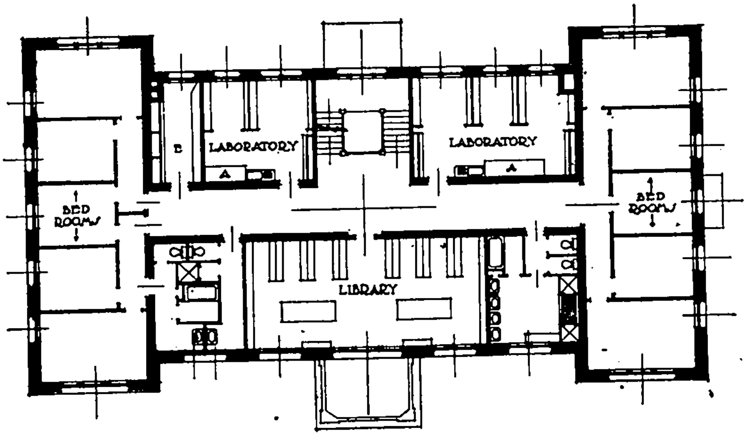

FIG. 3.—The biological laboratory, second floor plan: A, tank table; E, linen closet.

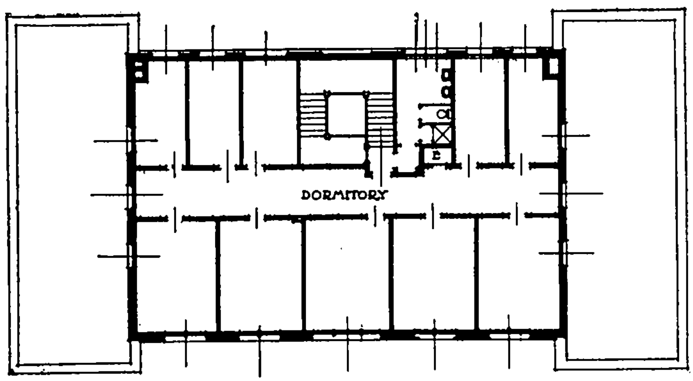

FIG. 4.—The biological laboratory: E, linen closet.

The survey of resources has resulted in opening new fields, and it helps also to furnish the necessary basis of information for estimate of the perpetuity of the resources, for the adoption of intelligent protective measures, and for guidance in the work of propagation. The special investigations and experimental studies have led to improvements in method of propagation and are pointing the way to further improvements. By investigations in the field and by continued observation of the industries, the Bureau has arrived at a better understanding of the measures necessary for effective conservation of mussels; and, by propaganda, correspondence, publications, and personal conferences, it has been enabled to stimulate more general interest in the subject and to cooperate with State authorities and others in the framing of suitable protective measures.

The enactment and enforcement of such measures must be left to the several States, but a commendable interest has been shown in some States, and a beginning has been made, notably in Wisconsin and Minnesota.

Mussel propagation is carried on by field parties engaged at various places on important rivers. Fishes are seined from the rivers or from overflow waters, are infected with the glochidia (the larval forms of mussels) and then liberated again in the public waters.

The methods of propagation are based upon a peculiar feature of the normal course of development of fresh-water mussels. The very young fresh-water mussels, with rare exception, when first liberated from the incubation pouches of the parent, must become parasitic upon fish in order to pass through the next stage of their existence. To this end, if the chance offers after liberation, the young mussels, or glochidia as they are called in this stage, attach themselves to the gills, fins, or scales of a fish. The mussels of economic importance attach themselves almost exclusively to the gills. In attaching, or biting on the fish, a very slight wound seems to be caused, which begins at once to heal over; but, in the process of mending, the glochidium is overgrown and thus inclosed within the tissues of the fish. The mussel is now actually an internal parasite, in which condition it remains for a period of two weeks, more or less. It is thus conveyed wherever the fish goes, until, when the proper stage of development is reached, it frees itself from the host and falls to the bottom; if, through favorable fortune, it finds suitable lodgment, it continues its growth to form an adult mussel.

The glochidia are so small that the infection, if not excessive, has no apparent injurious effect upon the fish that serves as host. Investigations by the station have shown that mussels do not attach to fish indiscriminately, but that for each species of mussel there is a limited number of species of fish which may serve as hosts.

The task of propagation is to bring together suitable fish and the glochidia of mussels. Careful studies of natural and artificial infections show that a moderate-sized fish may successfully carry in parasitism from 1,000 to 2,000 of the microscopic glochidia, but that under the chance operation of nature few of the glochidia find lodgment upon the proper fish or upon any fish.

During the fiscal year 1920, in round numbers, 183 million glochidia were liberated in parasitic condition. A considerable proportion of these glochidia undoubtedly fall upon unfavorable ground

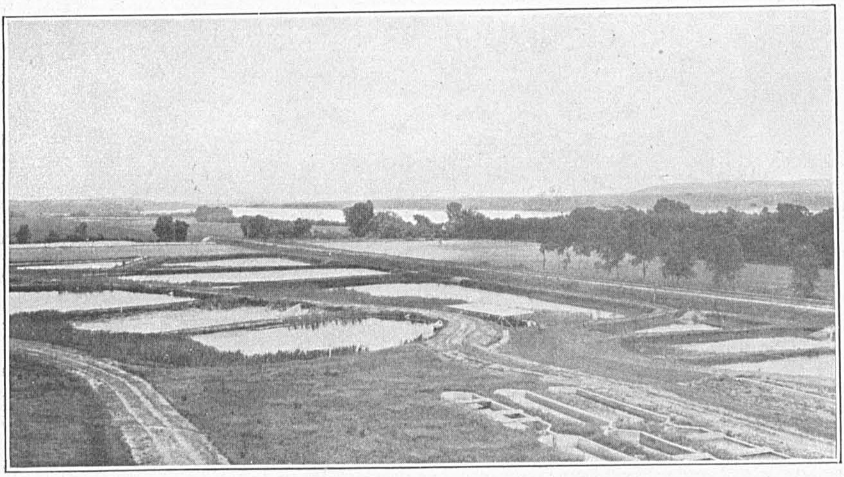

FIG. 1.—PONDS FOR EXPERIMENT WORK.

Earth-walled ponds of various sizes and forms present natural conditions such as may be reproduced on the farm. Small concrete-lined ponds serve the needs of special experiments. Both fish and mussels are reared here.

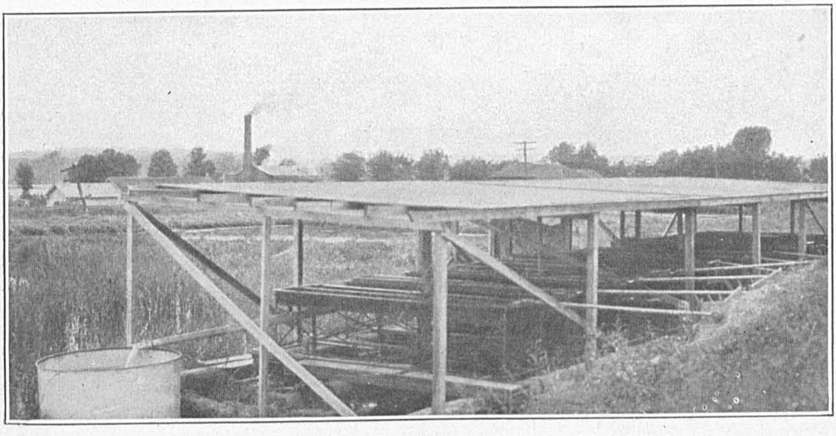

FIG. 2.—TROUGHS FOR REARING MUSSELS.

In troughs supplied with naturally clarified water flowing from near the surface of one of the ponds, the best conditions have been found for rearing several species of fresh-water mussels. As is the fortune of experimental work, success has been variable, but a single trough may produce in one season more than 2,000 young mussels one-fourth to one-half inch in length.

FIG. 1.—PONDS FOR FISH-CULTURAL EXPERIMENT WORK.

Part of the equipment used for fish-cultural experiment work. In these ponds we learn how to rear buffalofish and catfish, and how to make ponds more productive of black bass, bream, and other esteemed game fishes. Mussel culture, too, is practised in these ponds.

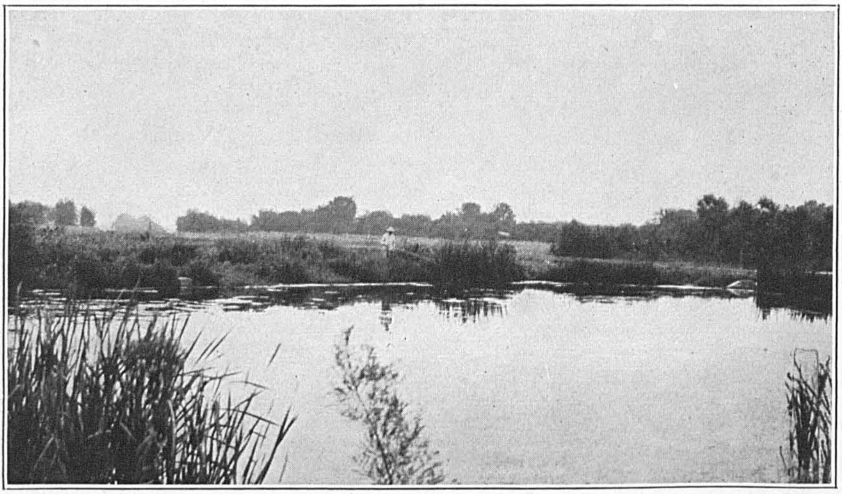

FIG. 2.—A SIMPLE FISHPOND.

This pond, a quarter of an acre in extent, simulates the natural conditions of a farm pond receiving minimum attention. Being stocked with generally esteemed fishes, it is intended to answer the question: What will a small pond yield without special attention?

or fail from other causes to reach maturity. However, it is the large number which can be infected on fish and liberated at small expense that justifies a confidence in the accomplishment of commensurate benefits. The average cost per 1,000 glochidia artificially infected on fish in the fiscal year 1920 was less than 6 cents, inclusive of overhead expenses.

Some of the streams in which this work has been carried on are the Mississippi River, at various points, the Ohio and Cumberland Rivers, the Wabash River in Indiana, and the White and Black Rivers of Arkansas.

In connection with the propagation of mussels, many fishes are rescued from land-locked ponds and restored to the rivers. In this way, during the fiscal year 1920, 36,442 adult and 871,553 fingerling fish were preserved from probable death by suffocation with the drying up of the temporary ponds, and this benefit was accomplished practically without expense additional to that necessarily incurred for the propagation of mussels.[1]

WHAT IS DONE FOR FISH CULTURE.

The services of agricultural and experimental stations to the farmer are so well understood that large appropriations are annually made by the Federal Government and by every State in order that there may be conducted the various sorts of investigations and experiments that are necessary to assist the farmer in producing larger and better crops with the greatest degree of economy. It is likewise important that studies and experiments be carried on to increase the productiveness of streams and lakes and ponds. The grower of fishes is even more dependent than the land farmer upon guidance from governmental experiments. A wheat grower or a cattle raiser has some chance to try out various methods and ascertain the effects by watching the growth of his crops or of his stock. The fish farmer, on the other hand, may try different methods, but he can not see how they work. Furthermore, nearly all of our water areas are under public and not private ownership and control, and only the public is justified in expenditures for experimental work.

Nearly all that we know of fish culture in America has been learned in connection with practical fish-cultural stations, where, since the establishment of the United States Fish Commission 50 years ago, many experiments have been carried out. The accumulated experience of keen and observant fish-culturists is of inestimable value; yet it should be pointed out that the function of a fish-cultural station is to produce as large as possible an output of fry or fingerling fish to be distributed in various waters where others must assume the responsibility for bringing the fish to maturity. It is not the purpose of such stations to work out by tedious experimentation and careful studies the conditions necessary to make individual ponds as productive as possible for market fish. As yet no other station of the Federal Government than Fairport has been designed to serve this function.

[1] During the first half of the fiscal year 1921, through the cooperation of the National Association of Button Manufacturers, more than 5 million fishes taken in the Bureau's rescue work along the Upper Mississippi River have been infected with mussels and liberated.

A few years ago no catfish except the small bullheads had been successfully propagated, although attempts to breed them in ponds had repeatedly been made. Having at Fairport the facilities and the personnel for continuous fish-cultural experiments, the channel cat, or common spotted catfish, the most favored of the tribe, was chosen as one of the fishes for experiment. Success was not attained in the first two or three years, but finally the right thing was done, and the propagation of the fish was found to be practicable. The methods may be and should be improved, but the results obtained can now be made useful for the promotion of fish culture and increase of food supply.

All attempts at artificial propagation of the buffalofish yielded most discouraging results until this station by properly conducted experiment demonstrated its entire feasibility and thus made a particularly valuable contribution to fish culture. The buffalofish are large species of commercial fish, in good esteem, formerly abundant in the principal rivers of the Mississippi Basin, but of late years diminishing in numbers. The hatching of the eggs of buffalofish by artificial means with the subsequent liberation of the fry or fingerling is now shown to be practicable, and it has been put into practice on a large scale through the fish-cultural stations of the Bureau. There are in progress at Fairport further experiments to determine if this fish may be successfully grown in properly controlled ponds.

Other experiments at this station relate to the growing of game fishes in ponds. Incidental to the experiment work, a considerable number of fish of several species are propagated each year and planted in the Mississippi River.

The task of fish culture is only begun when the fry or fingerling fish are produced and placed in ponds. The success of the pond depends upon the rate of growth of the fish and the proportion of the original stock which survives. The poultry raiser does not overrate his accomplishment when several thousand young chickens are transferred from brooders to yards. His success or failure is measured when the chickens are ready for market, by their number, weight, and quality. If fishes are to be grown successfully in ponds, it is necessary to know upon what they feed and how this food is maintained in the pond, and what other conditions are favorable or unfavorable to the survival and growth of the fish.

Let us again find a partial analogy in the rearing of farm animals. Is the farmer concerned only with his cattle, or does he in the selection, the preparation, and the conduct of his farm, give thought to the growing of pasture plants and hay grain foods? Can he ignore the parasites which cause disease or weakness among his animals; Would he not be stupid to overlook the insects or plant rusts that may sweep his pastures or crop fields bare? Evidently the stock farm is a good deal more than an abiding place for large and useful animals; it is a complex association of cattle, plants, insects, birds, worms, soil bacteria, and what else, not to mention such inanimate things as soil chemicals, water, and air. The fish pond or the fish stream is just as much a complex—more of one, it must be thought, because, though the air on the land farm is ever-present in unlimited quantities, the air in the water farm is limited and variable. Suffocation of the cow in the pasture is never feared, but partial or complete suffocation of fish is a frequent reality. Furthermore, the movements of fish are often governed by distribution of air or waste gases in the water, and the quantity of animal life in the pond is limited by the supply of dissolved gases.

Since the air supply of fish, without which they can not live, varies both seasonably and irregularly, the investigators must study the conditions of occurrence and distribution of gases in ponds and streams that we may learn what is favorable and what is unfavorable to the best conditions of gas content and thus to productivity of useful animals.

Since the air and the chemicals of water and soil are brought to the fish through the intermediation of small plants, small floating animals, creeping insects, and other things, these must all be carefully considered in their relation to fish culture. The relations are complex and the investigators must concentrate attention in different studies upon particular animals or plants. Some of the investigations so far pursued at Fairport relate to the food of the fishes at various stages of development, the kinds of plants that are most suitable and necessary in fish ponds, the relations of certain insect larvæ as food or as enemies of fish, and the occurrence of parasites that weaken the growing fishes and cause them to die or become an easier prey to enemies.

OTHER SERVICES TO FISHERIES.

A good deal of valuable work which is not directly related to mussels or to fish culture is done at and from the Fairport station. A few typical forms of service may be cited.

The construction of the dam across the Mississippi River, about 100 miles below Fairport, at Keokuk, Iowa, gave opportunity for a comprehensive investigation of the effects of water-power developments upon the fisheries of large rivers, and considerable information has been gained as the result of observations continued over a period of several years at Keokuk and at various points both above and below.

Chemical studies pursued in the laboratory have been directed toward ascertaining the food qualities of some aquatic products and possible methods of improving them.

Studies of the diseases of fishes, the causes and remedies, have been pursued. It has been learned that the slight injuries incidental to the handling of fish in warm weather, particularly in rescuing fishes from overflow waters, often lead to bacterial infections which cause serious mortalities. Means of prophylaxis are being devised which may be simple of application and effective in materially increasing the effectiveness of rescue operations in warm weather.

Somewhat apart from the ordinary lines of activity of the station, but corresponding to an evident need existing along the Mississippi River, there were conducted during a period of years some simple but immediately practical experiments in smoking the common fishes of the Mississippi River which had no particular value in the fresh state and which brought so little return to the fishermen that they were often allowed to go to waste. Some of these were occasionally smoked, but in many cases the smoking was so carelessly or ignorantly done that the product was inferior in taste and in keeping quality. Others were thrown away or sold for nearly nothing. The result of the experiments at Fairport was to enable the Bureau in a period of food emergency to issue a printed circular describing in detail the construction of a simple portable smokehouse, the methods of operation for different fishes, and the qualities of taste imparted to the fish by several sorts of fuel. This was followed almost immediately by sending out demonstration parties along principal rivers and even along the seacoast, proving by actual test, both to fishermen and to housekeepers, that "coarse" or "useless" fishes could be made palatable to the consumer and profitable to the fishermen. This was a simple and practical thing to do, but it required some years of experimental work, as opportunity offered, to try out various fishes by varied methods and to learn some things that were entirely unexpected.

The Fairport station, then, as a special agency of the Bureau of Fisheries, adapts its services within reasonable limits to the varying needs arising within its sphere of action. It endeavors to bring about a broader and better understanding of our inland waters as national resources—that they may be viewed not only as channels of surface-water drainage, as avenues of transportation, or as convenient and economical sewers, but as fields for the continuous production of necessities of food and raiment. It has set before it the task of discovering by scientific study and by practical experiment the conditions of preservation and increase of the useful life of inland waters.

Its work should tend to disclose what degree of protection is necessary and what methods are feasible, what conditions of biological, chemical, and physical environment are favorable for increased production of fish and other aquatic animals, and what measures may be taken to improve the environments in ponds, lakes, and streams.

The objective, let us say, is the prevention of the continued depletion of our aquatic resources, and the bringing of all interior waters to a condition of greatest fruitfulness. The way may be long and beset with obstacles, and success can be attained but gradually and by means of persistent effort and painstaking study. As we have indicated, some small milestones of progress have been passed, but it must be evident to all that the main task is for the future and that it is big enough and sufficiently complex and offers a degree of promise not only to justify the best efforts of the station, but to enlist the cooperation of all those having opportunity and interest to render public service through attention to the resources of interior waters.

PROGRESS IN BIOLOGICAL INQUIRIES

REPORT OF THE DIVISION OF SCIENTIFIC INQUIRY FOR THE FISCAL YEAR 1920

By R. E. Coker
Assistant in Charge

Appendix II to the Report of the U. S. Commissioner of Fisheries for 1920

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PROGRESS IN BIOLOGICAL INQUIRIES.

REPORT OF THE DIVISION OF SCIENTIFIC INQUIRY FOR THE FISCAL YEAR 1920.

By R. E. Coker,
Assistant in Charge.

INTRODUCTION.

There are times when it is worth while to inquire somewhat searchingly into the value of the varied activities of the Federal Government, to ask what good purposes are to be served through a particular governmental function. Clearly, such a time is upon us now, and it is appropriate, therefore, to prefix this report of progress with a brief statement suggestive of the purposes which the Bureau of Fisheries attempts to serve through the Division of Scientific Inquiry.

The direct and practical relation of scientific studies to the fishery industries is not always clearly understood. A successful industrial establishment depends no less upon the maintenance of the source of supply than upon the marketing of its product. The Division of Scientific Inquiry stands with reference to the fishery industries somewhat in the same relation as the supply department to a manufacturing concern: It does not produce the raw materials,[a] but it concerns itself with the problems of ultimate sources, of judicious exploitation, and of the means and conditions of maintenance or possible increase of supplies.

To be more concrete, an oyster industry is impossible without oysters, but it is now painfully evident to all concerned that, in northern waters at least, the continuance of a supply of oysters depends upon the solution of problems of scientific inquiry, the problem, for example, of the conditions of securing a set. The salmon industry ranks among the very first in the fisheries of the United States, yet in most waters we have witnessed a gradual decline in the abundance of salmon, and where such a decline is not manifest, as in the Columbia River, it is universally attributed to the measures of artificial propagation. The Bureau is therefore urged to investigate the conditions of success in maintaining the desired runs by artificial propagation, and to furnish that knowledge of the life history and migrations of salmon without which they can not be successfully protected and conserved. These are problems of scientific inquiry. The stock of whitefishes in the Great Lakes has been gradually depleted, but protective measures can not be most intelligently devised and enforced without knowledge of the life history, habits,

[a] That in this case is a function of nature as assisted by fish-cultural operations.

and movements of the fish, and this can be gained only by the skillful application of the methods of science. Nearly all persons concerned in the great shrimp fisheries recently developed off the South Atlantic and Gulf Coasts view with concern the future maintenance of the supply. Can the shrimp be wisely protected or most judiciously exploited while we do not know when or where it breeds or why it appears here or there in greater or lesser abundance? Clearly scientific studies have a very practical relation to the perpetuation of such a fishery.

Beyond a doubt, there is no one connected with the fishing industries who believes, with reference to the majority of the existing fisheries, that any of them will maintain its present importance in future time, except as the resources upon which it is based may be conserved by sensible measures of protection. And certainly no one concerned with the determination of protective measures would hesitate to say that we must know the fish (or shellfish) and its manner and conditions of life if we would successfully protect it.

It is, then, of direct and not indirect importance, of practical and not theoretical significance to the fisheries that we should study the fish and attempt to solve some of the many problems upon which depend the perpetuation of the resources and the development of the industries. The industries are founded absolutely upon the resources. The maintenance of the resources is conditioned upon the results of scientific inquiry. How shall depletion be prevented? To what extent can utilization be carried? What are the possibilities of propagation, the conditions, the results? What are the methods and conditions of protection? How can the natural environment be improved? How can disease be combated or unfavorable conditions of environment be changed? It is such questions as these that scientific inquiry must answer. The very statement of the purposes to be served renders unnecessary the presentation of argument for their pursuit. The merit of the service performed can best be determined from the report of its progress that follows, allowing, as one must, for the varied geographic and industrial interests to be served.

The Bureau does not, of course, fulfill all of its functions in scientific inquiry at any given time, but this report will serve to indicate the present scope of work, as well as the progress that is being made. It may be remarked finally that the activities of the fiscal year just closed were reduced as compared with that of previous years, and that further reduction will mark the year next to come, due to the loss in course of the last year of not a few of the men who contributed to the accomplishment of the year's work. What has been done is due to the loyal and efficient services of men who have labored without stint under conditions of discouragement. Acknowledgment is due no less to those who have left only under the impulsion of circumstances than to those who have found it possible to continue in service.

STUDIES OF FISHES.

ANATOMY OF THE SALMONS IN RELATION TO FISH CULTURE.

From time to time the Bureau has had reports of abnormal conditions of brood fish at its trout stations, such as the sterility of brood fish which have been used for several years. These conditions do not keep the hatcheries from having success in propagating fish, but they do make the output less and the cost more. They involve waste, and it will pay, therefore, to find and remove the cause. It has always been supposed and was seemingly established by published descriptions that the eggs of salmonidæ are passed into the abdominal cavity and thence discharged. Recently Dr. W. C. Kendall, scientific assistant, as the result of anatomical researches, discovered that the published descriptions were wrong as referring to the several species which have come under observation. He has found that the membrane by which the ovary is suspended enfolds it in such a manner that the mature eggs do not normally fall into the abdominal cavity but pass along a sort of trough formed by a continuation of the suspending and enfolding membrane of each ovary, which extends to a point not far from the outlet, where the two unite into a single trough attached to the upper surface of the intestine. It is also apparent from the conditions discovered that eggs which escape into the body cavity could not in any conceivably normal way be subsequently discharged. The escape of eggs into the abdominal chamber is then abnormal, and the common observation of eggs in this space may be presumed to result from the improper handling of fish in artificial spawning operations or in preparation for dissection.

It was suspected that the bad condition of brood trout at some fish-cultural stations may have been due to rough or careless handling during spawn taking. Examination of specimens sent in from several stations strengthened this suspicion. Dr. Kendall then proceeded to visit a fish-cultural station, observe carefully the operations of spawn taking, and make immediate examinations of the fish. The results of the observations made at one of the best stations, taken in connection with the studies just mentioned, indicate that the abnormal conditions referred to were probably due, not so much to careless spawn takers as to wrong practices. Improvements in method are required, though additional thought and study seem necessary before explicit directions can be given.

ATLANTIC SMELTS.

Dr. W. C. Kendall, with the aid of D. R. Crawford, is completing a monograph of the species of the smelts (Osmerus) of the Atlantic coast of North America. The smelts are abundant and widely distributed fish of small size, which are of value not only in the markets, but also in the water as a source of food for game and food fish of larger size. The studies pertain to the geographical distribution, life history, growth, habits, habitats, and importance, and to the conditions of conservation both of the marine and the fresh-water smelts. Particular attention is given to those of New England and to the "ice fish" of Lake Champlain. There are indications of local races of marine smelts, and some fresh waters appear to be inhabited each by a race or species, distinct not only from the marine smelt but also from smelts of other fresh waters. The variation in size attained in some of the fresh waters of Maine is remarkable. Some lakes are inhabited by two distinct sizes of mature smelts, each having well-defined breeding seasons and subsisting upon different kinds of food. In one lake the minimum size of the small smelt when mature is about 1½ inches and the maximum size of the large smelt 4 inches, while in another the minimum size of the small form at maturity is about 4 inches and the maximum size of the large form 15¾ inches. We have to do, it seems, either with different species or with distinct races; that is to be determined later.

DETERMINATION OF SPECIES AND RELATIONSHIPS IN THE SALMON FAMILY.

One of the obstacles to the best success in fish-cultural work is the great difficulty of distinguishing positively the species of trouts and salmon. To obtain the desired results in propagation and distribution of fish, it is necessary to know beyond a doubt what species is being propagated and planted, as well as what kinds are native to certain waters, and what have previously been introduced. Nevertheless there still exist among sportsmen, fish-culturists, and scientists varying and conflicting opinions regarding the identity and relationships of the species of Salmonidæ, notably in the case of the steelhead and rainbow, fish which are extensively propagated by Federal and State hatcheries.

The difficulty lies solely in the fact that sufficient technical work has not been done upon the structural examination and comparison of such fish in numbers and from varying localities. The bureau has, therefore, encouraged the prosecution of a thorough and critical study of the structure and relationships of the members of the important salmon family.

Dr. W. C. Kendall, scientific assistant and ichthyologist, has given much attention to the osteology (bony structure) of salmon, trout, and related fishes, which, with studies of scales, proves of much value in the determination of families, genera, and species. While verifying many of the statements of others, some new facts have been discovered.[a]

A paper which is in preparation, based upon a study of trout from various regions of the West and upon geological considerations, presents a scheme of origin and distribution of the trouts which offers a plausible explanation of their present distribution and throws light upon hitherto obscure problems of classification.

Another report nearing completion is believed to settle the much-discussed question of the specific identity or distinctness of the rainbow and steelhead trouts.[b]

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[a] It appears that the salmons, trouts, and chars form a family (Salmonidæ) distinct from the whitefishes and ciscoes (Coregonidæ), the latter being based upon the characters enunciated by Cope and given by later writers as the characters of a subfamily. It has not yet been decided whether or not the grayling should be regarded as a family (Thymallidæ, Gill) distinct from the whitefishes (Coregonidæ), in which Regan includes them. The separation of the Pacific coast salmons (Oncorhynchus) from the genus which embraces the Atlantic salmon and rainbow and steelhead trouts is definitely confirmed. The lake trout (Cristivomer) is found to be notably different from the brook trout (Salvelinus). The smelt family (Osmeridæ, Regan) should also stand as distinct from the Argentinidæ. The pelvic bones of *Argentina silus* are widely different from any other isospondylous fish examined.

[b] After a careful study of the fish from taxonomical, anatomical, and distributional evidence the conclusion is reached that there are at least two wild forms which have been confused under the names of rainbow and steelhead trouts. One is predominantly migratory (ascending fresh waters from the sea), the other predominantly a permanent fresh-water inhabitant. The name *Salmo irideus* was originally bestowed upon a small steelhead form, as was also *Salmo rivularis*. There is absolutely no doubt concerning the proper application of *Salmo gairdnerii* to the steelhead, as Richardson's description is that of a large Columbia River fish and not a small blueback salmon (*Oncorhynchus nerka*), as one writer has stated. Contrary to current descriptions, the steelhead has

THE WHITEFISHES AND THEIR RELATIVES.

For a long time the Bureau, the several State fishery authorities concerned, and the trade have felt the serious need of knowledge regarding the habits of the whitefishes, ciscoes, and so-called lake herrings of the Great Lakes. Yet up to the present time we have not had even that positive determination of the species which is an essential basis of an inquiry into migrations, propagation, and other habits. During the past two or three years Dr. Walter Koelz, general assistant, has been detailed to a comprehensive study of the whitefishes and their relatives in the Great Lakes, beginning in Lake Huron. During the past year he completed the field work and report based upon that lake.

His report, which represents a substantial advance in knowledge of these fishes, is based upon a collection of 3,000 specimens of Lake Huron Coregonines and on field data as to their breeding times and breeding places, geographic and depth distribution, and migrations. He has definitely distinguished and defined 10 forms—8 species and 2 subspecies—all of which are referred to the Linnaean genus *Coregonus*. Two new species are described and three subgenera are recognized (*Leucichthys*, *Coregonus*, *Prosopium*). The forms of one subgenus (Leucichthys) fall into two ecological groups: (1) the lake herrings (*artedi*, *manitoulinus*), and (2) the chubs (*alpenae*, *reighardi*, *johannae*, *nigripinnis*) and bloaters (*hoyi* and its variant *profundus*).

The lake herrings are taken in shallow water to a depth of 16 fathoms, rarely deeper. One of them (*artedi*) is known also to range the surface waters to a considerable distance from shore. They spawn in November in shallow water on sand and gravel. The chubs and bloaters are taken near the bottom in water 30 to 80 fathoms or deeper. They occur on mud or clay bottom and feed chiefly on species of crustacea and mollusca. The spawning season for the five species extends from late August to March.

The species of chubs and bloaters have definable but overlapping ranges as regards depth. Each form has its greatest density of population at the center of its bathymetric range, and this density diminishes toward the borders of its range.

The pilot, *Coregonus* (*Prosopium*) *quadrilateralis*, occurs usually along the shores to a depth of 20 fathoms. It breeds in November in shallow water on rock or gravel bottom. The whitefish, *Coregonus clupeiformis*, is also shore-loving, seldom occurring deeper than 20 fathoms. It spawns in November in shallow water on rock or gravel. It is not expected that the report will be offered for publication before the investigations in other lakes are completed.

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larger (fewer) scales than the rainbow, and there appear to be other though inconspicuous and concealed structural differences.

There is probably more than one species or race of rainbow trout, and possibly also of steelhead. However, the rainbow trout of fish culture is largely from McCloud River (Calif.) stock and should bear the name, not *Salmo irideus*, but *Salmo shasta*. The fish-cultural rainbow stock has been more or less affected by admixture of another form principally from Klamath River, which may be another form or species of rainbow or perhaps a steelhead. This admixture is clearly perceived in the appearance and structure of many specimens of the rainbow stock of some of the hatcheries. The steelhead stock has always, so far as known, been unadulterated *Salmo gairdnerii*, although in the distribution from hatcheries it is known that in some instances the two forms have been regarded as identical and distributed as rainbow trout. Pure *Salmo shasta* is distinguished from pure *Salmo gairdnerii* by the smaller scales of the former.

BIOLOGY OF THE PACIFIC SALMONS.

The salmon fisheries, very valuable in themselves, support a packing industry, the product of which is of still greater value. Speaking in terms of appropriate correctness, we may say that the salmon taken from the rivers and lakes of Pacific Coast States and Alaska now yield each year 6 pounds of highly nutritious meat food for each man, woman, and child in the United States and its possessions. We enjoy and esteem these valuable economic resources now, but it is a serious question if the generations to follow will derive like benefits from the same waters.

It is true that the salmon are not necessarily exhaustible like a mineral resource, but that they are by nature self-perpetuative, provided only that present and future utilization is rightly regulated and that artificial propagation is intelligently directed. The decline of the fishery in most of the waters of the Pacific coast is clear evidence that we are not yet properly meeting the requirements in propagation and regulation. The situation in Alaska waters, a relatively new field of exploitation, has already reached a stage which investigators assure us is critical and which may be but the beginning of an era of decline.

It becomes a high responsibility, then, that we find out what must be done, that we study the salmons until we know fully their life histories and habits and the conditions of the maintenance of the runs.

The investigations conducted by Prof. C. H. Gilbert and Mr. Henry O'Malley in Bristol Bay and other Alaska waters, through cooperation of the Divisions of Scientific Inquiry, Fish Culture, and Alaska Fisheries, are reported fully in "Alaska Fisheries and Fur Industries in 1919,"[a] and need not, therefore, be described in this connection.

In Pacific Coast States studies of salmon have been conducted primarily by Willis H. Rich, with particular attention to the life history of the chinook salmon of the Columbia River.

Considerable progress has been made in the study of the life history as based on scale analysis. The necessary foundation for this work was laid by studies conducted during previous years and published recently under the title, "The Early History and Seaward Migration of the Chinook Salmon in the Columbia and Sacramento Rivers."[b] Even with the data at hand, the accurate interpretation of the adult scales has proven an extremely difficult task, owing to the great diversity in the types of nuclear growth. As a result of the study of large series of scale photographs and the calculations of sizes at various ages of several hundred individuals, it has now become possible to interpret fairly accurately the age and early history from examination of the scales of adult fish. From investigations pursued in the various tributaries of the Columbia River, it is found that many contain distinguishable races, just as had previously been shown in the case of the sockeye. The study of the chinook salmon taken in the

[a] Bower, Ward T.: Alaska Fisheries and Fur Industries in 1919. Appendix IX, Report. U. S. Commissioner of Fisheries, 1919. Washington, 1920.

[b] Rich, Willis H.: Early History and Seaward Migration of Chinook Salmon in the Columbia and Sacramento Rivers. Bulletin, U. S. Bureau of Fisheries, Vol. XXXVII, 1919-20, pp. 1-73. Washington, 1920.

open ocean by trollers and purse seiners has progressed to the point where a preliminary report is in course of preparation.

Satisfactory returns are being obtained this year from one of the experiments in marking young chinook salmon at the hatcheries of the Columbia River. Some returns have been obtained from three other experiments, and it is possible that additional results may be obtained later this year.

Additional marking experiments have been started during the past year with particular reference to chinook fry and yearlings and yearling sockeyes. At the same time, and in cooperation with the State Fish and Game Commission of Oregon, a representative of the Bureau began last spring the tagging of adult steelhead in the Rogue River. A proposed study of the steelhead and chinooks in this stream has, for various reasons, been delayed.

HABITS OF FRESH-WATER FISHES.

Perhaps no papers published by the Bureau are of more service to fish culture, to angling, and to the utilization and conservation of fresh-water fishes than those which comprise the results of careful studies into the habits of useful fishes. The works of Dr. W. C. Kendall, Dr. A. S. Pearse, and Dr. Jacob Reighard fall naturally into this class. Recent studies by Dr. Kendall are referred to in another place. The results of Dr. Reighard's observations are to be given publication in other places.

Some results of Dr. Pearse's recent studies are embodied in two useful reports, of which one was published last year and the other of which is in press. They are entitled, respectively, "Habits of the Black Crappie in Inland Lakes of Wisconsin"[a] and "Habits of Yellow Perch in Wisconsin Lakes."[b] The observations, which have been extended to several lakes, are based upon numerous collections at various seasons, places, and depths, the tagging and recovery of individual fishes, studies of food and parasites, and various other considerations.

BREEDING HABITS OF THE PADDLEFISH.

During a considerable portion of the past two years Dr. A. D. Howard, field assistant, has conducted an inquiry into the breeding habits of the paddlefish, *Polyodon spathula*, a food fish of the Mississippi Basin, which attains a large size and which is of particular value because its eggs make a grade of caviar scarcely inferior to that of the sturgeon. This important fish is diminishing in numbers, but all attempts at artificial propagation and all previous investigations of the breeding habits of the species have been barren of practical results. The present investigation, which began in January, 1919, was made possible through the cooperation of the Conservation Department of Louisiana.

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[a] Pearse, A. S.: Habits of the Black Crappie in Inland Lakes of Wisconsin. Appendix III, Report, U. S. Commissioner of Fisheries, 1918, 16 pp. Washington, 1919.

[b] Pearse, A. S., and Henrietta Achtenberg: Habits of Yellow Perch in Wisconsin Lakes. Bulletin, U. S. Bureau of Fisheries, Vol. XXXVI, 1917–18, pp. 293–366. Washington, 1920.

Observations were first undertaken in White Lake, near the Gulf, where the Superintendent of Fisheries had previously conducted investigations of the spawning of paddlefish. Owing, however, to changes having occurred in the lake due, it was believed, in part to drought and removal of water from the lake for irrigation of rice fields and in part to overfishing, no paddlefish were obtained. The investigator then proceeded to Natchitoches and Red River Parishes, where better conditions were encountered both in the Red River and in the Oxbow Lakes adjacent to it. Here over 300 paddlefish were taken, of which 17 were mature females with eggs and 3 were mature males. No females with eggs free or running were found, but one spent female was taken April 2 and another April 11.

An experiment was made in retaining large paddlefish in a good-sized inclosure formed by placing fine-meshed wire netting across the mouth of an arm of a bayou. Although no results in propagation were obtained, it was demonstrated that paddlefish could be kept in such an inclosure for two or three months at least. It was found also that by tethering a paddlefish by a line 5 or 6 feet long to an empty gallon jug the fish could be kept in good condition and recovered at will.

It was observed that while large mature fish may be found in isolated lakes, young paddlefish are found only in those lakes or bayous which have a connection with the river. Nevertheless, it may be that paddlefish propagate successfully in isolated lakes of very large size, such as White Lake (in former years), where the chance of avoiding enemies is better. Fish retained in small pens or tied with a line were frequently attacked and killed by turtles, principally the soft-shell turtles. The turtle evidently sought the eggs, since this was the first part of the fish to be devoured, and turtles taken in the vicinity were observed with paddlefish eggs in mouths and stomachs.

In the spring of 1920 more attention was given to river fish than to those landlocked in lakes, but on account of flood conditions only a very small number were secured and none of these were mature males. While awaiting more favorable conditions, experiments were continued upon the lake fish, the eggs being treated by the artificial fecundation method successfully used with sturgeon. Eggs in sand remained free of fungus, but no development was observed in any of them. It is believed that success depends upon securing river fish (among which only have spent females been found), but a favorable season without too much high water is necessary for this.

LIFE HISTORIES OF MARINE FISHES.

One of the most important conditions of intelligent exploitation or protection of the great fisheries of the seas is a knowledge of the life histories of the species. Such knowledge is difficult to obtain, since it is manifestly impossible to observe directly the daily and seasonal movements of individual fish that possess the freedom of the sea. The desired knowledge can be accumulated but slowly through the pursuit of oceanographic studies and the continual collection of fishes under conditions of accurate record, with especial reference to eggs and larvæ. The material and the data accumulated at any one time may tell no useful story, but when there has been gradually gathered together a great store of materials, many of the several elements will be found to fall into series; a patchwork quilt is eventually formed which depicts in accurate form and in more or less complete detail the interesting and long-desired story of the migration and feeding and breeding habits of one or more species of fish. The studies of life histories of fishes of the sea are, therefore, linked with the oceanographic studies to receive brief reference in another place. W. W. Welsh, scientific assistant, has been engaged in the study and identification of the large collections of larval fishes now in the Bureau's possession. Collections were also made while he was engaged upon the *Albatross*, and just before the fiscal year closed his field studies were extended to a point on the New Jersey coast offering unusual facilities for the daily observation of fishes taken alongshore, for experiments in the hatching of such eggs as might be obtained, and for rearing the larval fishes to an advanced stage. Mr. Welsh has devised an ingenious automatic apparatus for holding pelagic fish eggs during incubation so that their development may be studied.

SARDINE OF NORTHWEST COAST.

A further inquiry into the occurrence of the pilchard or sardine, *Sardinia cærulea*, off the coasts of Washington and Oregon was conducted during the past summer by C. L. Anderson, assistant in the Bureau. Observations and inquiries were made near the mouths of the Columbia, Siuslaw, Umpqua, and Coquille Rivers, and at Yaquina, Alsea, and Coos Bays. It is reported that some sardines enter the inside waters every summer, but that the run is extremely variable as to abundance. Mr. Anderson suggests that the presence of sardines in the bays is largely controlled by the proportion of fresh water brought into the bays by the rivers, the run being light or wanting when the salinity of the bay water is lowered. Practically none entered these bays during the past summer. While sardines may be present in the ocean beyond the bars at practically all times, as evidenced by statements of trollers and halibut fishermen and by study of the stomach contents of troll-caught salmon, yet the nature of the bars over which access to the harbors must be had and the severity of weather conditions would make it difficult to operate a regular sardine fishery. The evidence now in hand is not favorable to the establishment of an important sardine-packing industry in Northwest States.

FISHES IN RELATION TO PUBLIC HEALTH.

It is doubtful if any function of the Bureau is worthy of higher public esteem than one which brings it into direct relation with improvement of the conditions of public health and makes it an effective and indispensable servant in the progressive elimination of a disease that not only produces vast economic losses by disability of laborers and employers, but year by year robs thousands of men, women, and children of energy, ambition, and happiness. The investigations of previous years not only bore abundant fruit when the Bureau could render a substantial service during war times in the protection of the health of soldiers in cantonments, but they have placed the Bureau in position to play an active and continuing part in the extensive antimalarial campaign in Southern States.

PARTICIPATION IN ANTIMALARIAL CAMPAIGN.

Responding to a request from the Surgeon General of the United States Public Health Service, Scientific Assistant S. F. Hildebrand was detailed in February to cooperate with that Service in making inspections in the Southern States and in conferring and advising with the various public health officers, Federal, State, and municipal, in the use of minnows for the destruction of the immature mosquito. As the work was extended to various points in 12 States, it was found that public health officers generally, when properly acquainted with the conditions of success of mosquito control by the use of fish, were glad to make use of a method which in many cases was both practicable and inexpensive. Many favorable reports, showing considerable savings accomplished by the use of fish under favorable conditions, have been given by sanitary engineers and others. As compared with control by oiling, the elimination of mosquitoes by the use of minnows is not only inexpensive but also relatively enduring in effect, if the bodies of water are permanent.

There appears at this time to be no other mode of mosquito control inexpensive enough to be widely applicable in rural communities where measures of drainage and oiling could be employed only at a per capita cost that renders them impracticable. The principal fish used is the common southern top minnow (*Gambusia affinis*), although the star-headed minnows (*Fundulus notatus* and *Fundulus nottii*) are being used to a limited extent. Many observations in various localities give positive demonstration of the effectiveness of Gambusia in eradication of mosquito breeding under appropriate conditions.

It is not to be inferred that mosquito control by fish is attained automatically; rather is the exercise of intelligence, knowledge, and care essential for success. It must be borne in mind, too, that as yet there have been discovered only some of the conditions of successful control. Much remains to be learned by repeated observations and experiments before the broadest use of fish as an agency for the prevention of malaria will be possible. Therefore advice and demonstration of what is now known must not be allowed to displace the plans for further investigational work. The same assistant will continue to prosecute investigations and extend practical services with particular reference to the conditions in Southern States.

FISH AND MOSQUITO STUDIES AT MOUND, LA.

Previous reports have mentioned the cooperative investigations which were being pursued with the Bureau of Entomology at the field laboratory of that Bureau at Mound, La., R. L. Barney being the Bureau's resident agent in charge. The observational and experimental work at that station was brought to a close about the middle of the fiscal year in order that the accumulated data might be compiled and a report prepared. Reports on certain phases of this investigation have been prepared, but the completion of a final report has been delayed by the loss of an assistant and by the unavoidable exactions of other duties.

MOSQUITO CONTROL IN NORTHERN WATERS.

While malaria is not prevalent in Northern States, the mosquito problem persists and exerts its ill effect upon property values, industrial productiveness, and personal efficiency. This was well illustrated when large sums of money were expended in the effort to exterminate mosquitoes in the vicinity of a large shipyard.

Prof. J. Percy Moore, of the University of Pennsylvania, as a temporary investigator for the Bureau, has been charged with certain experiments conducted in the vicinity of Philadelphia. He has also participated in investigations in the Palisades Interstate Park with reference to the control of mosquitos by the use of fish and other aquatic animals. A very gratifying degree of cooperation is extended by the officials of the park, and experiments have been started which are producing results of scientific and practical interest. Improvement of the shore conditions around one of the principal ponds of the park has already resulted in giving small fish better access to shallow coves and little cut-off pools, and this in turn has effected a material reduction in the abundance of mosquito larvæ. Subsequent examinations of the stomachs of young fishes admitted to such waters formerly teeming with mosquito larvæ have shown a large proportion of mosquito eggs, larvæ, or pupæ in the food. Other experiments are in progress.

This work is being done in connection with the cooperative investigation between the Bureau of Fisheries and the New York State College of Forestry at Syracuse, having to do with the control of mosquitoes, the elimination of blood-sucking leeches, and the development of the fish-cultural possibilities of the park. The general object is to promote favorable conditions in the park for fishing, bathing, and other forms of recreation.

EXPERIMENTAL FISH CULTURE.

Previous reports have stressed the need for fish-cultural experiment work; yet this field of endeavor remains in a condition of development that offers relatively small promise until circumstances may be changed. This is not for lack of possibilities of service to Government, State, and private fish culture, or for deficiency in facilities; the opportunity is there, but the special personnel is wanting. Fish-cultural work demands the service of specialists—those who can study systematically and continuously the functions and relations of plants, insects, crustacea, bottom conditions, fertility, form and depth of pond, etc., with reference to methods of fish culture and the productiveness of fishponds. The most the Bureau has been able to do during the year just closed has been to keep the flame of experimental fish culture burning, with the hope that provision may yet be made for its adequate conduct.

Some further results of importance have been gained in the experiments conducted at the Fisheries Biological Station, Fairport, Iowa, with catfish, buffalofish, bass, and sunfishes. Certain experiments are under way to determine the value of the use of manure or commercial fertilizers for increasing the fertility and productiveness of fishponds. Prof. C. B. Wilson at that station also continued his investigations of aquatic insects in relation to fish culture in ponds. There are shortly to be published two papers by this author on the life history and fish-cultural significance of some of the insects most commonly present in fishponds.

A paper consisting largely of compilation and analysis of published European and American data concerning the culture of fresh-water crustaceans ("shrimp," etc.) as food for fishes in hatcheries and in ponds was completed during the year by Dr. W. C. Kendall and submitted for publication. It is believed that the culture of some kinds of crustacea as food for fish would be economically feasible under certain conditions, depending much upon locality and the immediate surroundings of a particular fish-cultural plant.

A service of no little importance was rendered when Dr. Emmeline Moore, who has conducted several investigations for the Bureau, was detailed to visit some of the fish-cultural stations and advise with superintendents regarding the best use of plants in fishponds. Against what might have been assumed to be obvious handicaps, the advice of this investigator quickly established itself in the confidence and esteem of practical fish-culturists. Her work commanded such attention that her services were drafted by a State Government which could offer more favorable conditions of employment than this Bureau.

The greatest need in the fish-cultural experiment work of the Bureau is continuity and the application of persistence, skill, and judgment, and this need can be met only by the making of the special provision of personnel which the conditions may be found to warrant.

STUDIES OF DISEASES OF FISH.

Closely related to fish-cultural experimental work is the study of the diseases of fish and the conditions which occasion mortality or diminished vitality of fishes. The parasites of fishes also demand attention, not only because of their unfavorable effect upon the vitality of the fish but because the presence of parasites, even such as are not injurious, renders fish less attractive to the consumer and accordingly diminishes the market value of the fish. Diseases of fish are of real concern from an economic point of view, not only for the resulting direct losses to food supply but for the mortality of eggs, fry, or fingerling in hatcheries, which causes serious losses in efficiency and entails a substantial loss of public funds expended in fish-cultural operations. As a matter of fact, fish pathology is a broad subject, for the studies of pathological and other unfavorable conditions throw light upon the various fish-cultural practices and especially upon the propriety of use and the value of the several sorts of foods employed in artificial feeding.

The routine work of the fish pathologist, Dr. Franz Schrader, included investigation into reports of fish mortalities in various parts of the country, examination of specimens sent to the Bureau for the determination of the cause of disease or death, and trips to the stations in connection with epidemics among fish or unsatisfactory conditions among fry.

An analysis of the so-called white-spot disease in fish eggs has been virtually completed. It is apparent that the ordinary occurrence of this disease finds its cause in careless handling of the eggs, be it in the course of stripping or during transportation. Bacterial agency is not primarily responsible in causing white spot as it is commonly seen during hatching operations, and European observers who have reported it seem to have had exceptional cases. Mention may be made of a still different form of the disease in Alaska, of which only superficial investigation has been made.

Work was started on the study of ovarial conditions in various fishes, especially at time of spawning. It is this phase in the various activities of fishes which bears directly on the problems of sterility, production of "glassy" ova, hardening of ovaries when retained in pens or crates, and effect of stripping. The nature of the problem makes the work on it more or less sporadic.

The troublesome question of the great mortality in hatching pike-perch eggs is under investigation at present. A visit was made to Swanton, Vt., at the time of spawning, to observe conditions in the field. In spite of the fact that the problem is an old one, it seems that no definite analysis of the morphological features of affected eggs has ever been made. Consequently the few remedial measures employed have been of little or no advantage. The essential studies are now in progress.

FISH DISEASE IN ST. LAWRENCE RIVER.

While mortality of fish in natural waters as a result of disease is not usually conspicuous, nevertheless there are occasions when such occurrences demand attention. An investigation of an epidemic among the fish in the St. Lawrence River at Ogdensburg, N. Y., was made during the first week in July, by Prof. H. S. Davis, temporary investigator. The superintendent of a New York fish hatchery had reported that large numbers of fish were dying in the ponds and also in the river.

The epidemic was at its height during the first two weeks in June and then decreased rapidly in severity. At the time of the investigation the disease had entirely disappeared from the ponds and only a few diseased fish were taken in the river. None of these appeared to be seriously affected.

The fish taken in the river showed two distinct types of lesions on the skin. On the bullheads and catfish the infected areas were very distinct, about one-half to 1 inch in diameter and bright red in color, due to the complete destruction of the epidermis, thus exposing the inflamed dermis beneath.

The diseased areas in the skin of bass and suckers had a very different appearance. They were irregular in shape and so indistinct as to attract attention only on close examination. The most marked characteristic was a faint reddish border around the scales, due to a slight extravasation of blood into the epidermis.

A microscopic examination of sections of skin from the infected areas indicates that the disease in bullheads and catfish is probably distinct from that in the bass and suckers. In the former the disease is apparently due to bacteria, which are present in enormous numbers in the disintegrating epidermis. These bacteria are not present in the lesions on bass and suckers, and the cause of this affection is at present problematic. A further report may be made.

LINSEED MEAL A CAUSE OF TROUT DISEASE.

Some time ago a peculiar disease appeared at a commercial trout hatchery in Rhode Island among yearling and 2-year-old brook trout. The fish turned black, many became blind, and large numbers died. Just previous to death an affected fish would dart rapidly about, sometimes jumping entirely out of the water. After swimming nervously in this way for a few seconds, the fish would usually turn partly on its side, remain quiescent for an instant, and then resume its former unnaturally sluggish swimming. In most cases the fish would repeat this performance several times before finally succumbing.

Dr. L. H. Almy, then fish pathologist in this Bureau, was detailed to an investigation of the trouble. It was learned that the disease had manifested itself a few weeks after the superintendent had begun feeding with a mixture of linseed meal, wheat middlings, and meat scraps, the linseed meal having been substituted for cottonseed meal previously used. When the meat scrap, with flour and salt, was used without the linseed meal, the disease was definitely checked in both adult fish and fry. Experiments planned by the fish pathologist were then undertaken at the same hatchery to ascertain which, if either, of the two meals had brought on the disease. The results, which were but recently completed for publication, proved that linseed meal was responsible for the pigment change, blindness, and death; that linseed oil in the food of trout has a slightly injurious effect; and that fish affected with linseed-meal poisoning can be brought back to a healthy condition, except for the pigment change and blindness, by a diet of some fresh-meat product.

Further experiments conducted at the White Sulphur Springs (W. Va.) hatchery of the Bureau, with the cooperation of Supt. R. K. Robinson, gave clear evidence that the pigment change, excitability, and weakened eyesight or blindness, were due primarily to the prussic-acid constituent of linseed meal. The experiments indicated also that a food mixture consisting of wheat middlings and meat meal, although not injurious and apparently an acceptable food for the fish, does not compare with fresh hog lungs as a food for yearling trout.

SERIOUS DISEASE OF BUFFALOFISH.

A new bacterial disease of fresh-water fishes has been under investigation during the last two summers by Prof. H. S. Davis, temporary investigator. This disease seems to attack nearly all species of fresh-water fishes, but is especially destructive to the buffalofishes, crappies, and bluegills. It is preeminently a warm-weather disease and is apparently of little importance during the colder seasons of the year.

The disease is caused by an undescribed species of bacterium which develops only on the surface of the body and on the gills. On the body it destroys the skin, but never penetrates into the underlying muscles, while on the gills it destroys all the soft tissues. In either case the fish usually succumb within 48 to 72 hours after the appearance of the disease.

The disease does not ordinarily attack healthy or uninjured fish, but even a slight injury or the lowering of the vitality in any way renders the fish susceptible to infection. Fish are especially liable to contract the disease within a day or two after being handled.

It has been found that the disease can ordinarily be controlled by treating the fish after they have been handled with a 1 to 1000 solution of copper sulphate for two to three minutes. When properly used it has been found possible to reduce the loss from this disease from about 50 per cent to 5 per cent or less.

Studies on protozoan parasites of fishes have been continued and a paper is nearly ready for publication describing the development of the cysts and the formation of spores in a species of Myxobolus which is abundant on the gills of the buffalofishes. The early development of the myxosporidian cysts has not previously been worked out. It has been found that the young parasites reach the gills in the blood stream and become permanently fixed in the capillaries of the gills, where they develop into large, saclike cysts, which may cause considerable injury to the gills. The results of studies on several other species of myxosporidian parasites, several of them new, are also nearly ready for publication.

BLACK-SPOT DISEASE OF THE BULLHEAD.

A conspicuous and unsightly disease of the common bullhead or hornpout (*Ameiurus nebulosus*) became very evident in a pond near Falmouth, Mass., in the summer of 1917. The matter having been brought to the attention of the Bureau, and no information regarding a disease of this description being available, Prof. Raymond C. Osburn was engaged as a temporary investigator for a study of the disease.

The disease takes the form of swollen, rough, tumerous, intensely black areas, affecting the skin externally ordinarily, but sometimes entering the mouth cavity and the gill chamber. The subcutaneous tissues are but little affected, the disease being confined almost entirely to the skin, and there is no evidence of spread to other parts of the body. The tumors appear to grow very slowly, but there is evidence that they are infectious, for in 1919 the percentage of infected fish taken in the pond was much greater than in 1917, and nearly all the bullheads taken showed the disease.

Careful study and experimentation proves the disease to be of bacterial origin, the causative organism being a very minute coccus, or bacterium of that general class, probably undescribed. The disease appears to be unknown to science and a widespread inquiry has brought out only the information that no one has ever observed it. The one exception in the literature is found in Thoreau's Journal, where he twice makes mention of observing such black tumors on bullheads in the Concord River and one of its branches.

With the cooperation of Dr. W. W. Browne, bacteriologist, cultures of the bacteria were made on agar mixed with the juices of the fish to produce a proper medium. Though the bacteria grow very slowly, a number of colonies were developed to a diameter of one-eighth of an inch or more in from 12 days to 2 weeks. These had the same intensely black color as the tumors. The color is produced endogenously, and the color of the tumors is due entirely to the mass of black bacteria. In older tumors a slight pressure causes the liberation of an inky black fluid, formed by the bacteria in suspension, and microscopic sections show the presence of the bacteria throughout the substance of the tumor.

Inoculations of unaffected fish from another pond were made in three ways: (1) by subcutaneous injection, (2) by abrading the skin and rubbing in the fluid taken from a tumor, and (3) by grafting portions of the tumor into the skin. Several of these developed and showed some growth in the two months that the fish were kept under observation.

It seems probable that natural infection takes place through abrasions of the skin, as the tumors are usually located on the fins and lips where such abrasions would more naturally occur accidentally. The habits of the bullheads in schooling together render this mode of transfer easy.

As to the fatality of the disease we have no information. Certainly it is not rapidly fatal, for specimens with well developed tumors were kept alive in aquaria in the laboratory for six weeks without showing any appreciable change other than some slight growth in area and thickness of the tumor. It would thus appear that no active systemic poison or toxin is formed by the bacteria. There is, however, a tendency for the tumors to become fungused with *Saprolegnia*, a water mold, which would no doubt cause death in time if the tumor did not. While dead catfish have not been observed about the pond, the shores are such that they would not readily be noticed. No other species of fish in the pond showed any indication of the tumors, and the probability is that the disease is specific for the bullhead.

GENERAL STUDY OF PARASITES OF FISHES.

Systematic studies of the parasites of fishes are important for several reasons. While the presence of some parasites is a normal condition in fishes as well as in domestic animals, such as cattle, sheep, and poultry, they may upon occasion become so numerous as to cause the weakening or death of the animal infected. When not leading to death they may yet so affect the condition or appearance of the fish as to render them unacceptable to the housekeeper, which means the loss of the fish as a possible article of food. In cases of this kind, and they occur not infrequently, one can not approach the question of cause or remedy or give proper advice to the public unless there is a background of knowledge concerning the normal degree of prevalence of different kinds of parasites in the several species of fish. It is economically necessary, then, that observations of parasites should be made systematically and a large body of evidence obtained. Dr. Edwin Linton's studies in recent seasons have covered about 40 species of fish in the region of Woods Hole, Mass. Attention is being devoted now particularly to the round worms (nematodes). The fear has been felt that round worms, which occur on the viscera of certain fish and not normally in the edible parts of the fish, might during storage of the dead fish burrow into the flesh of the fish and thereby become objectionable. The experiments conducted indicate that the worms do not penetrate the flesh or become attached to it in such a way as not to be removable by the ordinary process of washing.

In this connection reference may be made to the studies of the food of young fishes conducted by the same investigator and applying to 18 species of fish of the Woods Hole region.

THE OYSTER.

The eastern oyster supports the most valuable fishery possessed by any country and based upon a single species; but, important as the oyster industry is in contribution to food supply as well as in its part in the economic life of the Nation, its future can be viewed only with keen anxiety. For some years the industry has been manifestly declining. In past times its chief seats have been on the south shores of New England and New York and in the Chesapeake Bay. During a long period the yield of the Chesapeake has gradually fallen away because of the depletion of natural beds and the misfortunes which have attended all attempts to establish a proper legal basis for the development of a great oyster farming industry. In waters of the vicinity of Long Island oyster farming has long been established on a large scale, but in recent years, and because of conditions which are not yet fully understood, there has been a notable failure of the setting of seed. The planting industry now depends to a very considerable extent upon the importation of seed oysters from distant points; and the expense and the uncertainties are such that leases of oyster bottoms are continually being given up, with consequent loss of revenue to States, as well as diminution in the production of a valuable article of food. The problem of the failure of set has therefore become one of great concern to State Governments as well as to the Nation. It is, however, one of great complexity and may well receive the best attention of all concerned.

There are oyster industries in Pacific Coast States which are now of no little importance and which may have much greater significance in future. It is, therefore, a cause for regret that the limitations of personnel and appropriations have prevented the Bureau from giving to these the attention which they merit.

OYSTER INVESTIGATIONS IN LONG ISLAND SOUND.

At the temporary field laboratory at Milford, Conn., Dr. E. P. Churchill and J. S. Gutsell, scientific assistants, continued the investigations relative to the propagation of oysters. R. V. Truitt, temporary assistant in oyster studies, was engaged in that laboratory for a part of the summer, but spent the greater part of the season in a preliminary reconnoissance of the Chesapeake Bay with reference to oyster culture. The conditions prevailing in the vicinity of Milford were in contrast to those in Great South Bay, Long Island, mentioned on another page. Water samples (usually 50 gallons at a time) were collected in various localities from June 16 to September 10, and, although 215 such samples were examined, only 303 oyster larvæ in all were encountered. Four of the samples yielded 250 of these larvæ, 23 other samples gave small numbers (from 1 to 8), and 188 were barren. (In Great South Bay, on the other hand, several thousand larvæ were sometimes found in one sample.) There being no larvæ, there was, of course, no set.

The virtual absence of free-swimming oyster larvæ from the Milford region is believed to be due to the low temperature of the water, which may have prevented either the fertilization of the eggs or the development of those that were fertilized. The larvæ found were all of the smallest sizes. The bottom temperature, where the water was 20 feet or more in depth, registered as high as 70° F. on only one occasion. For the remainder of the time during the usual spawning season of oysters, it ranged from 65 to 69.5° F., being usually about 68. Oysters in this region are found to begin spawning at a temperature between 68 and 70°. It was observed that oysters in the deeper water did not spawn until about the middle of August, the process continuing slowly and in patches over the beds during the rest of the month. Some of the oysters apparently gave out no spawn at all.

While the shallower water of the coves and harbors warmed up earlier than that outside, and the oysters there spawned earlier, the incoming tide was so cold this season as materially to affect the inside waters, and oyster eggs or larvæ carried from the shallow waters doubtless perished in the cold water outside. In any event, and corresponding with the absence of free-swimming larvæ, as noted, no set of oysters was found or reported anywhere in Long Island Sound.

As emphasized in the report covering the season of 1918, the best evidence obtainable indicates that in former years the set was produced in favorable seasons by natural inshore beds of oysters in warm waters where spawning occurred relatively early. All are agreed that such beds are largely exhausted. The result of the Bureau's investigations tends to substantiate the view that the securing of set in commercial quantities on planted beds, even during favorable seasons, is contingent upon the restoration of the natural beds in inshore waters. Acting upon suggestions to this effect previously offered by the Bureau, the State of Connecticut has appropriated $10,000 for building up the spawning beds, and the results of this practical experiment may be awaited with interest.

WATER POLLUTION AS AFFECTING GROWTH AND BREEDING OF OYSTERS.

It is the inshore waters which are most directly affected by pollution from sewage and industrial wastes, but indirectly the pollution may have a still more significant economic effect on offshore beds even though none of the polluting substances actually touch these beds. It must be remembered that oyster larvæ are free-swimming and may be borne by currents for some distances. The beds in deeper waters are not necessarily self-perpetuative, but may well have been reseeded in former times by set arising from larvæ borne in the waters from breeding oysters in shallow waters. Our observations have indicated, first, that successful propagation of oysters in the Long Island region is dependent upon early spawning, which allows time for development to an advanced and resistant stage before cool weather; second, that this in normal years may occur only in the warmer waters; and thirdly, that spawning beds in shallow waters have virtually disappeared, partly in consequence of excessive fishery, but principally because the excessive pollutions have led to the general abandonment of such areas for oyster planting.

Consequently, in approaching the vital problems of the oyster industry of this region it is impossible to escape attack upon the question of pollutions. Here both chemical and biological problems are involved. The analytical chemist ascertains what substances of possible toxic nature are discharged into the waters; the biologist must determine by experiment the effects of such substances upon the existence and growth of oysters and their efficiency in breeding, and must find the precise degree of concentration which is injurious; finally, the engineering chemist must discover how such substances may be either eliminated altogether from effluents or at least kept within the bounds of safety as indicated by the biologist.

Such investigations by analysis and experiment are now being prosecuted by the Bureau of Fisheries in cooperation with the Bureau of Chemistry, and probably something of a more definite and satisfactory nature may be embraced in a subsequent report.

EFFECTS OF LOWERED OXYGEN SUPPLY UPON OYSTERS.

While the investigation of the subject of pollution as affecting oysters is one of some complexity, it is known that one of the most immediate effects of pollution, generally speaking, is the reduction of the oxygen content in water. During the summer of 1919 an investigation was conducted by Dr. P. H. Mitchell, director of the Fisheries Biological Station at Woods Hole, Mass., to determine the effects of lowered oxygen content on the survival of oysters, the work being done in both field and laboratory.

Observations in the field were based upon a series of small plants of oysters in Seekonk River, a tidal estuary at Providence, R. I., and in Providence River, below the mouth of Seekonk River. Determinations of the dissolved oxygen in the water at the locations selected were made at various times and under various tidal and weather conditions. The results indicated a substantial mortality of oysters where the average dissolved oxygen content was 26 per cent of saturation or less and nearly all oysters died within a period of 50 days where the percentage of saturation was less than 12.

Observations in the laboratory were conducted by keeping oysters in small containers furnished with sea water of varying oxygen content and subject to as definite control as possible. The results indicated that the minimum oxygen content of water that will sustain oysters during a period of one month is between 25 and 33 per cent of saturation. Further experiments are planned to determine the effect of lowered oxygen supply upon the propagation of the surviving oysters.

Another series of experiments has substantiated the earlier findings of copper storage as the explanation of the appearance of a bluish-green color, and recent results point to a possible significant relation between the development of the undesirable blue-green spots and the deprivation of oxygen.

OYSTER INVESTIGATIONS IN GREAT SOUTH BAY.

Dr. Churchill and Mr. Gutsell completed a report upon the spawning of oysters and setting of oyster larvæ in Great South Bay, Long Island. The conditions in this shallow bay offer a contrast to those of the deeper water of Long Island Sound, where low temperatures had prevailed and a failure of set occurred.

In Great South Bay the spawning season extended from about June 5 to July 17, the heaviest spawning occurring July 2 to 6, and the greatest abundance of larvæ being found from July 7 to 11. Spawning began about the time the water temperature reached 70° F., and proceeded briskly while it ranged from 70 to 76°, but slowed down or ceased when the temperature fell to 70 and 68°. When the water temperature rose to 75° and above, about July 2 to 6, the bulk of the spawn was thrown out within the course of two or three days. The approximate length of the free-swimming period was 12 to 14 days. Considerable mortality of the free-swimming larvæ followed a sudden lowering of water temperature or the severe agitation of the water by storms.

The investigation served to throw considerable light on the proper time of planting cultch and the best location of plants for catching a set.

OYSTER INVESTIGATIONS IN LITTLE EGG HARBOR, N. J.

Dr. T. C. Nelson, assistant biologist of the New Jersey Agricultural Experiment Station, completed during 1919 a six months' study of the food and feeding of oysters. While this work, carried on at Edge Cove, Tuckerton, N. J., was primarily State work, yet, since its beginning and continuity were made possible by the cooperation of this Bureau, a summarized account of the results attained is not out of place in this connection.

Studies of the food of oysters were conducted from a floating laboratory anchored directly over the oysters, making it possible to keep a continuous record of the temperature, density, and rate of flow of water, parallel with examination of the food content of oysters.

The results of the microscopic analyses indicate that minute animals may play an important part in the oyster's nutrition. Copepods, nauplius larvæ, ostracods, gastropod and bivalve veligers, round worms, rotifers, and protozoa were found in great numbers. As a typical case, the contents of the stomach of one oyster showed over 4,000 nauplius larvæ and 60 large copepods, besides many protozoans. That these crustaceans are digested was shown by the large number of skeletal parts found in the stomach and intestine.

To study the rate of growth, 1,000 oysters were tagged, weighed, measured, and put out on a fixed platform 1 foot above the bottom. In 130 days these oysters grew in some instances as much as 3 centimeters (1.2 inches), while the increase in weight for oysters 1 and 2 years old was from 40 to 60 per cent. The duration of feeding in the oyster was determined by levers led from the shell of an oyster lying on the bottom to an electrical recording instrument (chimograph) above. The oyster, under natural conditions, continued to feed from 19 to 20 hours out of every 24.

One result of the investigation of the oyster's food has been the demonstration of the large part played by organisms growing on the oyster's shell. On the shell of one oyster 5 inches long were found diatoms in number computed to be over 56,000,000. Oysters covered with external growths may be partly independent of the actual food content of the water flowing over them.

OYSTERS IN VIRGINIA WATERS ENDANGERED BY FUEL OIL.

In the early part of 1919 the escapement of fuel oil upon the waters of Hampton Roads so affected the condition and flavor of planted oysters as to make them unmarketable for a time and to cause substantial financial losses. In the latter part of 1919, in response to reports that fuel oil, presumably discharged from oil tankers, was again threatening the oyster beds in Hampton Roads, the Bureau detailed an assistant to cooperate with the Navy Department in an investigation of the matter. After consultation with the captain of the port and several oyster planters, and after inspection of the water of Hampton Roads, it was found that at that time oil was not being discharged into the waters in sufficient quantities to menace the oysters. Strict orders forbidding the practice had been issued some time previous by the captain of the port, and these were apparently being enforced in such a way as to obviate injury to the oysters.

There have, however, been several subsequent complaints, and, after repeated attempts to render assistance through investigation, the Bureau found it advisable to refer the matter to the Department of Justice, which has taken appropriate action for the institution of legal proceedings upon complaints properly filed with the local United States attorney. It is understood that some convictions have been secured.

OYSTER INVESTIGATION IN THE YORK RIVER.

The investigation of the poor condition of oysters prevailing in a section of the York River, Va., since 1914, was brought to a conclusion during the year. The oysters have been consistently poor and watery and very generally affected with blue-green spots. Examination of the food content of the water revealed a condition of relative sterility. A special endeavor was made to determine the validity of the local belief that the trouble originated from toxic chemicals discharged from an industrial plant located on the banks of the river. With the cooperation of the Bureau of Chemistry, observations were made at intervals over a period of nearly a year, yet nothing was found in the effluents from the mill which could materially affect the oyster beds in any direct way. The trouble appears to rest upon the deficiency of food supply, but neither the biological nor the chemical studies served to fix a specific cause for the lack of food. The condition is presumed to result from natural causes which are at present obscure and therefore beyond control.

REPORT ON THE OYSTER INDUSTRY.

In the course of the year there was completed and sent to press a report comprising for public information a full account of the present condition and practices of the eastern oyster industry, both as it is based upon the exploitation of public oyster beds and as it manifests itself in the various phases of commercial oyster culture.[a] The report

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[a] Churchill, E. P., Jr.: The Oyster and the Oyster Industry of the Atlantic and Gulf Coasts. Appendix VIII, Report, U. S. Commissioner of Fisheries, 1919, 51 pp. Washington, 1920.

is published in response to the frequent demands upon the Bureau for information of the character furnished by it.

FRESH-WATER MUSSELS.

The Bureau continued the propagation of fresh-water mussels and investigation of problems affecting the mussel industries. The number of glochidia infected upon fish and liberated in the public waters was substantially greater than in the preceding year, and the unit cost per thousand correspondingly lower. The results of artificial propagation are detailed in another report.[a]

EXPERIMENTAL WORK.

Notable results were obtained in the experiments conducted at the Fairport station in rearing young mussels. The methods of artificial propagation, as regularly practiced, consist in liberating the fish immediately after infection, so that cultural operations are not involved. In the effort to improve upon the established practices, experiments have been conducted during several seasons in retaining infected fish during a period of two or three weeks, until the juvenile mussels are liberated, and then holding the young mussels, which at first are of microscopic dimensions, until they have attained a size (say one-half an inch in length) permitting of their being handled with convenience and planted deliberately upon bottoms which are known to be suitable. Simple as the task is in the stating, peculiar difficulties are encountered, and its accomplishment had baffled all previous attempts in this country and elsewhere. Before the past year a measurable degree of success had been attained at Fairport with one species of mussel (the Lake Pepin mucket). During the summer of 1919, the experiments conducted by Dr. F. H. Reuling led to the rearing of two additional species (yellow sand-shell and river mucket) in considerable quantities in small troughs supplied with naturally clarified river water.

Experiments having a somewhat similar object were conducted in Lake Pepin by Roy S. Corwin, scientific assistant. Here young mussels originating from artificial infections were reared in considerable quantities within inclosures on the bottom of the lake in relatively shallow water. Other experiments conducted at this place gave indication that glochidia carried over in the marsupia from the preceding year endured a shorter period of parasitism than those taken from the marsupia in the same season in which the eggs were deposited.

Dr. L. B. Arey, of Northwestern University Medical School, investigated the relations of glochidia to host as regards attachment and encystment, and the results of his investigations have been submitted for publication in another place.

PROTECTION OF MUSSELS.

In January, 1920, at La Crosse, Wis., the Bureau participated with officers of the Wisconsin Conservation Commission and the Minnesota Fish and Game Commission and other interested persons

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[a] Smith, Hugh M.: Report, U. S. Commissioner of Fisheries, 1920. Washington, 1920.

in a conference relative to the protection of fresh-water mussels. Acting upon the authority provided by recent concurrent legislation, it was determined to close against commercial shelling for a period of five years certain sections of the Mississippi River bordering the two States represented in the conference. The purpose is to allow opportunity for natural recuperation of the beds and to create favorable conditions for the artificial propagation of mussels.

After several years of earnest effort by various persons and agencies, in which the Bureau of Fisheries has played a leading part, concurrent legislation for the protection of fresh-water mussels has been enacted in the four States which control the principal mussel-producing portions of the Mississippi River. It is hoped that the practical steps now being taken to give effect to that legislation will result in a marked recuperation of mussel beds which have been exhausted or seriously depleted.

PUBLICATION OF REPORTS.

In the course of the fiscal year there has appeared a document of the Bureau describing in detail the commercial fresh-water mussels, the implements and practices of the mussel fishery, and the machinery and methods of manufacture of buttons from the shells.[a] There has also been completed and submitted for publication a general account of the natural history and propagation of the mussels.[b] These papers are issued in response to a regular demand for the varied information contained in them, and with a view to disseminating such knowledge of the resources and industries and the conditions of their perpetuation as will stimulate the adoption of measures and practices whereby unnecessary waste may be avoided and the future, as well as the present, may be served.

OCEANOGRAPHIC AND LIMNOLOGICAL STUDIES.

WORK OF THE ALBATROSS.

The oceanographic and fishery work of the steamer *Albatross* had been entirely abandoned for the period of the war, and the vessel was engaged exclusively in the service of the Navy Department. Some changes in the vessel had naturally been made to adapt her to military service, but, before the return of the vessel, that department restored such features of plan and equipment as were desired by the Bureau. At the same time the Bureau, at its own expense, developed the fixed equipment of the vessel, so that she is now better fitted than ever before for fishing trials. The new equipment consists principally of a more powerful steam winch and other necessary fixtures for operating fishing trawls. There have also been purchased and placed upon the boat a series of otter trawls and other fishing gear.

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[a] Coker, R. E.: Fresh-Water Mussels and Mussel Industries of the United States. Bulletin, U. S. Bureau of Fisheries, Vol. XXXVI, 1917–18, pp. 11–89. Washington, 1919.

[b] Coker, R. E., Shira, A. F., Clark, H. Walton, and Howard, A. D.: Natural History and Propagation of Fresh-Water Mussels. Bulletin, U. S. Bureau of Fisheries, Vol. XXXVII, 1919–20. In press.

The greatest obstacle to the oceanographic work of the vessel has been the impossibility up to the present time of maintaining an adequate supply of dependable reversing thermometers for taking temperatures at varying depths. No American manufacturer is yet in position to furnish thermometers that meet the precise requirements for deep-sea work, and it is only after considerable delay that a limited number of satisfactory instruments have been obtained in London and Copenhagen.

The operations of the *Albatross* during the fiscal year covered two principal cruises. The first, beginning off Cape Henry at the close of October, 1919, extended as far as the Yucatan Channel in the south. The investigations aboard the vessel were directed by Mr. W. W. Welsh, scientific assistant. Biological and physical oceanographic stations were occupied on four sections across the Gulf Stream between Cape Henry and Key West; across Florida Strait, between Key West and Habana; from Habana to Cape San Antonio, at the western end of Cuba; across the Yucatan Channel to Cape Catoche; and from Cape Catoche to Dry Tortugas. Considering that the ship had been but recently placed in commission in the Fisheries Service, after having done duty in the Navy for two years, that much of her gear was new, and that practically her entire personnel was inexperienced in work of this character, her performance was regarded as satisfactory. The work is intended as a contribution to a scientific basis for fishery investigations by the ship during the next two years.

On February 18, after having undergone repairs at Baltimore, the *Albatross* sailed from Norfolk for Boston, to make headquarters for fishery and oceanographic investigations in the Gulf of Maine. On the trip to Boston she made three hauls with a 60-foot otter trawl in the vicinity of the 100-fathom curve, with the purpose of determining the occurrence of tilefish and other ground fish off the middle Atlantic coast. The results were negative. She also occupied a series of hydrographic stations on a line across Georges Bank. The vessel was engaged in the investigation of the Gulf of Maine until the latter part of April, after which she prosecuted a search for spawning haddock in Massachusetts Bay and returned to Baltimore to lay up for necessary repairs. This work was in continuation of investigations begun in the same waters by the *Grampus* in 1912, and is under the direction of Dr. H. B. Bigelow, of the Museum of Comparative Zoology, Cambridge.

The hydrographic and dredging records obtained on those cruises with all previous unpublished records of the vessel have been prepared for printing and will appear at an early time. The recent work of the *Albatross* in the Atlantic Ocean and Gulf of Mexico has been guided by the deputy commissioner, Dr. H. F. Moore, who will be able to coordinate many of the activities of this vessel with the observational work done under the International Ice Patrol Board, of which he is a member. Prior to the fall of 1919 the *Albatross* had not worked in the Atlantic since 1887.

SURVEY IN CHESAPEAKE BAY.

The biological and physical examination of the Chesapeake Bay, begun some years ago and interrupted by the conditions of war, has been resumed under the immediate supervision of Dr. R. P. Cowles as temporary investigator. The chief purpose is to determine the normal biological and physical conditions throughout the year. This done, there would then be normal data at hand from which to determine the abnormal conditions which bring about such serious mortalities of fish or oysters as have occurred in previous years. The survey should reveal all that is possible regarding the movements of layers of water of different densities, different temperatures, and different fish-food values, and should indirectly throw light upon the migrations of fish and crabs into or about the Bay. Special attention will be given to the "deep holes" and to the alleged barren bottoms at the mouths of rivers, and, through the collection of bottom deposits and the collaboration of the United States Geological Survey, information of value to geologists will be secured. In general the purpose is to gather as much as possible of the data which are essential for the conservation and development of the fisheries of this important body of water.

BIOLOGICAL AND PHYSICAL STUDIES OF INLAND LAKES.

The Bureau has continued to cooperate with the Wisconsin Biological and Natural History Survey in the studies of the fundamental conditions of inland lakes. The principal burden of these investigations is borne by the State, but it is not out of place to present here a brief statement of the status of the work, based upon a progress report submitted by President E. A. Birge and Mr. Chancey Juday. Bulletins on the plankton algæ, on gravimetric and chemical analyses of the plankton of the lakes in the vicinity of Madison, and on the bottom fauna in deeper water of Lake Mendota are now substantially or entirely completed. These reports comprise descriptions of many of the plankton elements and other units of fish-food supply, data regarding chemical composition (the basis of food value), and measures and computations of the quantities of the crops of organisms which maintain the productiveness of lakes in fish. Studies of the bacteria of Lake Mendota are in progress.

MISCELLANEOUS STUDIES.

REDDENING OF SALT FISH.

The salt-fish industry of the United States suffers a large annual loss as a result of the salt fish developing a red coloration when stored under moist conditions. Investigations conducted for the Bureau by Dr. W. W. Browne indicate that the development of the red coloration is due to the growth of two microorganisms, whose probable origin is the sea salt in which the fish are cured. This coloration may vary from a pale pink to a deep crimson. The pale pink coloration is produced as a result of the growth of a spirochete and the deep red by a bacillus form; these two organisms may, however, grow in such close harmony that the pigmentation may vary from a pale pink to red. It was formerly thought that the varied pigmentation was due to varied dilutions of the red pigment. The separation of the two organisms is very difficult owing to this close union.

The optimum concentration of salt for the growth of these microorganisms seems to be saturation. They grow well on heavily salted fish, brine, salt piles, and fish agar saturated with salt. No growth appears on media containing less than 15 per cent salt, by weight. Due to their sensitiveness to changes in density, staining of these bacteria for microscopical examination is very difficult. The morphology or shape of the organisms depends upon the concentration of salt in the medium, varying from the largest form (14–16 micra), found in heavily saturated media, to the spherical form (2 micra diameter) in media of 16 per cent concentration. Likewise all intermediate forms are present in the concentrations between 15 per cent and saturation. The amount, character, and pigmentation of the colonial does not seem to be affected by the varying changes in the concentration of salt.

The most favorable temperature for the growth of both the spirochete and the bacillus is between 50 and 60° C., indicating the salt lagoons of the Tropics as the probable source of the infection. Sunlight is not germicidal to these organisms, and this also points to their tropical origin, where the pigmentation is required as a protection against the bright sunlight; ordinary bacteria are killed by 10 minutes' exposure to bright sunlight. Influenced by age, by the accumulation of their own metabolic products, and particularly by low temperatures, both organisms suffer a temporary loss of pigmentation. During this loss the formation of the so-called "coccoid bodies" is noted in the pink spirochete. No change in the shape of the bacillus during the absence of pigment has been noted. After transplantation, both pigmentation and the regular vegetative form is resumed.

All results indicate that the causative agents of this troublesome and costly coloration have been discovered and that their original source is the solar evaporated sea salt in which the fish are cured. Both European and American sea salts are infected. Mined or domestic salt seems to be free of their presence. Any method devised for the elimination of this reddening of salted fish must be based upon either the proper disinfection of the sea salt before use or the substitution of mined or domestic salt which is free of infection. In either case a thorough disinfection of the salt fish plants and equipment is essential, since at the present time all are highly infected. It would be useless to dump sterilized salt or even mined salt into a highly infected plant or to bring unsterilized salt into a thoroughly disinfected plant.

With this knowledge of the life history of the organisms, the conditions essential for their growth, and the sources of infection, the Bureau already has under way experiments to determine the best and most practical means of eradicating a most troublesome factor from the salt-fish industry. During the entire series of experiments the Bureau has had the hearty cooperation of the salt-fish industries.

LOCATION OF FISH FROM AIRCRAFT.

In July, 1919, in cooperation with the Naval Aviation Service, W. W. Welsh, a scientific assistant in this Bureau with naval experience, made a flight at Cape May, N. J., to determine the possibilities of scouting for schooling fish with the aid of aircraft. The results of this trial were very favorable, but, since the development of the method and its application to the fisheries lies properly within the sphere of activity of another office of the Bureau, the further history of the matter does not pertain to this report.

JELLY FROM SEAWEEDS.

During last summer Prof. Irving A. Field conducted for the Bureau, in connection with the Woods Hole laboratory, investigations concerning the feasibility of deriving from marine algæ a gelatin suitable for use in the preservation of fish. The experiments of commercial packers have previously indicated that animal gelatins liquefied at such low temperatures that they could not be employed for this purpose. The jelly is not ordinarily used as a preservative in a strict sense, but as a medium in which the preserved fish are held and prevented from breaking to pieces in shipment.

Of all the algæ of the New England coast employed in the investigation only the Irish moss (*Chondrus crispus*) yielded gelatin—or, more correctly, gelose—in commercial quantities. It was found that Irish moss contained 79 per cent water and that the desiccated material was approximately 65 per cent gelose. The gelatinous extract from Irish moss is commonly known as "caragenin," but Dr. Field's experiments indicate that it is closely comparable to agar-agar. Agar-agar is made in Japan from another seaweed, *Gelidium corneum*, which is found to some extent on our Pacific coast and, in limited quantities, on the Atlantic coast.

The investigation developed provisional methods of preparation of caragenin, and a series of tests showed that 1¼ grams of the dried extract added to a 14-ounce can of fish was sufficient to form a firm jelly that prevented such soft fish as whiting and herring from breaking to pieces when subjected to the rough treatment of being transported 400 miles in the back of an automobile. The jelly in no way impaired the condition or the flavor of the fish. The preparation of the jelly in a form satisfactory for commercial uses remains to be investigated to a further stage. Other problems arising from the investigation relate to the decolorizing and purification of the jelly to adapt it for other possible uses. Experiments will also be made with other seaweeds from both coasts of the United States.

UTILIZATION OF FRESH-WATER TURTLES.

A relatively unutilized food resource is found in the several species of turtles of our fresh-water streams and lakes, notwithstanding that their near relative, the diamond-back terrapin of the sea coast (not to mention the highly prized green turtle of the ocean) is the greatest delicacy of the fish markets. In the endeavor to direct proper attention to this source of meat supply and to furnish the information requested by many correspondents, assistants were designated to investigate market and fishery conditions, particularly in the Mississippi Basin. The report by H. Walton Clark, scientific assistant, and J. B. Southall, shell expert, comprises information regarding the distribution and habits of the most useful species, an account of the seasons and methods of capture and marketing, and data concerning the preparation of the meats for use as food.[a] The report will

[a] Clark, H. Walton, and John B. Southall. Fresh-Water Turtles: A Source of Meat Supply. Appendix VII, Report, U. S. Commissioner of Fisheries, 1919, 20 pp. Washington, 1920.

undoubtedly serve a useful purpose in promoting the utilization of an available source of food and thereby will contribute to the prevention of waste of the Nation's food supply.

UTILIZATION OF FROGS.

The daily correspondence of the Bureau has indicated for a long time the widespread interest in frogs, their utilization and propagation, and their elimination from localities where they are not desired. Nevertheless the Bureau has not yet felt justified in diverting to experiments in frog culture facilities which are required for other useful purposes, especially in view of the extensive natural resources in frogs which are not now fully availed of. It has been deemed distinctly worth while, however, to acquire as full knowledge as possible of the useful species, their habits, conditions of life, breeding, life history, food, and enemies, as well as of the methods of capture employed. The report by Dr. A. H. Wright, temporary investigator, went to press during the year.[a] With this handbook the frog fisher or the prospective frog-culturist may readily identify the frogs in any stage—eggs, larvæ, tadpoles, or adults—and may be guided in the selection of environments for fishing or propagation.

THE BIOLOGICAL LABORATORIES.

The Navy Department having withdrawn from the Woods Hole (Mass.) station, the laboratory was reopened at the beginning of the fiscal year, with Dr. P. H. Mitchell as director. With a limited staff, investigations were pursued with reference to oysters (p. 21), gelatin from seaweeds (p. 29), the reddening of salt fish (p. 27), and the food and the parasites of fishes (pp. 19 and 18), the results of which have previously been indicated. Some experiments were also conducted by Dr. F. E. Chidester to determine some of the factors which influence the migrations of fishes and the behavior of fish in presence of certain chemicals. A miniature river system was employed, in which the fish were given a choice between two tributaries having water supply of different nature or current of different rates. It was found that the behavior of the fish varied according to season or condition of the animal, and particularly according to the rate of flow of the water; but—given a proper condition of stream flow, the first were repelled by some salts and attracted by others. The results will be published after further experiments are made.

The Beaufort (N. C.) laboratory, after occupancy by the Navy, since January, 1918, was turned over to the Bureau of Fisheries shortly after the beginning of the fiscal year. Since that time many necessary repairs and renewals have been made both by the Navy Department and by this Bureau. The date of the station's return prevented its opening on the usual scale for investigational work during the summer and fall. Small salaries have tended to making the personnel changeable and have prohibited the beginning of any broad investigational project. O. W. Hyman served as acting director during the summer and until the director, R. L. Barney, who was still

[a] Wright, A. H. Frogs: Their Natural and Utilization. Appendix VI, Report, U. S. Commissioner of Fisheries, 1919, 44 pp. Washington, 1920.

absent on detail, could be returned to duty at the station. The director and three assistants, each of the latter for short periods, have devoted themselves to the preparation of a comprehensive report of the results of the experimental work on the propagation of the diamond-back terrapin. Attention has been given also to a study of a bacterial disease of the winter-fed yearling terrapin of the experimental broods. One temporary investigator has been engaged in the study of the life histories of crabs of the Beaufort region.

At the Fairport (Iowa) biological station (A. F. Shira, director) a notable event of the year was the construction of the new laboratory authorized by the Congress to replace the former building destroyed by fire in December, 1917. The building which was nearly ready for occupancy at the close of the fiscal year is virtually fireproof, creditable in appearance, and admirably adapted for the purposes to be served. It contains laboratory space for all needs that are expected to develop in the near future. In all, $95,000 has been appropriated for construction and equipment, and, as the building cost about $83,000, there remained approximately $12,000 available for furniture and equipment, including the purchase of the necessary scientific apparatus and books. Before the close of the year sufficient equipment had been ordered to make it possible to occupy and use the building as soon as it could be accepted from the contractors.

The experimental work of the Fairport station in relation to fish culture (p. 13) and mussels (p. 24), the service in promoting the protection of mussels (p. 24), and the investigation of the utilization of turtles (p. 29) have been referred to. Field investigations were conducted in western Montana, where scattering mussels were found in the Musselshell River, though not in quantities permitting of commercial exploitation. Experiments were made in transplanting mussels to eastern waters. Progress was made in reporting upon the biological survey of Andalusia Chute, and an examination of portions of Lake Keokuk was undertaken. Studies, which were conducted at the station and not hitherto mentioned in this report, relate to the food of mussels (by H. W. Clark) and the acanthocephalid parasites of fishes (by Dr. H. J. Van Cleave).

At Key West, Fla. (S. F. Hildebrand, director), attention was devoted to construction and equipment of the biological station provided for that place. Owing to the lack of funds and the high cost and scarcity of material and labor only one permanent structure, a concrete water tower containing three tanks, was built. A small electric-light plant and two pumping units, one for salt and one for fresh water, were installed. Nets, glassware, and microscopes were added to the station's equipment for conducting investigations. The grounds were graded in part and improved by planting, and a metal flag staff was erected at a central and prominent point on the reservation.

The station was visited by a severe hurricane on September 9 and 10 which worked some damage to buildings and grounds and occasioned some expense in repairs to buildings and in regrading of grounds. It was not noticed that the storm had any effect upon the local fisheries, except that so many of the boats in the vicinity were wrecked that few fishermen were able to continue their occupation for some time; those that were able to go out obtained the usual catches.

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Many collecting trips were made and observations gathered regarding the life histories and habits of fishes. An attempt was made to build up a representative series of the local fish fauna for future reference. Several species were obtained which had not hitherto been recorded from the vicinity of Key West. Observations of the markets were regularly made and reported, and it was found that, regardless of the handicap occasioned by the hurricane which destroyed or damaged many fishing boats, the catch of fish during the fiscal year 1920 was greater than during the preceding year, the increase applying particularly to kingfish and Spanish mackerel.

Investigation of the spawning of the mullet, *Mugil cephalus*, was made in the vicinity of the Ten Thousand Islands in December and January, but, although both nearly ripe and spent fish were found in course of the investigation, definite information of the time, place, and manner of spawning was not forthcoming. Observations upon the spiny lobster were continued as long as was practicable.

Examination was made of the quahaug or hard-clam beds in the vicinity of the Ten Thousand Islands and many data were obtained in regard to the abundance of clams, the manner and methods of catching them, and their commercial utilization. The investigation revealed the presence of such extensive resources in clams in this vicinity that an economic circular was prepared and issued by the Bureau to the trade.[a]

All positions connected with the Key West station, except that of engineer, became vacant in the course of the year, and the scientific work was therefore brought to a close in February. Since that time the station has remained inactive and in the charge of the engineer as caretaker. Regular incumbents for the positions at this station, including that of superintendent, have been unobtainable through the Civil Service Commission.

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[a] Clam Resources of the Ten Thousand Islands, Fla. Economic Circular 46, 5 pp. Washington, 1920.

DREDGING AND HYDROGRAPHIC RECORDS OF THE U. S. FISHERIES STEAMER "ALBATROSS" 1911–1920

Appendix III to the Report of the U. S. Commissioner of Fisheries for 1920

DREDGING AND HYDROGRAPHIC RECORDS OF THE U. S. FISHERIES STEAMER "ALBATROSS," 1911-1920.

INTRODUCTION.

On October 16, 1907, the U. S. Fisheries steamer *Albatross* left San Francisco, Calif., en route to the Philippine Islands on a cruise which covered a period of over two and one-half years of scientific investigation, during which stops were made at Midway, Guam, the Philippines, Borneo, Pratas Reef, China Sea, Dutch East Indies, and Formosa. The ship returned to San Francisco on May 4, 1910. The dredging and hydrographic records of this expedition have been published in the Bureau of Fisheries document No. 741, 1910.

On July 9, 1910, after two months' overhauling and preparation, the *Albatross*, under the command of Commander Guy H. Burrage, U. S. N., left San Francisco, Calif., for Alaska on a cruise of inspection, carrying on board the Secretary of Commerce and Labor and the Attorney General. The trip ended on September 20, 1910, when the ship reached San Francisco Bay.

No active work was engaged in until February 23, 1911, when a biological investigation was made along the coast of southern and Lower California, the Gulf of California, and the Guadaloupe Islands under the direction of Dr. C. H. Townsend, acting director of the American Museum of Natural History of New York City. An important result of this investigation was the rediscovery of the northern elephant seal, *Macrorhinus angustirostris* Gill, which was supposed to be extinct, and the capture alive of six yearlings, some of which lived for a considerable time at the New York Aquarium. The vessel returned to San Francisco on April 29, 1911, after making a series of dredge hauls along the California coast.

With but two weeks of preparation the *Albatross* was sent to Alaska to investigate the halibut and cod banks lying along the coast. A. B. Alexander, assistant in charge of the division of statistics and methods, directed the work, and Capt. J. B. Joyce had charge of the fishing operations. The cruise was completed about the middle of September, at which time the ship reached San Francisco.

Owing to the fact that the *Albatross* was found to be in an unseaworthy condition, no work was attempted outside of San Francisco Bay until April 12, 1914; but meanwhile, from January 30, 1912, to April 22, 1913, a biological survey of San Francisco Bay was carried out. A preliminary report on the physical conditions of the bay was published in 1914.[a] The direction of the work was vested in a board composed of three members—the commanding officer of the *Albatross*, the naturalist, and Dr. C. A. Kofoid, representing the University of California.

After being thoroughly repaired and overhauled under a special appropriation the *Albatross* left San Francisco on April 12, 1914, to investigate the waters off the coast of Washington and Oregon, with the object of determining their extent and value as fishing grounds. Edward Driscoll was in charge of the fishing operations, which were

[a] A Report upon the Physical Conditions in San Francisco Bay, based upon the Operations of the U. S. Fisheries Steamer *Albatross* during the Years 1912 and 1913; by Francis B. Sumner, George D. Louderback, Waldo L. Schmitt, and Edward C. Johnston. University of California Publications in Zoology, vol. 14, No. 1, pp. 1-198, pls. 1-13, 20 text figs. Berkeley, 1914.

conducted by practical fishermen employed for the purpose. On June 12 the *Albatross* was sent to Alaska on a tour of inspection by Dr. E. Lester Jones, deputy commissioner, U. S. Bureau of Fisheries. The halibut investigation in the meantime was continued from the coast cities of Washington and Oregon by the naturalist, assistant, fishery expert, and the temporarily employed fishermen. The ship returned from Alaska on August 27, and from that time until the middle of September the investigations off the coast of Washington and Oregon were continued, after which the *Albatross* went to San Francisco.

On July 1, 1915, the *Albatross* left San Francisco Bay for Seattle to continue the halibut investigations off the coast of Washington and Oregon started during the summer of 1914. This work was discontinued September 9 on account of adverse weather conditions, the ship returning to San Francisco Bay.

From October 11, 1915, to April 4, 1916, the vessel was laid up in San Francisco Bay for lack of funds for operation, being thoroughly overhauled and repainted by the crew during the enforced delay. From April 4 to November, 1916, she was engaged in an investigation of the tuna fisheries off the coasts of southern and Lower California. On May 2, 1917, she underwent repairs at Mare Island Navy Yard, and on their completion in November she was transferred to the Navy for the period of the war. She continued in naval service, principally in the Gulf of Mexico and the Caribbean Sea, until June 23, 1919, when she was returned to the Bureau.

After being refitted at Baltimore for fisheries investigations, including the installation of a new double winch, gallows, and other necessary appliances for using otter trawls, she proceeded from the capes of the Chesapeake on October 30, 1919, for oceanographic research under the direction of W. W. Welsh, on the South Atlantic coast and in the Gulf of Mexico, returning to Baltimore about the middle of December. On February 16, 1920, she sailed for Boston to take up investigations in the Gulf of Maine under the direction of Dr. H. B. Bigelow. In addition to the work in that region the vessel occupied several stations between Cape Henry and Cape Cod en route to Boston, and again on her return to Baltimore, where she arrived May 20, 1920.

F. M. Chamberlain, naturalist on the *Albatross*, was transferred and appointed agent, Alaska salmon fisheries, on August 23, 1911. L. M. Tongue, fishery expert, was transferred and appointed storekeeper, St. Paul Island, Alaska, in September. He was replaced by E. C. Johnston. Dr. F. B. Sumner was appointed naturalist on December 16, 1911, and R. A. Coleman, captain's clerk, in January, 1912.

Commander Guy H. Burrage, U. S. N., was detached from the *Albatross* on May 25, 1912, leaving Lieut. L. B. Porterfield senior officer on board. Lieut. Commander H. B. Soule, U. S. N., took command on June 10, 1912, and remained until April 4, 1914. Waldo L. Schmitt was appointed naturalist on December 13, 1913, Dr. F. B. Sumner having resigned on October 31, and E. P. Rankin was appointed assistant. On April 4, 1914, Lieut. L. B. Porterfield, U. S. N., relieved Lieut. Commander H. B. Soule, U. S. N., as commanding officer.

The position of naturalist was made vacant by the resignation of Waldo L. Schmitt on December 31, 1914. E. C. Johnston received the appointment as naturalist on April 1, 1915, leaving the position of fishery expert vacant. F. P. Shafer became fishery expert in October, 1915. Lieut. L. B. Porterfield, U. S. N., was detached and

Lieut. Commander J. J. Hannigan, U. S. N., made commanding officer on July 1, 1915. Mr. Johnston resigned from the position of naturalist October 18, 1917, to enter military service and was succeeded by E. P. Rankin December 1, 1917.

On the return of the vessel to the Bureau of Fisheries, June 23, 1919, Lieut. Commander C. D. Cochran, C. G. S., was in command, and he was succeeded on October 24, 1919, by Commander L. J. Wallace, U. S. N. Mr. Rankin resigned from the position of naturalist July 15, 1920.

EXPLANATION OF TABLES.

In Bureau of Fisheries document No. 741 the last *Albatross* dredging station was D. 5672 and the last hydrographic station H. 4937. The accompanying list gives the station numbers and the various investigations conducted by the *Albatross* from that point to the present time.

Lower California (Gulf of California) cruise	D. 5673–D. 5699 H. 4938–H. 4953
Alaska, 1911	H. 4954–H. 4955
Biological survey of San Francisco Bay [a] (1912–13)	D. 5700–D. 5849 H. 4956–H. 5350
Biological survey of San Francisco Bay (March, 1914)	H. 5351–H. 5365
Halibut investigation, 1914	H. 5366–H. 5774
Halibut investigation, 1915	H. 5775–H. 6408
Atlantic cruise south from Norfolk, 1919	C20001 to C20040
Atlantic cruise north from Norfolk, 1920	C20041 to C20130
Atlantic cruises surface temperatures while under way, 1919–20	

Prior to 1919 those stations at which the main object was the collection of specimens by dredging or trawling were designated as "D" stations and those where hydrographic and plankton collection was the object as "H". stations. Beginning in 1919 a single series of numbers is used and the stations at which collections are made are designated by the prefix letter "C," as "C20001."

The "Position" of a station is that point occupied by the vessel at the beginning of a haul or set of observations as determined by the navigator and plotted by him on the chart. On the halibut cruises of 1914 and 1915 the bearings and distances were worked out from the chart after the stations, indicated by small circles, had been plotted in by the navigator. In view of the fact that a large per cent of the stations on these two trips were within sight of land and that runs inshore were frequently made to check up the bearings, the percentage of error is very small. All bearings are "true" unless otherwise indicated. The charts used were either U. S. Hydrographic Office or U. S. Coast and Geodetic Survey, as indicated.

Where two figures are given under the heading "Time of day," "Depth," and "Temperature," the first represents the beginning and the second the end of the series of observations. Where one figure is given, it represents the beginning of the series of observations. In the case of the halibut fishing trials the time at which the dories left and returned to the ship is given in the "Remarks" column.

Temperatures are recorded in degrees Fahrenheit. The air and surface temperatures, except where indicated by an asterisk, have been taken from the ship's log. Their accuracy is not to be relied upon to any great extent owing to the unfortunate placing of the thermometer casing near the stack and the fact that the ship's ther-

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[a] Loc. cit. in foot note on p. 3.

mometers have not been standardized. The bottom temperatures and those marked by an asterisk represent the corrected readings of tested Negretti-Zambra thermometers used in appropriate trip cases.

On the Lower California cruise, 1911, "Density" was determined by salinometer tests. "Salinity" determinations have all been made by titration with the standard outfit supplied by the International Council for the Exploration of the Sea.

The "Depth" of the "Trial" is that at which the gear was used, and under "Drift" are given the "Direction" and "Distance" through which the dredge was hauled. These are approximations. The "Duration" is the length of time consumed in towing the apparatus or the length of time allotted to a "set."

The current velocities given for stations H. 5351–H. 5365, inclusive, represent the readings of a Price current meter, which has been tested by the U. S. Bureau of Standards.

ABBREVIATIONS AND SYMBOLS.

The abbreviations and symbols used in the tables are listed below. For convenience the abbreviations used in describing the character of the bottom are listed separately.

9′ Ag. . . . . 9-foot Agassiz beam trawl, including one tail weight and two wing weights; three glass floats; and a 150-pound sinker above the bridle, unless otherwise stated.
12′ Ag. . . . . 12-foot Agassiz beam trawl, rigged as above.
Alb. smp. . . . . Albatross bottom-sampling apparatus. (Described on pp. 16–18, University of California Publications in Zoology, vol. 14, No. 1, pls. 12, 13. Berkeley, 1914.)
botm. . . . . bottom.
botm. net. . . . . frame, Welsh-Helgoland; net, strainer top, No. 10 silk bottom.
C. . . . . collecting station.
clsg. net. . . . . Bigelow frame, meter net, No. 000 top, No. 0 bottom.
80′ cod. . . . . 80-foot cod trawl, otter rigged.
C. S. . . . . U. S. Coast and Geodetic Survey.
D. . . . . dredging or trawling station.
19″ dr. . . . . 19-inch boat dredge. A fine-meshed net bag covered with a canvas bag, the mouth of which is held open by an iron frame 19 inches long by about 6 inches wide.
dyn. . . . . dynamite.
Ek. bot. . . . . Ekman reversing water bottle.
Ek. mtr. . . . . Ekman current meter.
Ek. smp. . . . . Ekman bottom-sampling apparatus.
El. sdr. . . . . electric (Weule) sounding machine.
30′ fldr. . . . . 30-foot flounder trawl, otter rigged.
75′ fldr. . . . . 75-foot flounder trawl, otter rigged.
GB bot. . . . . Greene-Bigelow water bottle.
H. . . . . hydrographic station.
Helgo. net. . . . . . . square frame of Helgoland; net, strainer top, No. 10 silk bottom; used as surface net.
H. O. . . . . U. S. Hydrographic Office.
Hvg. ln. . . . . heaving line and lead.
4′ inter. . . . . townet made of No. 000 silk, mounted on 48-inch metal ring.
Inter. sal. . . . . intermediate salinity.
Inter. temp. . . . . . intermediate temperature.
L. . . . . left thermometer (looking toward the instrument).
25-lb. lead. . . . . . }
28-lb. lead. . . . . . }
30-lb. lead. . . . . . } cone-shaped sounding lead armed with soft soap.
32-lb. lead. . . . . . }
35-lb. lead. . . . . . }
Lt. . . . . light.
Luc. sdr. . . . . Lucas sounding machine, including a 35-pound detachable iron shot, unless otherwise stated.

m. b............mud bag ("boat dredge") usually fastened to tail of net or trawl.
mtr. net.........1 meter diameter, 000-X top, 0-x bottom.
NZ.............Negretti & Zambra reversing thermometer.
o. p. dr..........regular commercial orange-peel bucket dredge.
oys. dr..........oyster dredge.
P. N. bot........Pettersson-Nansen insulating water bottle.
Pr. m............Price current meter.
P. S. #9..........Plotting sheet No. 9.
psc.............per standard compass, magnetic variation not having been applied.
R...............(in tables 1911–1915), right thermometer (looking toward instrument); (in tables 1919–20), Richter thermometer.
sdg.............sounding.
35′ shr. trl.......35-foot shrimp trawl, otter rigged.
Sigs. bot........Sigsbee water bottle.
Sigs. rod........Sigsbee sounding (bottom-sampling) rod.
5′ sldg..........5-foot Tanner beam trawl improved by attaching a broad wooden "shoe" to each runner to prevent the frame from sinking in mud too far.
snap. ld.........snapper-jawed sounding lead.
Sp. G............specific gravity.
subm. lt.........submarine light.
surf.............surface.
SV..............Schmidt-Vossberg thermometer.
tang............tangent.
therm...........thermometer.
3′ Tnr...........3-foot Tanner beam trawl, including float, tail weight, and sinker above the bridle.
5′ Tnr...........5-foot Tanner beam trawl, rigged as above.
9′ Tnr...........9-foot Tanner trawl on Agassiz trawl frame.
Tnr.-Blish sdr....Tanner-Blish sounding machine.
Tnr. cse..........Tanner reversing thermometer case.
Tycos...........Tycos Instrument Co. Fahrenheit thermometer, used in surface work.
vert. net.........½ meter diameter, No. 6 silk, used for vertical hauls except where otherwise stated.
wt..............weight.
#6..............½ meter diameter, No. 6 silk, surface tow net.
#10.............½ meter diameter, No. 10 silk, surface net.
#12.............plankton net, No. 12 bolting silk, mounted on 14-inch metal ring.
#20.............(in tables 1911–1915), plankton net, No. 20 bolting silk, mounted on 14-inch metal ring. (Lohmann, 1911, states that this number was changed by the manufacturers in 1907 to "No. 25 bolting silk.") (In tables 1919–20), 12″ diameter, No. 20 silk, surface net.

"CHARACTER-OF-BOTTOM" ABBREVIATIONS.

Material:
- C...............Clay.
- Co..............Coral.
- E. G............Eel grass.
- For.............Foraminifera.
- G...............Gravel.
- Glob............Globigerina.
- Lav.............Lava.
- M...............Mud.
- Mi..............Mica.
- Oz..............Ooze.
- P...............Pebbles.
- R...............Rocks.
- S...............Sand.
- Sh..............Shells.
- Shl.............Shale.
- Sp..............Specks.
- St..............Stones.

Descriptive adjectives:
- bk..............black.
- bl..............blue.
- bn..............brown.

Descriptive adjectives—Continued.
- brk..................broken.
- co...................coral.
- crs..................coarse.
- dk...................dark.
- fne..................fine.
- gn...................green.
- gran.................granular.
- gy...................gray.
- hrd..................hard.
- m....................muddy.
- med..................medium.
- pter.................pteropod.
- rd...................red.
- rky..................rocky.
- s....................sandy.
- sft..................soft.
- sh...................shelly.
- stk..................sticky.
- wh...................white.
- yl...................yellow.

DREDGING AND HYDROGRAPHIC RECORDS SECURED

Station number.	Position.	Chart.	Date.	Time of day.	Depth.	Character of bottom.
	Near boundary between Mexico and United States.	*H. O.*	1911.		*Fms.*	
D. 5673	3,782-ft. Cone (32° 18′ 30″ N., 116° 46′ W.), N. 42° E.; 4,900-ft. Cone (31° 36′ 30″ N., 116° 14′ 30″ W.), N. 82° E. (31° 26′ N., 117° 42′ W.).	1006	Mar. 1	6.11 a. m. to 10.30 a. m.	1,090	bl. and gy. M., few Glob.
	Guadaloupe Id., east coast, northern end.					
H. 4938	Black Rk., near North Pt., N. 89° W., 1.5 miles (29° 10′ 20″ N., 118° 15′ 45″ W.).	1681	Mar. 2	6.55 a. m.	0/300	....
H. 4939	Black Rk., near North Pt., N. 12° E.; Block House, S. 78° W. (29° 08′ 50″ N., 118° 17′ 50″ W.).	1681	...do.....	7.55 a. m.	290	hrd...............
H. 4940	Elephant Rk., S. 23° W.; Cone on N. side of Id., S. 71° E. (29° 09′ 30″ N., 118° 23′ W.).	1681	...do.....	9.10 a. m.	110	....
H. 4941	Elephant Rk., S. 18° W.; Cone on N. side of Id., N. 75° E. (29° 09′ N., 118° 23′ 20″ W.).	1681	...do.....	9.25 a. m.	30	crs. bk. S.........
H. 4942	Elephant Rk., S. 1° W.; Cone on N. side of Id., N. 65° E. (29° 08′ 40″ N., 118° 24′ 10″ W.).	1681	...do.....	9.50 a. m.	27	.....do...........
H. 4943	Elephant Rk., S. 40° E.; Cone on N. side of Id., N. 60° E. (29° 08′ N., 118° 24′ 30″ W.).	1681	...do.....	10.05 a. m.	31	.....do...........
H. 4944	Elephant Rk., N. 46° E.; Steamer Pt. Rk., S. 11° E. (29° 06′ 50″ N., 118° 25′ W.).	1681	...do.....	10.25 a. m.	58	gy. S., Sh.........
H. 4945	Elephant Rk., N. 17° E.; Rk. at Steamer Pt., S. 7° E. (29° 06′ 20″ N., 118° 24′ 30″ W.).	1681	...do.....	11.00 a. m.	42	crs. bk. S.........
H. 4946	Midway between point at Elephant Rk. and Steamer Pt. Elephant Rk., N. 6° E.; Rk. at Steamer Pt., S. 21° E. (29° 04′ 50″ N., 118° 24′ W.).	1681	...do.....	11.30 a. m. 2.00 p. m.	25 12	.....do...........
....	East side of Id.............	....	...do.....	morning..	....	....
....	North of first party.........	....	...do.....	..do......	....	....
....	Midway between point at Elephant Rk. and Steamer Pt.	1681	Mar. 3	night......	....	....

DURING THE LOWER CALIFORNIA CRUISE, 1911.

Temperature.			Density.		Apparatus.	Trial.		Drift.		Remarks.
Air.	Surf.	Botm.	Surf.	Botm.		Depth.	Duration.	Direction.	Distance.	
°*F.* 56 58	°*F.* 56 58	°*F.*	....	....	Luc. sdr.; Sigs. rod; Sigs. bot.; NZ.; Tnr. cse.; 12′ Ag.; m.b.	botm...	*Min.* 28	NE.......	*Mi.* 0.2	NZ #104914. Cable out 2,240 fms. Sp. G. (*surf.*) 24.2 at 15° C., (botm.) 25.0 at 13.8° C. Botm. therm. failed to trip. One bridle stop parted.
58	59	......	....	....	Tnr.-Blish sdr	300 fms.	......	....	.....	Guadaloupe Id. North Pt. appears to extend about 1 mile too far eastward from tangent bearing of east coast and patent log run on north side of Id. Reference made to position of North Pt. as given on chart 29° 10′ 50″ N., 118° 17′ 30″ W.
61	59	......	....	....	.....do........	botm...	......	....	.....	
63	59	......	....	....	.....do........	...do....	......	....	.....	
63	59	......	....	....	.....do........	...do....	......	....	.....	
64	59	......	....	....	.....do........	...do....	......	....	.....	
64	59	......	....	....	.....do........	...do....	......	....	.....	
64	59	......	....	....	.....do........	...do....	......	....	.....	
66	60	......	....	....	.....do........	...do....	......	....	.....	From this position groups of seals on the beach bore S. 75° E. and S. 48° E.
66 63	60 61	......	....	....	hand lead-line	...do....	......	....	.....	Rock at Steamer Pt. and Rt. Tang. Inner Id. in line.
....	.....	......	....	....	....	....	......	....	.....	Shore party collected various land and marine fauna and flora.
....	.....	......	....	....	....	....	......	....	.....	Shore party collected elephant seals.
....	.....	......	....	....	subm. lt......	surf....	......	....	.....	Worms, eels, and fish were taken.

DREDGING AND HYDROGRAPHIC RECORDS SECURED

Station number.	Position.	Chart.	Date.	Time of day.	Depth.	Character of bottom.
	Guadaloupe Id., east coast, northern end—Continued.	*H.O*	1911.		*Fms.*	
H. 4947	Rk. at Steamer Pt., S. 21° E.; Rt. Tang. Inner Id., S. 23° E. (29° 30′′ N., 118° 24′ 30′′ W.).	1681	Mar. 4	4.08 p. m.	89	hrd
H. 4948	Elephant Rk. and Rk. at Steamer Pt. in line, N. 2° W.; Rt. Tang. Inner Id., S. 22° E. (28° 59′ 30′′ N., 118° 25′ 50′′ W.).	1681	...do.....	4.12 p. m.	0/250	
H. 4949	Elephant Rk. and Steamer Pt. in line, N. 4° W.; Rt. Tang. Inner Id., S. 21° E. (29° 01′ 15′′ N., 118° 23′ W.).	1681	...do.....	4.20 p. m.	226	fne. gy. S
H. 4950	Steamer Pt., N. 26° W.; Rt. Tang. Inner Id., S. 21° E. (29° 01′ 15′′ N., 118° 22′ 50′′ W.).	1681	...do.....	4.43 p. m.	138	.....do
	.....do		...do.....	all day		
	Between San Diego, Calif., and San Benito Id., Mexico.					
H. 4951 D. 5674	3,782-ft. Cone, N. 22° E.; Bluff Peak (1,450 ft.), N. 78° E. (31° 28′ 45′′ N., 117° 09′ 50′′ W.).	1149	Mar. 8	6.04 a. m. to 8.37 a. m.	540	gn. M., fne. S., Glob.
	W. San Benito Id. S. side (anch.).		Mar. 9	a. m	13	S., G., R
	SE. Pt. W. San Benito Id., S. 62° W.; NE. Pt., N. 34° W.		...do.....	p. m	13	
	Cerros Id.					
	South Bay (anch.); Prominent Black Rk., N. 58° W.; Rk. ½ mile E. of latter, N. 19° E.		Mar. 10	all day		
	S. part of E. side (anch.); E. Tang. Cerros Id., N. 26° E.; Morrow Redondo Pt., S. 5° W.		Mar. 11	...do		
	Middle of E. side (anch.); E. of 1,808-ft. Peak, Lat. 28° 13′ N.		Mar. 12	...do		S., R., G
	Lower California.					
	Port San Bartolome (anch.); Coffin Rk. S. Tang., S. 65° W.; Entrance Rk., N. 68° W.		Mar. 13	all day		M., S., G
	.....do		Mar. 14	...do		.....do
	San Cristobal Bay.					
	San Cristobal Bay (anch.); Morro Hermoso Pt., N. 59° W.; San Pablo Bluff, S. 10° E.		Mar. 15	a. m	7	
D. 5675	San Pablo Pt., N. 33° E.; Asuncion Pt., N. 87° E. (27° 07′ 08′′ N., 114° 33′ 10′′ W.).	1310	...do.....	2.08 p. m. to 3.28 p. m.	284	gn. M., fne. S
	Lower California.					
	San Roque Id. (anch.): NE. end of Id., S. 68° E.; W. end of Id., S. 10° W.		Mar. 15	all day		
	Abreojos (anch.): Abreojos Pt., S. 73° W.; 312-ft. Hill, N. 08′ W.		Mar. 16	...do	6	

DURING THE LOWER CALIFORNIA CRUISE, 1911—Continued.

Temperature.			Density.		Apparatus.	Trial.		Drift.		Remarks.
Air.	Surf.	Botm.	Surf.	Botm.		Depth.	Duration.	Direction.	Distance.	
°F.	°F.	°F.					Min.		Mi.	
60	60	...	...	...	Tnr. Blish sdr.	botm...	...	...	...	
60	60	...	...	...	...do...	250 fms.	...	...	...	
60	60	...	...	...	...do...	botm...	...	...	...	
60	60	...	...	...	...do...	...do...	...	...	...	
...	...	...	...	...	...	...	...	...	...	Sealing party.
60 61	58 59	39.4	...	...	Luc. sdr.; Sigs. rod; Sigs. bot.; NZ; Tnr. cse.; 12' Ag.; m.b.	botm...	24½	N. 49° W..	2.4	Sdg. register read —50 at arrival of wt. at machine. Sigs. bot. failed to work. Cable out 1,300 fms. Sp. G. (surf.) 24.3 at 15.3° C.
...	...	...	...	...	seine...	...	...	...	...	Shore collecting. Seining party.
...	...	...	...	...	...	...	...	...	...	Shore collecting.
...	...	...	...	...	...	...	...	...	...	Shore collecting.
...	...	...	...	...	...	surf., 10 ft., 20 ft.	...	...	...	Do.
...	...	...	...	...	hand line; 19" dr.; 8' Tnr.; seine.	botm., 10 ft.	...	...	...	Shore collecting. Seining.
...	...	...	...	...	3' Tnr.; seine.	botm., 5 ft.	...	...	...	Shore collecting. Seining.
...	...	...	...	...	3' Tnr.; seine; sub. lt.	surf., 4 feet, botm.	...	...	...	Do.
...	...	...	...	...	...	...	...	...	...	Sealing party.
67	64 63	44.6	...	...	Luc. sdr.; Sigs. bot.; 12' Ag.; m. b.	botm...	20	S. 50° W..	.7	Sigs. bot. used in sounding. Cable out 600 fms.
...	...	...	...	...	...	...	...	...	...	Shore collecting.
...	...	...	...	...	seine...	6 ft., 10 ft., botm.	...	...	...	Ballenas Bay. Shore collecting. Seining.

Station number.	Position.	Chart.	Date.	Time of day.	Depth.	Character of bottom.
	Between Ballenas Bay and Santa Maria Bay.	*H. O.*	1911.		*Fms.*	
H. 4952 D. 5676	25° 31′ 15″ N., 113° 29′ 30″ W.	1493	Mar. 17	8.09 a. m. to 9.58 a. m.	645	gn. M., fne S., Glob.
H. 4953 D. 5677	25° 23′ 45″ N., 113° 16′ W.	1493	...do.....	1.05 p. m. to 2.57 p. m.	735	.....do
....	Santa Maria Bay (anch.): Hughes Pt., S. 10° W.; Mt. San Lazaro, N. 70° W.	....	Mar. 18	all day....	....	S
	Magdalena Bay.					
....	Off N. side of Santa Margarita Id. (anch.): Left Tang. Deering Bluff, N. 60° E.; NW. Tang. Id., N. 88° W.	....	Mar. 19	p. m......	8½	....
....	Mercy Channel (anch.): Cisne Pt., S. 70° W.; E. Tang. Santa Margarita Id., S. 46° E.	....	Mar. 20	all day....	....	....
D. 5678	Sail Rk. Entrada Pt., S. 53° W.; Redondo Pt., S. 15° W. (24° 35′ 20″ N., 111° 59′ 35″ W.).	1636	Mar. 21	9.58 a. m. to 10.25 a. m.	13½	S., brk. Sh.
....	Off Magdalena (anch.): Magdalena Whf., S. 82° W.; Cove Pt., S. 57° E.	....	...do.....	p. m......	....	M
	Between Magdalena Bay and San Lucas Bay.					
D. 5679	23° 47′ 45″ N., 111° 23′ W.	1664	Mar. 22	6.37 a. m. to 7.57 a. m.	325	dk. gn. M., For.
D. 5680	23° 40′ 30″ N., 111° 12′ 45″ W.	1664	...do.....	10.05 a. m. to 11.52 a. m.	389	.....do
D. 5681	23° 33′ 15″ N., 111° 02′ 10″ W.	1664	...do.....	2.05 p. m. to 3.26 p. m.	405	.....do
	San Lucas Bay.					
....	San Lucas Bay (anch.): Cape San Lucas, S. 7° E.; Customhouse, N. 77° W.	....	Mar. 23	all day....	13½	crs. S
D. 5682	Cabo Falso, N. 61° W.; Cape San Lucas, N. 11° W. (22° 48′ 20″ N., 109° 52′ 40″ W.).	1666	Mar. 24	7.27 a. m. to 9.05 a. m.	491	S.
....	San Lucas Bay (anch.): Cape San Lucas, S. 3° W.; Customhouse, S. 88° W.	....	...do.....	all day....	....	....

During the Lower California Cruise, 1911—Continued.

Temperature.			Density.		Apparatus.	Trial.		Drift.		Remarks.
Air.	Surf.	Botm.	Surf.	Botm.		Depth.	Duration.	Direction.	Distance.	
°F.	°F.	°F.					Min.		Mi.	
65 70	66 65	39.0	1.02449	1.02483	Luc. sdr.; Sigs. rod.; Sigs. bot.; NZ; Tnr.cse.; 12′ Ag.; m. b.	botm...	20	NW.by W.	0.2?	Cable out 1,000 fms. Sp. G. (surf.) 23.8 at 18.3°C., (botm.) 24.6 at 16°C.
70	66	38.6	1.02402	1.02885	Luc.sdr.; Sigs., rod.; Sigs. bot.; NZ; Tnr.cse.; 12′ Ag.; m. b.; #12, #20.	...do....	20	WNW....	.2	Cable out 950 fms. Townets towed astern for 50 min. during dredging. Sp. G. (surf.) 23.2 at 19.1°C., (botm.) 28.2 at 18°C.
....	....	......	....	....	19″ dr........	...do....	......	....	.....	Shore collecting. About 13 hauls with dr
....	.....	......	....	....	....	....	......	....	.....	Shore collecting.
....	.....	......	....	....	seine........	....	......	....	.....	Shore collecting. Mangrove and Santa Margarita Ids.
71	66	......	....	....	12′ Ag.; m. b.; hand lead line; 14-lb. lead.	botm...	20	N. 81° W..	.6	Cable out 50 fms.
....	.....	......	....	....	seine; 19″ dr...	...do....	......	....	.....	Shore collecting. Seining.
65	67	44.1	....	....	Luc. sdr.; Sigs. rod; Sigs. bot.; NZ; Tnr.cse.; 12′ Ag.; 1 flat, 2 round m. b.	botm...	16	N. 68° W..	.2	Cable out 600 fms. Botm. water specimen lost in Lab. through oversight.
68 71	68	43.6	....	....	Luc. sdr.; Sigs. rod.; Sigs. bot.; NZ; Tnr.cse.; 12′ Ag.; 1 m. b.	...do....	21½	N. 68° W..	.2	Accumulator registered 3 or 4 tons on hauling in. Cable out 650 fms. Towed 16 min. at 600 fms. Sp. G. (surf.) 23.6 at 20°C., (botm.) 26.6 at 15°C.
70	68	43.3	....	....	.....do........	...do....	20	N. 65° W..	.2	Sigs. bot. failed to work. Cable out 650 fms.
....	.....	......	....	....	seine; subm. lt.; 19″ dr.	surf., botm.	......	....	.....	Shore collecting. Seining.
69	69	40.8	....	....	Luc. sdr.; Sigs. rod.; Sigs. bot.; NZ; Tnr.cse.; 12′ Ag.; m. b.	botm...	20	S. 18° W..	.6	Sigs. bot. defective. Sp. G. (surf.) 24.2 at 25°C. Accumulator registered 3 tons in towing. Cable out 800 fms.
....	.....	......	....	....	seine; subm; lt.	....	......	....	.....	Shore collecting. Seining. At night El. lt. used.

Station number.	Position.	Chart.	Date.	Time of day.	Depth.	Character of bottom.
	San Jose del Cabo Bay.	*H. O.*	1911.		*Fms.*	
....	(anch.): Semaphore, S. 83° W.; Customhouse, N. 42° W.	....	Mar. 25 Mar. 26	all day....	....	....
	Gulf of California, Western Coast.					
....	Pichilinque Harbor (anch.): SE. Tang. San Juan Id., S. 14° W.; SW. Tang. N. side of False Bay, S. 41° E.	....	Mar. 27 Mar. 28 Mar. 29	all day....	....	....
....	Amortajada Bay, San Josef Id. (anch.): S. Tang. Cayo Id., S. 81° W.; Cayote Id., S. 12° E.	....	Mar. 30 Mar. 31	p. m......	....	....
....	Agua Verde Bay (anch.): San Pasquel Pt., N. 10° W.; Opposite Pt., N. 83° E.	....	Apr. 1 Apr. 2	...do...... a. m......	....	....
....	Salenas Bay, Carmen Id. (anch.): Perico Pt., S. 63° E.; White Pt. S. 29° W.	....	...do..... Apr. 3	p. m...... all day....	....	....
....	Mulege, mouth of Concepcion Bay (anch): Sombrerito Pt., S. 44° W.; Gallito Pt., S. 54° E.	....	Apr. 4	...do......	....	....
....	S. part of Concepcion Bay (anch.): Concepcion Peak, S. 22° E.; 500′ Peak, S. 27° W.	....	Apr. 5 Apr. 6	p. m...... all day....	....	....
....	S. part of Concepcion Bay (anch.): Ranada Pt., S. 83° W.; Rt. Tang. Ricason Id., S. 39° E.	....	Apr. 7 Apr. 8	...do......	....	....
....	San Francisquito Bay (anch.): NW. Tang., N. 11° E. E. Tang., N. 80° E.	....	Apr. 9	...do......	....	....
....	Angel de la Guardia Id., SE. side (anch.): E. Tang. Pond Id., N. 34° E.; E. Tang. Isla Partida, S. 28° E.	....	Apr. 10	p. m......	....	....
....	Tiburon Id., S. side (anch.): Red Bluff Pt., S. 86° W.; S. Tang. Turners Id., S. 47° E.	....	Apr. 11 Apr. 12 Apr. 13	...do...... all day.... a. m......	....	....
	Gulf of California.					
....	San Estaban Id. (anch.); NE. Tang., N. 5° W.; 25′ Rk., S. 54° W.	....	Apr. 13 Apr. 14	p. m...... a. m......	....	....
....	Santa Catalina Id. (anch.): Santa Cruz Id.	....	Apr. 16	...do...... p. m......	....	....
....	Pichilinque Harbor (anch.): Off Coaling Sta.	....	Apr. 17	all day....	....	....
....	Espiritu Santo Id.: San Gabriel Bay (anch.).	....	...do..... Apr. 18	...do...... a. m......	....	....
....	Ceralbo Id..................	....	Apr. 19	p. m......	....	....
	West coast, Lower California.					
D. 5683	Off Cape San Lucas: Cabo Falso, N. 53° W.; Cabeza Bellana N. (22° 46′ 45″ N., 109° 50′ 15″ W.).	1664	Apr. 20	12.41 p. m. to 2.49 p. m.	630	crs. S., gn. M., G..

DURING THE LOWER CALIFORNIA CRUISE, 1911—Continued.

Temperature.			Density.		Apparatus.	Trial.		Drift.		Remarks.
Air.	Surf.	Botm.	Surf.	Botm.		Depth.	Duration.	Direction.	Distance.	
°F.	°F.	°F.					Min.		Mi.	
....	....	....	....	....	seine........	....	....	....	....	Shore collecting.
....	....	....	....	....	subm. lt.; 19" dr.	....	....	....	....	Shore collecting.
....	....	....	....	....	subm. lt.; 19" dr.; seine; dyn.	surf., botm.	....	....	....	Shore collecting. Four dredge hauls.
....	....	....	....	....	seine; 19" dr..	....do...	....	....	....	Shore collecting. Dredge hauls along the beach
....	....	....	....	....	175' seine; dyn.;19"dr.	...do....	....	....	....	Shore collecting.
....	....	....	....	....	100' seine; dyn.; 19" dr.	...do....	....	....	....	Do.
....	....	....	....	....	seine; 19" dr.; dyn.; subm. lt.	surf., botm.	....	....	....	Do.
....	....	....	....	....	175' seine; dyn.; 19" dr.	...do....	....	....	....	Do.
....	....	....	....	....	dyn.; subm. lt.	surf....	....	....	....	Shore collecting. El. lt. used at night.
....	....	....	....	....	dyn.; 19" dr..	botm...	....	....	....	Shore collecting.
....	....	....	....	....	subm. lt.; seine; dyn.	surf....	....	....	....	Do.
....	....	....	....	....	....	....	....	....	....	Shore collecting.
....	....	....	....	....	dyn........	....	....	....	....	Do.
....	....	....	....	....	....do.......	....	....	....	....	Do.
....	....	....	....	....	dyn.; subm. lt.	....	....	....	....	Shore collecting. El. lt. used at night.
....	....	....	....	....	dyn........	....	....	....	....	Shore collecting.
70 69	73	39.1	1.02511	1.02329	Luc. sdr.; Sigs. rod; Sigs. bot.; NZ Tnr. cse.; 12' Ag.	botm...	15	S. 26° W..	1.5	One bridle stop carried away. Runners twisted. Sp. G. (surf.) 23.2 at 23.5°C., (botm.) 21 at 25°C. Cable out 1,200 fms.

Station number.	Position.	Chart.	Date.	Time of day.	Depth.	Character of bottom.
	West coast, Lower California—Continued.					
D. 5684	S. of Magdalena Bay (23° 23′ 30″ N., 112° 30′ W.)	*H. O.* 1664	1911. Apr. 21	6.06 a. m. to 11.26 a. m.	*Fms.* 1,760	....
D. 5685	S. of Abreojos Pt. (25° 42′ 45″ N., 113° 38′ 30″ W.)	1493	Apr. 22	8.08 a. m. to 10.26 a. m.	645	bk. S., Co........
D. 5686	SW. of Abreojos Pt. (26° 14′ N., 114° W.)	1493	...do....	3.07 p. m. to 5.22 p. m.	930	gn. M., Glob......
....	Port San Bartolome (anch.): Entrance Rk., N. 79° W.; S. Tang. Coffin Id., S. 52° W.	....	Apr. 23	a. m......	....	....
	Coast of California.					
D. 5687	S. of Cerros Id.: W. Tang. Natividad Id., N. 10° E.; Breaker Pt., Lower Calif., N. 72° E. (27° 39′ 15″ N., 115° 16′ W.)	1310	Apr. 23	12.37 p. m. to 2.23 p. m.	480	gn. M., Glob......
D. 5688	W. Tang. Natividad Id., N. 15° E.; Breaker Pt. N. 72° E. (27° 38′ 45″ N., 115° 17′ 40″ W.)	1310	...do.....	2.30 p. m. to 4.23 p. m.	525	.....do............
D. 5689	E. of Guadaloupe Id.: Hat Mt., N. 59° E.; St. Vincent Peak, N. 47° E. (29° 23′ N., 116° 14′ W.)	1193	Apr. 24	6.11 a. m. to 8.49 a. m.	879	gy. M., fne. S., G., Glob.
D. 5690	East of Guadaloupe Id. (29° 29′ N., 116° 18′ W.)	1193	...do.....	10.07 a. m. to 12.57 p. m.	1,101	gn. M., Glob......
D. 5691	SW. of San Diego, Calif. (31° 08′ 20″ N., 118° 29′ 30″ W.).	1006	Apr. 25	6.06 a. m. to 8.45 a. m.	868	gy. M............
D. 5692	SW. of San Diego, Calif. (31° 23′ 45″ N., 118° 31′ 30″ W.).	1006	...do.....	11.21 a. m. to 2.17 p. m.	1,076	.....do............
D. 5693	W. of San Nicolas Id. (33° 13′ 30″ N., 120° 04′ 30″ W.).	*C. S.* 5002	Apr. 26	6.06 a. m. to 7.52 a. m.	451	....

DURING THE LOWER CALIFORNIA CRUISE, 1911—Continued.

Temperature.			Density.		Apparatus.	Trial.		Drift.		Remarks.
Air.	Surf.	Botm.	Surf.	Botm.		Depth.	Duration.	Direction.	Distance.	
°F.	°F.	°F.					Min.		Mi.	
64 66	67	.....	....	....	Luc. sdr.; Sigs. rod; Sigs. bot.; NZ; Tnr. cse.; 12′ Ag.	botm...	30	NW. by W.	.....	250-lb. weight placed above bridle instead of 140-lb. Sounding wire carried away losing Sigs. bot., sounding cup and therm. Glass floats carried away. Accumulator registered over 5 tons. Cable out 3,015 fms.
60 61	61	.....	....	....	.....do........	...do...	30	W. by S..	.....	Sigs. bot. failed to work. NZ #108018, replacing #104914, did not register. Cable out 1,200 fms.
60 61	61	37.3	....	....	.....do........	...do...	20	...do......	.....	Water specimen thrown out by mistake. Cable out 1,250 fms.
....	.....	.....	....	....	250′ seine.....	....	....	....	.....	
61 62	60	41.1	1.02379	1.0248	Luc. sdr.; Sigs. rod; Sigs. bot.; NZ Tnr. cse.; 12′ Ag.	botm...	30	S. 72° W..	1.5	Cable out 750 fms. Sp. G. (surf.) 24 at 15.7 °C., (botm.) 24.8 at 14.9°C.
62 61	60	39.9	1.02424	1.02482	.....do........	...do...	30	S. 85° W..	2.0	Cable out 900 fms. Sp. G. (surf.) 24.1 at 15.5°C., (botm.) 25.3 at 12°C.
58	58	.....	1.02398	1.02564	.....do........	...do...	30	N. 87° W..	.....	Botm. therm. failed to register. Cable out 1,410 fms. Sp. G. (surf.) 24.1 at 14.2°C., (botm.) 26.2 at 11.5°C.
60	58	38.1	1.02385	1.02476	.....do........	...do...	18	S. 82° W..	.....	Cable out 1,600 fms. Sp. G. (surf.) 23.9 at 14.5°C., (botm.) 27.8 at 11.6°C. NZ #98244 replaced #108018.
57 58	59	37.2	1.02397	1.02563	Luc. sdr.; Sigs. rod; Sigs. bot.; NZ; Tnr. cse.; 12′ Ag.	botm...	20	S. 82° W..	.....	Cable out 1,450 fms. Sp. G. (surf.) 24 at 14.6°C., (botm.) 26.2? at 11.8°C.
58 61	59 60	37.1	1.02362	1.02534	.....do........	...do...	20	...do......	.....	Cable out 1,500 fms. Sp. G. (surf.) 23.6 at 15°C., (botm.) 25.8 at 12.2°C.
54 53	56 54	.....	....	....	.....do........	...do...	30	N. 86° W..	.....	Cable out 800 fms. Stray line carried away with all instruments.

DREDGING AND HYDROGRAPHIC RECORDS SECURED

Station number.	Position.	Chart.	Date.	Time of day.	Depth.	Character of bottom.
	Coast of California—Contd.	*C. S.*	1911.		*Fms.*	
D. 5694	NW. of San Nicolas Id. (33° 24′ 36″ N., 120° 12′ 30″ W.).	5002	Apr. 26	9.09 a. m. to 11.28 a. m.	640	gn. M.............
D. 5695	(33° 33′ N., 120° 17′ 30″ W.).	5002	...do.....	1.08 p. m. to 3.22 p. m.	534	gn. S., Glob.......
D. 5696	W. of Pt. Buchon, Calif.: Pine Mt., N. 42° E. (35° 18′ 30″ N., 121° 28′ W.).	5002	Apr. 27	6.15 a. m. to 7.45 a. m.	440	....
D. 5697	W. of Piedras Blanca, Calif.: Silver Peak, N. 40° E., Pine Mt., N. 75° E. (35° 35′ N., 121° 39′ W.).	5002	...do.....	10.02 a. m. to 11.42 a. m.	485	gn. M., bk. S......
D. 5698	Off Pt. Sur, Calif.: Pt. Sur, N. 6° W.; Juniperro Mt., N. 47° E. (35° 50′ N., 121° 49′ 30″ W.).	5002	...do.....	2.02 p. m. to 3.48 p. m.	475	....
D. 5699	Pt. Sur Lt., N. 12° E. (36° 30″ N., 122° W.).	5002	...do.....	6.07 p. m. to 8.11 p. m.	659	gn. M.............

DREDGING AND HYDROGRAPHIC RECORDS

Station number.	Position.	Chart.	Date.	Time of day.	Depth.	Character of bottom.
	Off Coronation Id., Alaska.		1911.		*Fms.*	
H. 4954	5 miles ES., ¾ S. from the position (55° 57′ 30″ N., 135° 27′ W.).	....	Aug. 21	9.05 a. m.	134	C.................
H. 4955	38 miles SSW. ½ W. from Kerourat Id., Alaska (51° 29′ N., 131° 48′ W.).	....	Aug. 22	9.49 a. m.	1,368	bn. M.............

DURING THE LOWER CALIFORNIA CRUISE, 1911—Continued.

Temperature.			Density.		Apparatus.	Trial.		Drift.		Remarks.
Air.	Surf.	Botm.	Surf.	Botm.		Depth.	Duration.	Direction.	Distance.	
°F.	°F.	°F.					Min.		Mi.	
60 56	57	......	1.02374	1.02483	Luc. sdr.; Sigs. rod; Sigs. bot.; NZ; Tnr. cse.; 12' Ag.	botm...	30	S. 63° W..	.....	Cable out 1,200 fms. NZ #108154 replacing #98244 failed to trip. One bridle stop carried away. Sp. G. (surf.) 23.9 at 14°C., (botm.) 25 at 14°C.
58 57	57 56	38.9	1.02389	1.02466	.....do........	...do....	30	S. 85° W..	.....	Sounding register read −10 fms. when cup arrived at surf. Cable out 1,200 fms. Sp. G. (surf.) 24.2 at 13°C., (botm.) 25.3 at 11°C.
50 52	54	39.9	1.02346	1.02438	.....do........	...do....	13½	N. 63° W..	.....	Cable out 700 fms. Sp. G. (surf.) 23.9 at 12.2°C., (botm.) 25.1 at 10.5°C.
55 56	52 53	39.8	1.0236	1.02478	.....do........	...do....	31	N. 72° W..	.....	Cable out 750 fms. Sp. G. (surf.) 24 at 12.5°C., (botm.) 25.3 at 11.8°C.
53	53	39.9	1.02451	1.02450	.....do........	...do....	20	...do......	.....	Cable out 900 fms. Sp. G. (surf.) 24 at 12°C., (botm.) 25 at 11.9°C.
51 52	52	37.9	1.02373	1.02471	.....do........	...do....	30	S. 86° W...	.....	Cable out 1,000 fms. Sp. G. (surf.) 24.2 at 12°C., (botm.) 24.9 at 13.9°C.

SECURED IN ALASKA, 1911.

Temperature.			Density.		Apparatus.	Trial.		Drift.		Remarks.
Air.	Surf.	Botm.	Surface.	Bottom.		Depth.	Duration.	Direction.	Distance.	
.....	.....	.....	....	....	Luc. sdr.; Sigs. rod.	botm...	....	....	.....	
.....	.....	.....	....	....	.....do........	...do....	....	....	.....	

Station number.	Position.	Chart.	Date.	Time of day.	Depth.	Character of bottom.
	Middle section of bay.	*C. S.*	1912.		*Fms.*	
D. 5700 H. 4956	Angel Id. Lt., N. 24¾° E. Alcatraz Lt., S. 78¾° E. Tang. Lime Pt., S. 68¼° W.	5532	Jan. 30	10.00 a. m.	19 17	S., crs., fne. G., brk. Sh.
D. 5701 H. 4957	Alcatraz Lt., S. 87¾° E. Rt. Tang. Angel Id., N. 43½° E. Mile Rk. Lt., S. 52¾° W.	5532	...do.....	1.20 p. m.	13 17	S., fne. G., brk. Sh.
D. 5702 H. 4958	Alcatraz Lt., S. 61¾° E. Lft. Tang. Angel Id., N. 20¼° E. Tang. Lime Pt., S. 53¼° W.	5532	...do.....	2.54 p. m.	13 12¾	Sh., St.
D. 5703 H. 4959	Rt. Tang. Angel Id., S. 42° W. Southampton Lt., S. 83° E. Rt. Tang. Red Rk., N. 7° W.	5532	Feb. 1	10.10 a. m.	8½ 8¼	dk. gy. stk. M.
D. 5704 H. 4960	Center Red Rk., N. 13° W. Southampton Lt., S. 51° E. Rt. Tang. Angel Id., S. 32° W.	5532	...do.....	2.09 p. m.	7½ 7	.....do
D. 5705 H. 4961	Southampton Lt., N. 70° E. Quarry Pt., S. 1° E. Pt. Chauncey, N. 56° W.	5532	Feb. 6	9.50 a. m.	9 9	gy. M.
D. 5706 H. 4962	Lft. Tang. Goat Id., S. 31° E. Rt. Tang. Angel Id., S. 89° W. Southampton Lt., N. 1⅓° E.	5532	...do.....	1.00 p. m.	9 7	.....do.
D. 5707 H. 4963	Lft. Tang. San Quentin, N. 88⅔° W. Brothers Lt., N. 2° W. Bluff Pt., S. 4° W.	5532	...do.....	2.15 p. m.	8 9¾	
D. 5708 H. 4964	Brothers Lt., N. 1⅔° E. Lft. Tang. San Quentin, S. 88° W. Bluff Pt., S. ⅔° W.	5532	...do.....	2.37 p. m.	10½ 12¾	S. M.
D. 5709 H. 4965	Brothers Lt., N. 8⅓° E. Lft. Tang. San Quentin, S. 74½° W. Rt. Tang. Castro Pt., S. 55⅔° E.	5532	...do.....	3.13 p. m.	12½ 10	M., S.
H. 4966	Alcatraz Lt., S. 62⅔° E. Angel Id. Lt., N. 73⅓° E. Yellow Bluff, Tang., S. 13⅔° E.	5532	Feb. 13	10.24 a. m.	7	bl. M.
H. 4967	Alcatraz Lt., S. 51° E. Angel Id. Lt., N. 14⅓° E. Lime Pt. Lt., S. 55⅓° W.	5532	...do.....	11.06 a. m.	13	M.
H. 4968	Southampton Lt., N. 10° E. Alcatraz Lt., S. 27° W. Lft. Tang. Angel Id., N. 78° E.	5532	...do.....	12.30 p. m.	20	gy. S.
H. 4969	Southampton Lt., N. 15° E. Alcatraz Lt., S. 18° W. Lft. Tang. Red Rk., N. 17¼° W.	5532	...do.....	12.58 p. m.	17½	M.
H. 4970	Rt. Tang. Red Rk., N. 12° W. Southampton Lt., N. 60° E. Pt. Campbell, S. 72° W.	5532	...do.....	2.15 p. m.	8	.....do.
H. 4971	Southampton Lt., S. 69° E. Rt. Tang. Red Rk., N. 4° W. Pt. Stuart, S. 27° W.	5532	...do.....	2.47 p. m.	12½	.....do.
H. 4972	Rt. Tang. Red Rk., N. 13° E. Bluff Pt., S. 1½° W. Southampton Lt., S. 52° E.	5532	...do.....	3.15 p. m.	7	hrd.
H. 4973	Southampton Lt., S. 48° E. Rt. Tang. Red Rk., N. 58° E. Bluff Pt., S. 17° E.	5532	...do.....	3.47 p. m.	7	M.
H. 4974	Brothers Lt., N. 30° E. Lft. Tang. Red Rk., S. 62° E. Lft. Tang. San Quentin, S. 88° W.	5532	...do.....	4.22 p. m.	9	.....do.

FRANCISCO BAY, CALIF., 1912–13, AND MARCH, 1914.

Temperature.			Salinity.		Apparatus.	Trial.		Drift.		Remarks
Air.	Surf.	Botm.	Surf.	Botm.		Depth.	Duration.	Direction.	Distance.	
°F.	°F.	°F.					Min.		Mi.	
56	51.83	53.13	......	......	9′ Ag.; 19″ dr.	botm...	18	327°......	0.3	Bridle stops parted, frame tripped, and net torn.
57	50.83	......	......	......	.....do.........	...do...	17	358°......	.4	Net carried away.
57	50.83	......	......	......	.....do.........	...do...	16½	61°......	.4	Trawl contained chiefly shells, few fair-sized stones in trawl; dr. did not drag properly.
57	49.83	52.93	......	......	9′ Tnr.; 19″ dr.	...do...	15½	353°......	.8	One bridle stop had parted; on hoisting inboard net parted close to frame; frame was bent, boom likewise.
68	52.83	52.93	......	......	9′ Ag.; 19″ dr..	...do...	11	179°......	.3	Accumulator registered nearly 7 tons; net gave way on haul in; was beyond redemption.
51	51.83	......	......	......	5′ Tnr.; 19″ dr. #12.	...do...	5	117°......	.4	Mud filled with worm tubes and ophiurians.
55	51.83	......	......	......	.....do.........	...do...	6	2°......	.4	Fewer worm tubes than preceding; few, if any, ophiurians. No complete examination or inventory was made of contents of haul.
54.5	51.83	......	......	......	.....do.........	...do...	8	331°......	.4	Boat dr. was not tied, hence botm. not accurately determined.
55	51.83	......	......	......	9′ Ag.; 19″ dr.; #12.	...do...	14½	338°......	.6	
56	51.83	......	......	......	5′ Tnr.; 19″ dr. #12.	...do...	13½	212°......	.5	
55	54.23	53.93	29.10	30.48	Sigs. bot.; #12; #20; Tnr. cse.	surf. and botm.	10	Against tide.	.....	Strong ebb.
55	53.83	53.93	29.53	31.01	.....do.........	...do...	10	...do......	.....	Do.
56	53.83	53.93	27.59	26.10	.....do.........	...do...	10	...do......	.....	Strong ebb; lost #20 townet; was fouled in propeller strut.
56	54.03	55.78	26.49	28.40	Sigs. bot.; Tnr. cse.; #12.	...do...	10	...do......	.....	Strong ebb.
57	53.83	53.83	26.96	28.46	.....do.........	...do...	10	...do......	.....	Do.
56	53.83	53.73	26.16	26.32	.....do.........	...do...	10	...do......	.....	Do.
56	53.73	53.83	23.91	25.39	.....do.........	...do...	10	...do......	.....	Ebb.
57.5	53.73	53.73	18.23	22.76	.....do.........	...do...	10	...do......	.....	Do.
58	53.73	53.53	17.47	21.74	.....do.........	...do...	10	...do......	.....	Do.

DREDGING AND HYDROGRAPHIC RECORDS SECURED IN SAN

Station number.	Position.	Chart.	Date.	Time of day.	Depth.	Character of bottom.
	Upper section of bay.	*C. S.*	1912.		*Fms.*	
H. 4975	Tang. Crockett Whf., S. 74° E. Carquinez Lt., N. 50° W. Tang. Selby Whf., S. 69° W.	5533	Feb. 15	1.10 p. m.	14½	hrd
H. 4976	Tang. Crockett Whf., S. 76° E. Carquinez Lt., S. 48° E. Mare Id. Lt., N. 27° W.	5533	...do.....	1.43 p. m.	10½	bl. M
H. 4977	Carquinez Lt., N. 71° E. Lone Tree Pt. Whf., S. 36° E. Pinole Pt. Tang., S. 53½° E.	5533	...do.....	2.20 p. m.	5¾	.....do
H. 4978	Mare Id. Lt., N. 66° E. Lone Tree Pt. Whf., S. 82° E. Pinole Pt., S. 41° W.	5533	...do.....	2.48 p. m.	5	.....do
H. 4979	Mare Id. Lt., N. 63° E. Brothers Lt., S. 32° W. Lft. Tang. Pinole Pt., S. 54° E.	5533	...do.....	3.20 p. m.	7	M
H. 4980	Pinole Pt. Lft. Tang., N. 76° E. Lft. Tang. Sisters, S. 58° W. Brothers Lt., S. 23° W.	5533	...do.....	3.48 p. m.	6¼	.....do
H. 4981	Brothers Lt., S. 7° E. Lft. Tang. Sisters, N. 22° W. Lft. Tang. Pinole Pt., N. 59° E.	5533	...do.....	4.17 p. m.	13	.....do
	Middle section of bay.					
D. 5710 H. 4982	Lime Pt., N. 77° E. Alcatraz, Lft. Tang., N. 70° E. Angel Id. Lt., N. 9° E.	5532	Feb. 16	9.38 a. m.	16 9	Sh., hrd. M
D. 5711 H. 4983	Lime Pt., N. 68° W. Angel Id. Lt., N. 6° E. Alcatraz Lt., N. 63° E.	5532	...do.....	10.00 a. m.	8¼ 9¾	M., S., Sh
D. 5712 H. 4984	Lime Pt., N. 87° W. Angel Id. Lt., N. 6° W. Alcatraz Lt., N. 79° E.	5532	...do.....	11.04 a. m.	10½ 14¾	gy. S., Sh
D. 5713 H. 4985	Alcatraz Lt., N. 10° E. Angel Id. Lt., N. 19° W. Lime Pt., N. 78½° W.	5532	...do.....	1.47 p. m.	17 10	gy. S., P
	Upper section of bay.					
H. 4986	Tang. Crockett Whf., S. 74° E. Carquinez Lt., N. 53° W. Tang. Selby Whf., S. 80° W.	5533	Feb. 20	11.39 a. m.	12¼	sft. M
H. 4987	Tang. Crockett Whf., S. 70½° E. Carquinez Lt., N. 28° E. Mare Id. Lt., N. 50° W.	5533	...do.....	12.45 p. m.	8	stk. M
H. 4988	Carquinez Lt., N. 69° E. Lone Tree Pt. Whf., S. 38° E. Pinole Pt., S. 55° W.	5533	...do.....	1.35 p. m.	7	br. M
H. 4989	Mare Id. Lt., N. 65° E. Lone Tree Pt. Whf., S. 82° E. Pinole Pt., S. 42° W.	5533	...do.....	2.13 p. m.	6¾	M
H. 4990	Lft. Tang. Sisters, S. 53° W. Brothers Lt., S. 31° W. Lft. Tang. Pinole Pt., S. 73° E.	5533	...do.....	2.59 p. m.	7	.....do
H. 4991	Rt. Tang. Sisters, S. 63° W. Pinole Pt., N. 74° E. Brothers Lt., S. 25° W.	5533	...do.....	3.24 p. m.	7	.....do
H. 4992	Brothers Lt., S. 4° E. Lft. Tang. Sisters, N. 36° W. Lft. Tang. Pinole Pt., N. 60° E.	5533	Feb. 21	10.25 a. m.	12¾	gy. S
	Middle section of bay.					
H. 4993	Lft. Tang. Red Rk., S. 87° E. Brothers Lt., N. 26° E. Lft. Tang. San Quentin, N. 89° W.	5532	Feb. 21	11.00 a. m.	8	hrd. M., S
H. 4994	Brothers Lt., N. 14° E. Bluff Pt., S. 16° E. Rt. Tang. Red Rk., N. 44° E.	5532	...do.....	11.35 a. m.	7	bk. S., hrd. M

FRANCISCO BAY, CALIF., 1912-13, AND MARCH, 1914—Continued.

Temperature.			Salinity.		Apparatus.	Trial.		Drift.		Remarks.
Air.	Surf.	Botm.	Surf.	Botm.		Depth.	Duration.	Direction.	Distance.	
°F.	°F.	°F.					Min.		Mi.	
55	53.83	53.63	13.91	18.56	Sigs. bot.; Tnr. cse.; #12, #20.	surf. and botm.	10	Against tide.	.....	Strong ebb.
57	53.83	53.63	13.94	17.68	.....do.........	...do....	10	...do.......	.....	Strong ebb; as botm. therm. was tripped before 10-min. period had elapsed, botm. temp. was taken again.
58	53.73	53.83	15.10	19.85	.....do.........	...do....	10	...do.......	.....	Strong ebb.
54.5	53.63	53.93	14.19	21.47	.....do.........	...do....	10	...do.......	.....	Do.
58	54.03	53.93	21.54	22.11	.....do.........	...do....	10	...do.......	.....	Do.
58.5	53.83	53.93	19.02	21.28	.....do.........	...do....	10	...do.......	.....	Do.
59	53.33	54.03	21.41	22.51	.....do.........	...do....	10	...do.......	.....	Do.
56.5	51.83	......	......	......	5′ Tnr.; 19″ dr.; #12, #20.	botm...	4	90°........	0.4	Flood.
59	51.83	......	......	......	.....do.........	...do....	4	101°.......	.25	Do.
58	51.83	......	......	......	5′ Tnr.; 19″ dr.; m. b.; #12, #20.	...do....	5	107°.......	.3	Do.
55	51.83	......	......	......	.....do.........	...do....	28½	270°.......	1.2	Ebb.
56	54.03	54.13	7.01	12.67	Tnr. cse.; Sigs. bot.; 4′ inter.; #12, #20.	surf. and botm.	10	Against tide.	.....	Flood.
63	54.23	54.53	13.33	17.40	.....do.........	...do....	10	...do.......	.....	Flood; net touched bottom.
62.5	55.33	54.73	11.35	19.57	.....do.........	...do....	8	...do.......	.....	Flood; full of mud; most of catch of #20 townet let go because of mud.
62	55.23	54.83	21.42	21.12	.....do.........	...do....	7	...do.......	.....	Slight flood.
62	55.13	54.73	24.22	24.19	.....do.........	...do....	12	...do.......	.....	Do.
62	54.83	54.83	24.03	24.77	.....do.........	...do....	12	...do.......	.....	Slack water changing to fairly strong ebb.
58	54.13	54.63	18.95	23.95	.....do.........	...do....	....	...do.......	.....	Flood; slow stream.
58	54.33	54.63	22.35	24.49	Tnr. cse.; Sigs. bot.; 4′ inter.; #12, #20.	surf. and botm.	10	Against tide.	.....	Flood.
56.5	54.63	54.43	23.77	25.35	.....do.........	...do....	7	...do.......	.....	Do.

DREDGING AND HYDROGRAPHIC RECORDS SECURED IN SAN

Station number.	Position.	Chart.	Date.	Time of day.	Depth.	Character of bottom.
	Middle section of bay—Con.	*C. S.*	1912.		*Fms.*	
H. 4995	Southampton Lt., S. 47° E. Bluff Pt., S. 9° W. Rt. Tang. Red Rk., N. 7° E.	5532	Feb. 21	11.55 a. m.	7	
H. 4996	Bluff Pt., S. 42° W. Southampton Lt., S. 66° E. Rt. Tang. Red Rk., N. 5° W.	5532	...do....	1.25 p. m.	12¼	stk. M
H. 4997	Southampton Lt., N. 66° E. Pt. Campbell, S. 69° W. Lft. Tang. Red Rk., N. 14° W.	5532	...do....	1.50 p. m.	9½	M.
H. 4998	Southampton Lt., N. 23° E. Pt. Blunt, S. 32° W. Pt. Simpton, N. 56° W.	5532	...do....	2.10 p. m.	14½	.....do.
H. 4999	Pt. Blunt, N. 80° W. Southampton Lt., N. 14° E. Alcatraz Lt., S. 21° W.	5532	...do....	2.35 p. m.	18½	S., M.
H. 5000	Alcatraz Lt., S. 56° E. Fort Pt., S. 40° W. Angel Id. Lt., N. 10° E.	5532	...do....	3.10 p. m.	14	hrd
	Lower section of bay.					
H. 5001	No. 2 Beacon, S. 36° E. San Bruno Lt., N. 60° W. Pt. San Mateo, S. 23° W.	5531	Feb. 23	11.30 a. m.	6	M.
H. 5002	Candlestick Pt., N. 43° W. San Bruno Lt., S. 88° W. Pt. Avisadero, N. 23° W.	5531	...do....	12.50 p. m.	5	.....do.
H. 5003	Candlestick Pt., N. 47° W. San Bruno Lt., S. 65° W. Pt. Avisadero, N. 24° W.	5531	...do....	1.20 p. m.	4	.....do.
H. 5004	Candlestick Pt., N. 54° W. San Bruno Lt., N. 42° W. Pt. Avisadero, N. 23° W.	5531	...do....	1.50 p. m.	5	.....do.
H. 5005	Shag Rk., N. 48° W. San Bruno Lt., S. 21° W. Candlestick Pt., N. 71° W.	5531	...do....	2.15 p. m.	6¾	.....do.
H. 5006	Shag Rk., S. 58° W. Rt. Tang. Pt. Avisadero, S. 74° W. Goat Id. Lt., N. 21° W.	5531	...do....	2.50 p. m.	7	.....do.
H. 5007	Goat Id. Lt., N. 23° W. Ferry Bldg., N. 54° W. Pt. Avisadero, S. 19° W.	5531	...do....	3.20 p. m.	7	.....do.
H. 5008	Rt. Tang. Goat Id., N. 15° E. Lft. Tang. Goat Id., N. 5° W. Ferry Bldg., N. 72° W.	5531	...do....	4.00 p. m.	12¾	.....do.
H. 5009	Rt. Tang. Goat Id., N. 19° E. Lft. Tang. Goat Id., N. 7° W. Ferry Bldg., N. 8° W.	5531	Feb. 27	10.30 a. m.	11	S., M.
H. 5010	Pt. Avisadero, S. 22° W. Goat Id. Lt., N. 26° W. Ferry Bldg., N. 57° W.	5531	...do....	11.15 a. m.	7½	.....do.
H. 5011	Pt. Avisadero, S. 12° W. Goat Id. Lt., N. 16° W. Ferry Bldg., N. 54° W.	5531	...do....	11.35 a. m.	10	.....do.
H. 5012	Rt. Tang. Pt. Avisadero, S. 71° W. Goat Id. Lt., S. 55° W. Shag Rk., N. 22° W.	5531	...do....	12.50 p. m.	7½	M.
H. 5013	Candlestick Pt., N. 73° W. Shag Rk., N. 49° W. San Bruno Lt., S. 18° W.	5531	...do....	1.25 p. m.	6¼	bk. M.
H. 5014	Candlestick Pt., N. 55° W. San Bruno Lt., S. 43° W. Pt. Avisadero, N. 26° W.	5531	...do....	1.55 p. m.	4¾	M.
H. 5015	Candlestick Pt., N. 40° W. San Bruno Lt., S. 66° W. Pt. Avisadero, N. 22° W.	5531	...do....	2.15 p. m.	4¾	.....do.

FRANCISCO BAY, CALIF., 1912-13, AND MARCH, 1914—Continued.

Temperature.			Salinity.		Apparatus.	Trial.		Drift.		Remarks.
Air.	Surf.	Botm.	Surf.	Botm.		Depth.	Duration.	Direction.	Distance.	
°F.	°F.	°F.					Min.		Mi.	
55	54.63	54.23	25.20	27.59	Tnr. cse.; Sigs. bot.; 4' inter.; #12, #20.	surf. and botm.	3	Against tide.	.....	Flood.
54	.....	54.93	26.78	29.14	.....do.........	...do....	13	...do......	.....	Flood; slow stream.
55	55.23	54.23	....	28.74	.....do.........	...do....	6	...do......	.....	Do.
55	54.63	54.03	28.40	28.92	.....do.........	...do....	10?	...do......	.....	Do.
56	54.53	54.03	28.23	28.14	.....do.........	...do....	8	...do......	.....	Do.
57	53.93	53.93	31.00	31.18	.....do.........	...do....	....	...do......	.....	Slack.
53	54.23	54.33	28.53	27.30	Tnr. cse.; Sigs. bot.; 4' inter.; #12, #20.	surf. and botm.	9	Against tide.	.....	Flood; moderate current, nearly slack at end.
55	54.73	54.63	28.56	28.40	.....do.........	...do....	7	...do......	.....	Do.
57	54.83	54.63	28.29	28.33	.....do.........	...do....	9	...do......	.....	Do.
57	54.83	54.63	28.14	28.02	.....do.........	...do....	7	...do......	.....	Do.
57	54.83	54.63	27.87	27.83	.....do.........	...do....	6	...do......	.....	Do.
57	54.53	55.13	27.48	27.52	.....do.........	...do....	6	...do......	.....	Flood; moderate current, nearly slack at end. Mud haul, townets emptied; mud in bag of one saved.
56	54.43	53.93	26.94	27.17	.....do.........	...do....	8	...do......	.....	Flood; moderate current, nearly slack at end.
56	54.73	53.73	27.68	27.85	.....do.........	...do....	7	...do......	.....	Do.
49	52.63	51.53	27.37	28.84	.....do.........	...do....	7	...do......	.....	Swift ebb at outset. Water very much clearer than on last few working days.
50	52.83	52.53	27.01	27.72	.....do.........	...do....	10	...do......	.....	Ebb. Passed abruptly into muddy water.
51	50.33	52.43	27.40	27.11	.....do.........	...do....	4	...do......	.....	Ebb. Return was made to blue water a few hundred yds. from line of division. After churning with propeller the Surf. Sal. was 27.52.
51	53.33	52.93	27.81	27.65	.....do.........	...do....	7	...do......	.....	Ebb.
51.5	53.13	53.13	27.79	27.75	.....do.........	...do....	10	...do......	.....	Do.
53	52.83	52.83	28.11	28.12	.....do.........	...do....	9	...do......	.....	Do.
53	53.03	52.93	28.23	28.28	.....do.........	...do....	6	...do......	.....	Do.

DREDGING AND HYDROGRAPHIC RECORDS SECURED IN SAN

Station number.	Position.	Chart.	Date.	Time of day.	Depth.	Character of bottom.
	Lower section of bay—Con.	*C. S.*	1912.		*Fms.*	
H. 5016	Candlestick Pt., N. 41° W. San Bruno Lt., S. 89° W. Pt. Avisadero, N. 21° W.	5531	Feb. 27	2.30 p. m.	4¾	M.
H. 5017	San Bruno Lt., N. 57° W. San Mateo Pt., S. 13° W. No. 2 Beacon, S. 41° E.	5531	...do....	3.00 p. m.	5¼	....do.
	Middle section of bay.					
D. 5714 H. 5018	Brothers Lt., N. 40° E. Rt. Tang. Red Rk., S. 27° E. San Pedro Pt., N. 2° E.	5532	Feb. 28	10.15 a. m.	15 9	bk. S., M., Sh.
	Upper section of bay.					
D. 5715 H. 5019	Brothers Lt., S. 11° W. Rt. Tang. Sisters, N. 86° W. Pt. Pinole, N. 64° E.	5533	...do....	11.07 a. m.	9½ 13½	gy. S., gy. M.
D. 5716 H. 5020	Pt. Pinole, N. 80° E. Brothers Lt., S. 23° W. Rt. Tang. Sisters, S. 55° W.	5533	...do....	1.10 p. m.	6 9	sft. M.
D. 5717 H. 5021	Mare Id. Lt., N. 64° E. Pt. Pinole, S. 77° E. Brothers Lt., S. 29° W.	5533	...do....	2.05 p. m.	7 6¾	....do.
	Middle section of bay.					
D. 5718 H. 5022	Quarry Pt., S. Chauncey Pt., N. 57½° W. Southampton Lt., N. 76° E.	5532	Feb. 28	3.19 p. m.	7½ 9	gy. M.
	Upper section of bay.					
D. 5719 H. 5023	Pinole Pt., S. 52° E. Mare Id. Lt., N. 66° E. Brothers Lt., S. 30° W.	5533	Mar. 1	10.45 a. m.	6¼ 6	M.
D. 5720 H. 5024	Lft. Tang. Crockett Whf., S. 68° E. Rt. Tang. Selby Whf., S. 74° W. Carquinez Lt., N. 57° W.	5533	...do....	1.13 p. m.	14¾ 11	sft. M., m. S.
D. 5721 H. 5025	Carquinez Lt., N. 41° E. Mare Id. Lt., N. 32° W. Lft. Tang. Crockett Whf., S. 76° E.	5533	...do....	1.49 p. m.	8½ 8	M., S., St.
D. 5722 H. 5026	Carquinez Lt., N. 74° E. Lft. Tang. Selby Whf., E. Lone Tree Pt., S. 42° E.	5533	...do....	2.44 p. m.	5¼ 4¾	M., Sh.
	Lower section of bay.					
D. 5723 H. 5027	Rt. Tang. Mission Rk., N. 81° W. Goat Id. Lt., N. 1° E. Ferry Bldg., N. 46° W.	5531	Mar. 6	10.09 a. m.	9½ 11	bk. M., Sh.
D. 5724 H. 5028	Goat Id. Lt., N. 20½° W. Rt. Tang. Mission Rk., N. 53° W. Shag Rk., S. 45° W.	5531	...do....	1.21 p. m.	8¾ 9½	sft. M., Sh.
D. 5725 H. 5029	Goat Id. Lt., N. 21½° W. Shag Rk., S. 61° W. San Bruno Lt., S. 20° W.	5531	...do....	1.50 p. m.	7½ 7	sft. M.
D. 5726 H. 5030	Shag Rk., W. Goat Id. Lt., N. 17° W. San Bruno Lt., S. 23½° W.	5531	Mar. 8	10.38 a. m.	6¾ 7¼	bk. S., M.
D. 5727 H. 5031	Shag Rk., N. 63° W. Goat Id. Lt., N. 13° W. San Bruno Lt., S. 27° W.	5531	...do....	12.40 p. m.	6¼ 5¼	stk. bk. M.
D. 5728 H. 5032	Shag Rk., N. 36° W. Candlestick Pt., N. 57° W. San Bruno Lt., S. 27½° W.	5531	...do....	1.19 p. m.	5 5	S., bk. M., Sh.
D. 5729 H. 5033	Shag Rk., N. 28½° W. Candlestick Pt., N. 43° W. San Bruno Lt., S. 59° W.	5531	...do....	2.37 p. m.	4¾ 4¾	bk. M., Sh.
D. 5730 H. 5034	Shag Rk., N. 28½° W. San Bruno Lt., S. 77° W. Candlestick Pt., N. 39½° W.	5531	...do....	3.11 p. m.	5 5½	bk. M.

FRANCISCO BAY, CALIF., 1912–13, AND MARCH, 1914—Continued.

Temperature.			Salinity.		Apparatus.	Trial.		Drift.		Remarks.
Air.	Surf.	Botm.	Surf.	Botm.		Depth.	Duration.	Direction.	Distance.	
°F.	°F.	°F.					Min.		Mi.	
53.5	52.83	52.93	28.28	28.25	Tnr. cse.; Sigs. bot.; 4′ inter.; #12, #20.	Surf and botm.	7	Against tide.	.....	Ebb.
54.5	52.33	52.73	28.38	28.33	.....do.........	...do....	8	...do......	.....	Do.
60	50.00	......	......	......	5′ Tnr.; 19″ dr.	botm...	18	172°.......	0.8	Ebb.
64	50.00	......	......	......	5′ Tnr.; 19″ dr.	botm..	15½	199°.......	1.0	Ebb.
78	51.00	......	......	......	5′ Tnr.........	...do....	15	221°.......	1.0	Do.
78	51.00	......	......	......	.....do.........	...do....	13	224°.......	1.0	Do.
63	51.00	......	......	......	5′ Tnr.; 19″ dr.	botm..	22	124°.......	.9	Ebb. Quantities of worm tubes and ophiurians.
55	51.00	......	......	......	5′ Tnr.; 19″ dr.	botm..	20	44°........	.7	Flood. Boat dr. net lost.
54	52.00	......	......	......	5′ Tnr.; m. b...	...do....	11	258°.......	.4	Ebb.
54	52.00	......	......	......	9′ Ag.; m. b....	...do....	28½	265°.......	1.0	Do.
53	52.00	......	......	......	.....do.........	...do....	25¾	245°.......	1.0	Do.
54	50.00	......	......	......	5′ Tnr.; m. b...	botm..	3	121°.......	.3	Flood. Abundant ophiurians.
50	50.00	......	......	......	9′ Ag.; m. b....	...do....	10	172°.......	.4	Flood.
52	50.00	......	......	......	5′ Tnr.; m. b...	...do....	14	82°........	.4	Do.
51.5	51.50	......	......	......	9′ Ag.; m. b....	...do....	17	340°.......	.3	Ebb.
62.5	52.00	......	......	......	.....do.........	...do....	15	154°.......	.7	Flood.
62.5	52.00	......	......	......	5′ Tnr.; m. b...	...do....	35	162°.......	.7	Do.
62	52.00	......	......	......	9′ Ag.; m. b....	...do....	13	159°.......	.6	Do.
64.5	52.00	......	......	......	.....do.........	...do....	12	140°.......	.5	Do.

DREDGING AND HYDROGRAPHIC RECORDS SECURED IN SAN

Station number.	Position.	Chart.	Date.	Time of day.	Depth.	Character of bottom.
	Outside Golden Gate.					
D. 5731 H. 5035	Mile Rk. Lt., N. 71° E. Bonita Pt. Lt., N. 9° E. Lime Pt. Lt., N. 49° E.	*C. S.* 5532	1912. Mar. 11	9.47 a. m.	*fms.* 16 *fms.* 9¾	crs. S., P., Sh.
D. 5732 H. 5036	Mile Rk. Lt., N. 75° E. Bonita Pt. Lt., N. 37° E. Lime Pt. Lt., N. 56½° E.	5532	...do...	10.31 a. m.	*fms.* 11¾ *fms.* 9½	crs. S., G.
D. 5733 H. 5037	Bonita Pt. Lt., N. 46° E. Lime Pt. Lt., N. 58° E. Mile Rk. Lt., N. 72° E.	5532	...do...	11.06 a. m.	*fms.* 9 *fms.* 8	fne. dk. S.
D. 5734 H. 5038	Bonita Pt. Lt., N. 67° E. Lime Pt. Lt., N. 71° E. Mile Rk. Lt., N. 87° E.	5532	...do...	12.40 p. m.	*fms.* 7¾ *fms.* 9½	fne. gy. S.
D. 5735 H. 5039	Bonita Pt. Lt., N. 67° E. Lime Pt. Lt., N. 71° E. Mile Rk. Lt., E.	5532	...do...	1.27 p. m.	*fms.* 9¾ *fms.* 10	...do...
D. 5736 H. 5040	Bonita Pt. Lt., N. 67° E. Lime Pt. Lt., N. 72° E. Mile Rk. Lt., S. 85½° E.	5532	...do...	2.11 p. m.	*fms.* 9¾ *fms.* 10	...do...
D. 5737 H. 5041	Bonita Pt. Lt., N. 63¼° E. Fort Pt. Lt., N. 81° E. Mile Rk. Lt., S. 83° E.	5532	...do...	2.46 p. m.	*fms.* 10½ *fms.* 13	...do...
	Middle section of bay.					
D. 5738 H. 5042	Mile Rk. Lt., S. 33° W. Bonita Lt., S. 87° W. Lime Pt. Lt., N. 47° E.	5532	Mar. 13	9.30 a. m.	*fms.* 60 *fms.* 23	R., sh. S.
D. 5739 H. 5043	Alcatraz Lt., S. 24½° W. Southampton Lt., N. 9° E. Blunt Pt., S. 71½° W.	5532	...do...	10.56 a. m.	*fms.* 18 *fms.* 22	S., s. M.
D. 5740 H. 5044	Alcatraz Lt., S. 69° W. Rt. Tang. Angel Id., N. 33° W. Rt. Tang. Goat Id., S. 35½° E.	5532	...do...	1.21 p. m.	*fms.* 7 *fms.* 5¾	fne. gy. S., gy.-gn. M.
D. 5741 H. 5045	Belvedere Pt., S. 52° W. Lft. Tang. Angel Id., S. 85° E. Rt. Tang. Bluff Pt., N. 10° E.	5532	Mar. 18	9.34 a. m.	*fms.* 19¾ *fms.* 18	crs. gy. S., Sh., St.
D. 5742 H. 5046	Belvedere Pt., S. 55° W. Rt. Tang. Bluff Pt., N. 30° W. Lft. Tang. Angel Id., N. 52½° W.	5532	...do...	10.02 a. m.	*fms.* 20½ *fms.* 20	crs. gy. S., Sh., St., bk. M.
D. 5743 H. 5047	Alcatraz Lt., S. 75½° W. Southampton Lt., N. 2° W. Rt. Tang. Goat Id., S. 42° E.	5532	...do...	10.50 a. m.	*fms.* 10 *fms.* 15½	m. S.
D. 5744 H. 5048	Alcatraz Lt., S. 82° W. Southampton Lt., N. 30° W. Rt. Tang. Goat Id. S. 15½° W.	5532	...do...	1.23 p. m.	*fms.* 5½ *fms.* 5	s. M.
D. 5745 H. 5049	Alcatraz Lt., N. 75° W. Southampton Lt., N. 11° W. Lft. Tang. Goat Id., S. 80° E.	5532	...do...	3.12 p. m.	*fms.* 14½ *fms.* 12½	gy. S., blk. M., Sh.
D. 5746 H. 5050	Belvedere Pt., N. 84° W. Angel Id. Lt., S. 56° E. Lft. Tang. Angel Id., N. 59½° E.	5532	...do...	4.09 p. m.	*fms.* 18 *fms.* 18	gy. S., P., Sh., M.
D. 5747 H. 5051	Southampton Lt. to Rt. Tang. Red Rk., 74° 39′. Rt. Tang. Red Rk. to Brothers Lt., 53° 39′.	5532	Mar. 19	9.52 a. m.	*ft.* 4 *fms.* 5	dk. stk. M.
D. 5748 H. 5052	Tang. Pt. Chauncey to Rt. Tang. Red Rk., 64° 40′. Rt. Tang. Red Rk. to Brothers Lt., 27° 27′.	5532	...do...	10.34 a. m.	*ft.* 4 *fms.* 5	...do...
D. 5749 H. 5053	California Pt. to Rt. Tang. Red Rk., 50° 29′. Rt. Tang. Red Rk. to Pt. San Pedro, 55° 43′.	5532	...do...	11.13 a. m.	*ft.* 5 *fms.* 5	dk. stk. M., Sh.
....	Sausalito.	....	...do...	....	....	....
D. 5750 H. 5054	Lft. Tang. Red Rk. to Brothers Lt., 46° 32′. Brothers Lt. to Lft. Tang. Sisters, 29° 54′.	5532	Mar. 20	10.12 a. m.	*ft.* 5 *fms.* 5	....

FRANCISCO BAY, CALIF., 1912–13, AND MARCH, 1914—Continued.

Temperature.			Salinity.		Apparatus.	Trial.		Drift.		Remarks.
Air.	Surf.	Botm.	Surf.	Botm.		Depth.	Duration.	Direction.	Distance.	
°F.	°F.	°F.					Min.		Mi.	
50.5	50.00	...	...	...	9′ Ag.; m. b...	Surf. and botm.	10¾	233°...	0.8	Ebb.
51.5	50.00	...	...	...	9′ Ag.; 19″ dr..	...do...	17	248°...	.8	Do.
52	51.00	...	...	...	9′ Ag.; m. b...	...do...	20	235°...	1.0	Do.
54	51.00	...	...	...	...do...	...do...	18	61°...	.8	Flood.
54.5	51.00	...	...	...	...do...	...do...	14	92°...	.6	Do.
55	51.00	...	...	...	...do...	...do...	13½	68½°...	.5	Do.
55	51.00	...	...	...	...do...	...do...	20	79½°...	.6	Do.
53.5	50.00	...	...	...	9′ Ag.; m. b...	Surf. and botm.	9	228°...	.8	Ebb.
51	50.00	...	...	...	5′ Tnr.; m. b...	...do...	15	178°...	.4	Do.
51	50.00	...	...	...	...do...	...do...	29	16°...	.4	Do.
52.5	50.00	...	...	...	9′ Ag.; m. b...	...do...	4	26½°...	.4	Flood.
53	50.00	...	...	...	...do...	...do...	11	3°...	.4	Do.
54	51.00	...	...	...	...do...	...do...	6	150½°...	.4	Flood. Large quantity living worms, molluscs, and brittle stars. Bridle-stops parted.
61	52.00	...	...	...	...do...	...do...	15	288°...	.5	Ebb. Quantities of worm tubes.
59	52.00	...	...	...	...do...	...do...	16	305½°...	.8	Do.
60	52.00	...	...	...	...do...	...do...	9	224°...	.5	Do.
58	50.00	...	...	...	3′ Tnr.; 19″ dr.	...do...	14 7	352°...	.27	Flood.
53	50.00	...	...	...	...do...	...do...	8 8	57°...	.25	Do.
53	50.00	...	...	...	...do...	...do...	21½ 14½	41°...	.7	Do.
...	...	...	...	...	...	...	...	...	...	Material collected from piles of Ferry Bldg.
54.5	51.00	...	...	...	...do...	botm...	33 16	70°...	.7	Flood.

DREDGING AND HYDROGRAPHIC RECORDS SECURED IN SAN

Station number.	Position.	Chart.	Date.	Time of day.	Depth.	Character of bottom.
	Middle section of bay—Con.	*C. S.*	1912.			
D. 5751 H. 5055	San Quentin Pt. to Lft. Tang. Red Rk., 60° 42′. Lft. Tang. Red Rk. to Brothers Lt., 47° 23′.	5532	Mar. 20	11.18 a. m.	*ft.* 4½ *fms.* 5	....
	Upper section of bay.					
D. 5752 H. 5056	Lft. Tang. Marin Id. to Lft. Tang. Red Rk., 49° 00′. Lft. Tang. Red Rk. to Lft. Tang. San Pablo Pt., 37° 02′.	5532	Mar. 20	1.03 p. m.	*ft.* 5 *fms.* 5½	bn.-gy. M.........
	Middle section of bay.					
D. 5753 H. 5057	Rt. Tang. Sister to Lft. Tang. San Quentin Pt., 73° 30′. Lft. Tang. San Quentin Pt. to California Pt. 33° 48′.	5532	Mar. 20	1.54 p. m.	*ft.* 6 *fms.* 5	bn.-gy. M.........
D. 5754 H. 5058	Southampton Lt. to Alcatraz Lt., 92° 56′. Alcatraz Lt. to Rt. Tang. Goat Id., 60° 23′.	5532	Mar. 25	10.16 a. m.	*fms.* 4½ *ft.* 3½	bn. M.............
D. 5755 H. 5059	Southampton Lt. to Alcatraz Lt., 78° 36′. Alcatraz Lt. to Ferry Bldg., 62° 09′.	5532	...do.....	1.34 a. m.	*fms.* 3½ *ft.* 5	m. S., Sh..........
D. 5756 H. 5060	Brothers Lt. to Lft. Tang. San Quentin Pt., 64° 38′. Lft. Tang. San Quentin Pt. to Bluff Pt., 78° 44′.	5532	Mar. 26	10.13 a. m.	*fms.* 4½ *fms.* 2	gy. M.............
	Upper section of bay.					
D. 5757 H. 5061	Rt. Sister Id. to Lft. Tang. Marin Id., 66° 56′. Lft. Tang. Marin Id. to Brothers Lt., 38° 03′.	5532	Mar. 26	11.08 a. m.	*fms.* 4 *ft.* 4½	m. S..............
D. 5758 H. 5062	Brothers Lt., 236°, 0.33 mile..	5532	...do.....	1.07 p. m.	*fms.* 2 *ft.* 4	gy. M.............
D. 5759 H. 5063	End of brickworks pier, indicated on chart.	5533	Apr. 1	12.45 p. m.	*fms.* 4 *fms.* 3½	dk. gy. stk. M.....
D. 5760 H. 5064	Pt. Edith Beacon, 84°, 1.65 miles.	5534	Apr. 2	9.06 a. m.	*fms.* 2½ *ft.* 3	S., Ml.............
D. 5761 H. 5065	Pt. Edith Beacon, 230°, 0.4 mile.	5534	...do.....	9.55 a. m.	*fms.* 3 *fms.* 5	m. S..............
	Middle section of bay.					
D. 5762 H. 5066	Began 25 yds. off Pt. Stuart and along shore at distances of from 20-50 yds.; along south side of Angel Id.	5532	Apr. 3	....	*fms.* 3½ *fms.* 3½	R.................
D. 5763 H. 5067	See chart. Stood up Raccoon St. at distances of from 25-50 yds. from shore.	5532	...do.....	....	*fms.* 2 *fms.* 5½	E. G ....

FRANCISCO BAY, CALIF., 1912–13, AND MARCH, 1914—Continued.

Temperature.			Salinity.		Apparatus.	Trial.		Drift.		Remarks.
Air.	Surf.	Botm.	Surf.	Botm.		Depth.	Duration.	Direction.	Distance.	
°F.	°F.	°F.					Min.		Mi.	
50.5	52.00	......	......	......	3′ Tnr.; 19″ dr.	botm...	13 9	120°......	0.6	Flood.
55	52.00	......	......	......	3′ Tnr.; 19″ dr.	botm...	3 2	140°......	.2	Flood.
58	52.00	......	......	......	3′ Tnr.; 19″ dr.	botm...	1 2	299°......	.1	Flood.
52	50.00	......	......	......	....do........	..do...	6 7	77°......	3.4	Ebb. Operations conducted from launch.
59.5	50.00	......	......	......	....do........	..do...	47 16½	332°......	1.0	Flood. Operations conducted from launch.
62	50.00	......	......	......	....do........	..do...	7 5½	127°......	.6	Ebb. Operations conducted from launch.
70	51.00	......	......	......	3′ Tnr.; 19″ dr.	botm...	12 9	56°......	.6	Ebb. Operations conducted from launch.
58	52.00	......	......	......	....do........	..do...	21 10	92°......	.7	Do.
56	53.00	......	......	......	....do........	..do...	110	11½° [a]...... 325° [b]......	2.7	Flood. Operations conducted from launch.
50	49.00	......	......	......	....do........	..do...	10 10	73°......	1.1	Flood and ebb. Operations conducted through change of tide from launch.
54	49.00	......	......	......	....do........	..do...	45 19	73°......	1.4	Do.
......	......	......	......	......	3′ Tnr.; 19″ dr.	botm...	......	130°......	.8	Hauled twice on run, but before third haul, dr. was lost with 20 fms. line. Flood. Operations conducted from launch.
......	......	......	......	......	....do........	..do...	......	42°......	.5	Ebb and flood. Operations conducted through change of tide from launch. Places dredged are indicated on chart by black line. Entire run is indicated by dotted line. Dr. down twice on this run, then ran over in same direction. Dredged off sand beaches in only two places.

[a] For 0.9 mile. [b] For 1.8 mile.

DREDGING AND HYDROGRAPHIC RECORDS SECURED IN SAN

Station number.	Position.	Chart.	Date.	Time of day.	Depth.	Character of bottom.
	Middle section of bay—Con.	*C. S.*	1912.		*Fms.*	
D. 5764 H. 5068	Pt. Campbell, 287°, 0.8 mile..	5532	Apr. 3	....	4¾ 2¼	E. G.............
D. 5765 H. 5069	Pt. Blunt, 84°, 120 yds........	5532	...do.....	....	1¾ 2½	S.................
	Lower section of bay.					
D. 5766 H. 5070	In Alameda Channel, 3.87 miles from end of piers.	5532	Apr. 8	1.03 p. m.	3 4	gy. M.............
D. 5767 H. 5071	Goat Id. Lt., Ferry Bldg., 23° 57′. Ferry Bldg., Hunter's Pt., 79° 12′.	5532	Apr. 9	10.44 a. m.	3 1¼	m. S..............
D. 5768 H. 5072	Goat Id. Lt., Ferry Bldg., 22° 48′. Ferry Bldg., Pt. Avisadero, 75° 22′.	5532	...do.....	1.25 p. m.	3½ 1¾	hrd. Sh...........
	Middle section of bay.					
D. 5769	Fort Pt. Lt., 19½°, 0.8 mile..	5532	Apr. 15	9.45 a. m.	3¼ 3	hrd. S?...........
D. 5770 H. 5073	Bonita Pt. Lt., 199½°, 0.25 mile.	5532	...do.....	10.37 a. m.	5 7½	R.................
D. 5771 H. 5074	Sausalito Pt., 169½°, 150 yds..	5532	...do.....	1.09 p. m.	3¼ ½	bn. M.............
D. 5772 H. 5075	Belvedere Pt., 123½°, 0.7 mile.	5532	...do.....	2.57 p. m.	1¼ 4½	sft. M............
D. 5773 H. 5076	Yellow Bluff, 154°, 0.44 mile..	5532	...do.....	3.55 p. m.	3½ 2¾	R., St............
D. 5774 H. 5077	Lime Pt. Lt., 68°, 200 yds....	5532	Apr. 16	9.45 a. m.	4½ 4¾	G., R.............
D. 5775 H. 5078	Pt. Cavallo, 263°, 25 yds.....	5532	...do.....	10.45 a. m.	7 4	R.................
D. 5776 H. 5079	Mile Rk. Lt., 276°, 1.12 miles.	5532	Apr. 17	9.48 a. m.	3½ 3¼	fne. gy. S., R......
D. 5777 H. 5080	Fort Pt. Lt., 241°, 140 yds...	5532	...do.....	10.44 a. m.	3½ 2¾	R.................
D. 5778 H. 5081	Fort Pt. Lt., 288½°, 0.32 mile..	5532	...do.....	11.00 a. m.	3½ 2¾	gy. S., St.........

FRANCISCO BAY, CALIF., 1912–13, AND MARCH, 1914—Continued.

Temperature.			Salinity.		Apparatus.	Trial.		Drift.		Remarks.
Air.	Surf.	Botm.	Surf.	Botm.		Depth.	Duration.	Direction.	Distance.	
°F.	°F.	°F.					Min.		Mi.	
......	......	......	......	......	3' Tnr.; 19" dr.	botm...	......	159°......	0.62	Ebb and flood. Operations conducted through change of tide from launch. Ran down on NE. and E. shore of Angel Id., 25-50 yds. off shore. Dr. down as indicated by black lines on chart.
......	......	......	......	......	....do........	...do...	......	288½°......	.48	Ebb and flood. Operations conducted through change of tide from launch. Ran along S. shore of Angel Id.; dr. down as indicated by black lines on chart.
63	55.00	......	......	......	3' Fnr.; 19" dr.	botm...	......	286°......	3.87	Flood. Operations conducted from launch.
52	52.50	......	......	......	....do........	...do...	33 28½	347°......	1.7	Ebb. Operations conducted from launch.
53.5	54.00	......	......	......	19" dr........	...do...	14 12 9	44½°[a].... 129½°.[a] 241°.[a]	3.00	Flood. Operations conducted from launch; beam trawl lost in beginning.
61.5	53.00	......	......	......	3' Tnr.; 19" dr.	botm...	6¾ 5	17°......	.48	Flood. Operations conducted from launch. No botm. samples taken.
61.5	53.00	......	......	......	....do........	...do...	29	86°......	1.2	Ebb. Along N. side Golden Gate. Both drs. caught frequently. Run with 3' Tnr. over same ground May 8, 1912.
60	54.00	......	......	......	....do........	...do...	54 26½	313°......	1.45	Ebb. Operations conducted from launch.
57	53.00	......	......	......	....do........	...do...	20½ 9½	128°......	.7	Do.
57	53.00	......	......	......	....do........	...do...	14½ 7½	148°......	.38	Do.
59	55.00	......	......	......	....do........	...do...	16 16	264°......	.6	Flood. Operations conducted from launch. Stones covered with barnacles and bryozoas.
62	55.00	......	......	......	....do........	...do...	10 7	9°......	.25	Flood. Operations conducted from launch.
57	54.00	......	......	......	....do........	...do...	20 16	283½°......	.87	Do.
61	55.00	......	......	......	....do........	...do...	5 3½	112°......	.29	Do.
62	55.00	......	......	......	....do........	...do...	22½ 16	99½°......	.68	Do.

[a] For 1 mile.

DREDGING AND HYDROGRAPHIC RECORDS SECURED IN SAN

Station number.	Position.	Chart.	Date.	Time of day.	Depth.	Character of bottom.
	Upper section of bay.	C. S.	1912.		Fms.	
H. 5082	Brothers Lt., S. 13¼° E. Lft. Tang. Marin Ids., S. 51½° W. Rt. Tang. Sisters, N. 12° W.	5533	Apr. 23	10.55 a. m.	14½	M.
H. 5083	Brothers Lt., S. 27° W. Rt. Tang. Sisters, S. 69½° W. Pt. Pinole, N. 72° E.	5533	...do....	11.40 a. m.	6	....do.
H. 5084	Brothers Lt., S. 32¼° W. Rt. Tang. Sisters, S. 55½° W. Pt. Pinole, S. 73½° E.	5533	...do....	1.20 p. m.	6	....do.
H. 5085	Lone Tree Whf., S. 84° E. Mare Id. Lt., N. 65° E. Pt. Pinole, S. 40° E.	5533	...do....	1.55 p. m.	4¾	....do.
H. 5086	Mare Id. Lt., N. 63° E. Lone Tree Whf., S. 37½° E. Selby Whf., S. 88° E.	5533	...do....	2.35 p. m.	5	....do.
H. 5087	Mare Id. Lt., N. 32° W. Oleum Whf., S. 32° W. Carquinez Lt., N. 56¼° E.	5533	...do....	3.10 p. m.	10	....do.
H. 5088	Carquinez Lt., N. 55° W. Crockett Whf., S. 68¾° E. Selby Whf., S. 64° W.	5533	...do....	3.40 p. m.	14½	....do.
	Lower section of bay.					
H. 5089	Ferry Bldg., N. 83° W. Goat Id. Lt., N. 8° E. Pt. Avisadero, S. 5° E.	5531	Apr. 26	10.03 a. m.	12	bk. S.
H. 5090	Goat Id. Lt., N. 23° W. Lft. Tang. Mission Rk., N. 84° W. Pt. Avisadero, S. 18° W.	5531	...do....	10.37 a. m.	9¾	sft. M.
H. 5091	Shag Rk., S. 57° W. Goat Id. Lt., N. 16¼° W. San Bruno Lt., S. 17½° W.	5531	...do....	11.16 a. m.	9¾	....do.
H. 5092	Shag Rk., N. 52¼° W. San Bruno Lt., S. 17° W. Pt. Avisadero, N. 21° W.	5531	...do....	11.47 a. m.	7	M.
H. 5093	San Bruno Lt., S. 40½° W. Shag Rk., N. 33° W. No. 2 Beacon, S. 29° E.	5531	...do....	12.52 p. m.	4¾	....do.
H. 5094	No. 2 Beacon, S. 27½° E. San Bruno Lt., S. 67½° W. Shag Rk., N. 34½° W.	5531	...do....	1.17 p. m.	4½	....do.
H. 5095	No. 2 Beacon, S. 30½° E. San Bruno Lt., N. 89° W. Shag Rk., N. 29½° W.	5531	...do....	1.40 p. m.	4¾	....do.
H. 5096	No. 2 Beacon, S. 54° E. San Bruno Lt., N. 61½° W. Shag Rk., N. 26° W.	5531	...do....	2.10 p. m.	6	....do.
	Middle section of bay.					
H. 5097	Alcatraz Lt., S. 51° E. Lime Pt. Lt., S. 52¼° W. Angel Id. Lt., N. 22½° E.	5532	Apr. 29	12.59 p. m.	10	hrd.
H. 5098	Alcatraz Lt., S. 28¾° W. Pt. Blunt, N. 61° W. Southampton Lt., N. 10° E.	5532	...do....	1.48 p. m.	23½	....do.
H. 5099	Alcatraz Lt., S. 17½° W. Rt. Tang. Angel Id., N. 63° W. Southampton Lt., N. 20° E.	5532	...do....	2.15 p. m.	16	....do.
H. 5100	Southampton Lt., N. 64° E. Rt. Tang. Angel Id., S. 73° W. Rt. Tang. Red Rk., N. 11° W.	5532	...do....	2.39 p. m.	7½	M.

FRANCISCO BAY, CALIF., 1912–13, AND MARCH, 1914—Continued.

Temperature.			Salinity.		Apparatus.	Trial.		Drift.		Remarks.
Air.	Surf.	Botm.	Surf.	Botm.		Depth.	Duration.	Direction.	Distance.	
°F.	°F.	°F.					Min.		Mi.	
58	55.73	53.96	13.83	22.68	Tnr. cse.; Ek. bot.; 4′ inter.; #12, #20; Ek. smp.; Pr. m.	surf. and botm.	10	Against tide.	.....	Ebb, 3.03 knots per hr
60	55.43	54.81	16.17	....	.....do.........	...do....	10	...do.......	.....	Ebb, 2.09 knots per hr.
61.5	56.23	55.76	13.13	....	.....do.........	...do....	9	...do.......	.....	Ebb, 0.97 knot per hr.
59.5	56.23	55.96	....	8.09	.....do.........	...do....	10	...do.......	.....	Ebb, 0.52 knot per hr.
56.5	56.23	56.66	4.15	7.79	.....do.........	...do....	10	...do.......	.....	Ebb, 0.82 knot per hr.
56	56.03	55.91	3.75	9.71	.....do.........	...do....	20	...do.......	.....	Flood, 0.57 knot per hr.
59	56.23	55.91	3.25	9.03	.....do.........	...do....	10	...do.......	.....	Flood, 0.68 knot per hr.
54	55.33	52.86	25.85	29.06	Tnr. cse.: Ek. bot.; 4′ inter.; #12, #20; Ek. smp.; Pr. m.	surf. and botm.	10	Against tide.	.....	Ebb, 1.96 knots per hr. Cable out 8 fms.
54.5	54.63	53.71	26.55	27.79	.....do.........	...do....	9	...do.......	.....	Ebb, 1.91 knots per hr. Cable out 7 fms.
55	55.73	54.81	26.21	26.39	.....do.........	...do....	12	...do.......	.....	Ebb, 2.23 knots per hr. Cable out 8 fms.
56	55.73	55.36	24.85	....	.....do.........	...do....	8	...do.......	.....	Ebb. Cable out 5 fms.
56	55.73	56.86	....	27.01	.....do.........	...do....	12	...do.......	.....	Ebb, 1.46 knots per hr. Cable out 8 fms.
56	57.53	57.01	27.17	27.08	.....do.........	...do....	11	...do.......	.....	Ebb, 1.42 knots per hr. Cable out 3 fms.
56	57.23	57.01	27.17	....	.....do.........	...do....	9	...do.......	.....	Ebb, 1.59 knots per hr. Cable out 3 fms.
56	57.53	57.11	26.87	27.31	.....do.........	...do....	10	...do.......	.....	Ebb, 1.58 knots per hr. Cable out 3½ fms.
56	52.03	51.81	31.36	31.61	Tnr. cse.; Ek. bot.; 4′ inter.; #12, #20; Ek. smp.; Pr. m.	surf. and botm.	12	Against tide.	.....	Ebb, 0.54 knot per hr. Cable out 28 fms. Botm. too hard for penetration by sampler; no botm. sample taken. Net towed for 5 min.
56	53.23	51.86	30.02	31.16	.....do.........	...do....	13	...do.......	.....	Ebb, 0.79 knot per hr. Cable out 20 fms. Botm. too hard; no sample taken.
55	53.73	52.01	29.95	30.79	.....do.........	...do....	9	...do.......	.....	Ebb, 1.89 knots per hr. Cable out 13 fms. Botm. too hard; no sample taken.
54	54.23	52.86	28.56	29.56	.....do.........	...do....	21	...do.......	.....	Ebb, 1.76 knots per hr.; 2.23 knots at 3.15 p. m. Cable out 4½ fms.

DREDGING AND HYDROGRAPHIC RECORDS SECURED IN SAN

Station number.	Position.	Chart.	Date.	Time of day.	Depth.	Character of bottom.
	Middle section of bay—Con.	C. S.	1912.		Fms.	
H. 5101	Rt. Tang. Red Rk., N. 5½° W. Lft. Tang. Bluff Pt., S. 47½° W. Southampton Lt., S. 69° E.	5532	Apr. 29	3.31 p. m.	12½	M.
H. 5102	Rt. Tang. Red Rk., N. 8° E. Lft. Tang. Bluff Pt., S. 8° W. Southampton Lt., S. 50° E.	5532	...do....	4.00 p. m.	7½	....do.
H. 5103	Rt. Tang. Red Rk., S. 53½° E. Southampton Lt., S. 51° E. Brothers Lt., N. 16° E.	5532	...do....	4.25 p. m.	8	hrd. M.
H. 5104	Rt. Tang. Red Rk., S. 62° E. Brothers Lt., N. 28° E. Southampton Lt., S. 36½° E.	5532	...do....	4.54 p. m.	9	....do.
	Upper section of bay.					
H. 5105	Brothers Lt., S. 4° E. Lft. Tang. Marin Ids., S. 59½° W. Rt. Tang. Sisters, N. 27½° W.	5533	Apr. 30	9.49 a. m.	14	M.
H. 5106	Brothers Lt., S. 22° W. Rt. Tang. Sisters, S. 62½° W. Pt. Pinole, N. 71½° E.	5533	...do....	10.13 a. m.	7	....do.
H. 5107	Brothers Lt., S. 28° W. Rt. Tang. Sisters, S. 50° W. Pt. Pinole, S. 71° E.	5533	...do....	10.41 a. m.	6¾	....do.
H. 5108	Lone Tree Whf., S. 83½° E. Mare Id. Lt., N. 65° E. Pt. Pinole, S. 37° W.	5533	...do....	11.18 a. m.	4	....do.
H. 5109	Mare Id. Lt., N. 63° E. Lone Tree Whf., S. 43° E. Selby Whf., N. 89° E.	5533	...do....	11.49 a. m.	6½	....do.
H. 5110	Mare Id. Lt., N. 44° W. Carquinez Lt., N. 40° E. Crockett Whf., S. 71° E.	5533	...do....	12.42 p. m.	9¾	....do.
H. 5111	Mare Id. Lt., N. 63° W. Selby Whf., S. 69° W. Crockett Whf., S. 67½° E.	5533	...do....	1.07 p. m.	15	....do.
	Lower section of bay.					
H. 5112	Goat Id. Lt., N. 19½° E. Ferry Bldg., N. 68° W. Pt. Avisadero, S. 11½° E.	5531	May 1	9.38 a. m.	14¾	S.
H. 5113	Goat Id. Lt., N. 14½° W. Lft. Tang. Mission Rk., N. 77½° W. Pt. Avisadero, S. 9½° W.	5531	...do....	10.12 a. m.	10	M.
H. 5114	Shag Rk., S. 63° W. Goat Id. Lt., N. 18° W. San Bruno Lt., S. 20° W.	5531	...do....	10.41 a. m.	9¾	....do.
H. 5115	Shag Rk., N. 42° W. San Bruno Lt., S. 18¼° W. Pt. Avisadero, N. 16¼° W.	5531	...do....	11.12 a. m.	7	....do.
H. 5116	San Bruno Lt., S. 40° W. Shag Rk., N. 38° W. No. 2 Beacon, S. 28° E.	5531	...do....	11.38 a. m.	5	....do.
H. 5117	Shag Rk., N. 31° W. No. 2 Beacon, S. 30½° E. San Bruno Lt., S. 69° W.	5531	...do....	12.05 p. m.	5½	....do.
H. 5118	No. 2. Beacon, S. 30° E. Shag Rk., N. 32° W. San Bruno Lt., N. 88° W.	5531	...do....	12.29 p. m.	5	....do.
H. 5119	No. 2 Beacon, S. 36½° E. San Bruno Lt., N. 63° W. Shag Rk., N. 28° W.	5531	...do....	1.00 p. m.	4¾	....do.
	Middle section of bay.					
H. 5120	Angel Id. Lt., N. 12° E. Alcatraz Lt., S. 48½° E. Lime Pt. Lt., S. 55½° W.	5532	May 6	11.09 a. m.	11¾	hrd.

FRANCISCO BAY, CALIF., 1912–13, AND MARCH, 1914—Continued.

Temperature.			Salinity.		Apparatus.	Trial.		Drift.		Remarks.
Air.	Surf.	Botm.	Surf.	Botm.		Depth.	Duration.	Direction.	Distance.	
°F.	°F.	°F.					Min.		Mi.	
53	54.23	52.81	26.71	29.89	Tnr. cse.; Ek. bot.; 4′ inter.; #12, #20; Ek. smp.; Pr. m.	surf. and botm.	13	Against tide.	.....	Ebb, 2.36 knots per hr. Cable out 10 fms.
54	54.83	53.81	25.30	27.48	.....do.........	...do....	12	...do......	.....	Ebb, 2.49 knots per hr. Cable out 5 fms.
54.5	55.53	54.11	23.31	26.39	.....do.........	...do....	7	...do......	.....	Ebb, 2.41 knots per hr. Cable out 5½ fms.
55	55.53	55.26	22.29	23.64	.....do.........	...do....	10	...do......	.....	Ebb, 2.14 knots per hr. Cable out 7 fms.
57.5	55.63	54.86	19.75	23.29	Tnr. cse.; Ek. bot.; 4′ inter.; #12, #20; Pr. m.	surf. and botm.	10	Against tide.	.....	Flood, 2.05 knots per hr. Cable out 11 fms.
58	55.63	55.01	19.96	22.05	.....do.........	...do....	10	...do......	.....	Flood, 2.52 knots per hr. Cable out 8 fms.
57	56.03	55.06	18.95	21.89	.....do.........	...do....	12	...do......	.....	Flood, 2.47 knots per hr. Cable out 7 fms.
57.5	56.03	55.91	17.08	17.22	.....do.........	...do....	11	...do......	.....	Flood, 1.71 knots per hr. Cable out 3½ fms.
58.5	56.93	56.56	14.00	14.00	.....do.........	...do....	10	...do......	.....	Flood, 1.64 knots per hr. (at surf.), 1.37 per hr. (at botm.). Cable out 4 fms.
59	56.73	56.81	12.45	14.29	.....do.........	...do....	7	...do......	.....	Flood, 1.10 knots per hr. Cable out 7 fms.
59	57.63	56.96	9.96	13.35	.....do.........	...do....	13	...do......	.....	Flood, 0.88 knot per hr. Cable out 10 fms.
55	54.73	54.71	26.58	27.89	Tnr. cse.; Ek. bot.; 4′ inter.; #12, #20; Pr. m.	surf. and botm.	14	Against tide.	.....	Flood, 2.90 knots per hr. Cable out 12 to 14 fms.
55	54.93	54.86	27.33	27.85	.....do.........	...do....	15	...do......	.....	Flood, 1.59 knots per hr. Cable out 8 fms.
57	55.53	55.56	27.26	27.79	.....do.........	...do....	15	...do......	.....	Flood, 2.41 knots per hr. Cable out 7 fms.
58	55.73	55.86	27.01	27.01	.....do.........	...do....	11	...do......	.....	Flood, 1.64 knots per hr. Cable out 5 fms.
58	56.53	56.76	27.17	27.01	.....do.........	...do....	11	...do......	.....	Flood, 0.85 knot per hr. Cable out 3-2 fms.
58	57.63	57.71	27.01	27.01	.....do.........	...do....	10	...do......	.....	Flood, 0.63 knot per hr. Cable out 3 fms.
56.5	57.63	57.71	26.87	27.01	.....do.........	...do....	12	...do......	.....	Flood, 0.48 knot per hr. Cable out 3 fms.
55	57.33	57.06	26.87	26.78	.....do.........	...do....	10	...do......	.....	Do.
57	56.33	55.16	26.55	27.79	Tnr. cse.; Ek. bot.; 4′ inter.; #12, #20; Pr. m.	surf. and botm.	30	Against tide.	.....	Flood, 0.54 knot per hr. Cable out 9 fms.

DREDGING AND HYDROGRAPHIC RECORDS SECURED IN SAN

Station number.	Position.	Chart.	Date.	Time of day.	Depth.	Character of bottom.
	Middle section of bay—Con.	*C. S.*	1912.		*Fms.*	
H. 5121	Alcatraz Lt., S. 25½° W. Blunt Pt., N. 54° W. Southampton Lt., N. 12° E.	5532	May 6	11.38 a. m.	24½	hrd. M.
H. 5122	Alcatraz Lt., S. 19° W. Rt. Tang. Angel Id., S. 47° W.	5532	...do	12.29 p. m.	17	S., M.
H. 5123	Southampton Lt., N. 70° E. Rt. Tang. Red Rk., N. 12° W. Rt. Tang. Angel Id., S. 65° W.	5532	...do	12.59 p. m.	8	M.
H. 5124	Rt. Tang. Red Rk., N. 7° W. Lft. Tang. Bluff Pt., S. 39° W. Southampton Lt., S. 61° E.	5532	...do	1.26 p m.	14	...do
H. 5125	Rt. Tang. Red Rk., N. 8½° E. Lft. Tang. Bluff Pt., S. 6° W. Southampton Lt., S. 49° E.	5532	...do	1.51 p. m.	7½	hrd
H. 5126	Brothers Lt., N. 12½° E. Rt. Tang. Red Rk., N. 52° E. Southampton Lt., S. 46° E.	5532	...do	2.15 p. m.	7½	hrd. M.
H. 5127	Brothers Lt., N. 28½° E. Rt. Tang. Red Rk., S. 55° E. Southampton Lt., S. 35° E.	5532	...do	2.44 p. m.	9	...do
D. 5779	Alcatraz Lt., 51°, 1.83 miles.	5532	May 8	9.36 a. m.	3 3	gy. S., R.
	Upper section of bay.					
D. 5780	Pt. Pinole, S. 43° E. Mare Id. Lt., N. 66° E. Brothers Lt., S. 32½° W.	5533	May 13	12.40 p. m.	5 1	gy. M., Sh.
	Middle section of bay.					
H. 5128	Alcatraz Lt., S. 44° E. Lime Pt. Lt., S. 64° W. Angel Id. Lt., N. 6° W.	5532	May 14	7.00 a. m.	15	
	...do	5532	...do	7.55 a. m.	15	
	...do	5532	...do	8.55 a. m.	15	
	...do	5532	...do	9.55 a. m.	15	
	...do	5532	...do	10.55 a. m.	15	
	...do	5532	...do	11.55 a. m.	15	
	...do	5532	...do	12.55 p. m.	15	
	...do	5532	...do	1.55 p. m.	15	
	...do	5532	...do	2.55 p. m.	15	
	...do	5532	...do	3.55 p. m.	15	
	...do	5532	...do	4.55 p. m.	15	
	...do	5532	...do	5.55 p. m.	15	
H.5129A	Southampton Lt., 321°, 2½ miles.	5532	May 15		4½	
H.5129B	Southampton Lt., 309½°, 2.7 miles	5532	...do		3	
H.5129C	Berkeley Pier, 61°, 0.88 mile.	5532	...do		2	
H.5129D	Berkeley Pier, 283°, 0.43 mile.	5532	...do		3½	
	Lower section of bay.					
D. 5781	San Bruno Lt., N. 61° W. Shag Rk., N. 16° W. No. 2 Beacon, S. 47° E.	5531	May 27	12.27 p. m.	2½ ½	M., Sh.
D. 5782	San Bruno Lt., N. 50° W. San Mateo Pt., S. 86° W. No. 2 Beacon, S. 70° E.	5531	...do	3.00 p. m.	[illegible]	Sh.

FRANCISCO BAY, CALIF., 1912-13, AND MARCH, 1914—Continued.

Temperature.			Salinity.		Apparatus.	Trial.		Drift.		Remarks.
Air.	Surf.	Botm.	Surf.	Botm.		Depth.	Duration.	Direction.	Distance.	
°F.	°F.	°F.					Min.		Mi.	
56	56.13	54.61	22.99	....	Tnr. cse.; Ek. bot.; 4' inter.; #12; #20; Pr. m.	surf. and botm.	17	Against tide.	.....	Flood, 0.36 knot per hr. Cable out 20 fms.
55	58.33	54.16	20.82	28.88	.....do.........	...do....	10	...do.......	.....	Flood, 0.45 knot per hr. Cable out 13 fms.
58	58.63	54.71	19.70	28.88	.....do.........	...do....	14	...do.......	.....	Flood, 0.13 knot per hr. Cable out 4½ fms.
58	57.13	55.41	18.34	27.33	.....do.........	...do....	10	...do.......	.....	Flood, 1.33 knots per hr. Cable out 10 fms.
60	58.03	55.61	21.60	27.21	.....do.........	...do....	8	...do.......	.....	Flood, 1.51 knots per hr. Cable out 5 fms.
60	57.03	55.71	23.08	27.33	.....do.........	...do....	11	...do.......	.....	Flood, 1.53 knots per hr. Cable out 5 fms.
57	57.73	55.81	20.66	26.55	.....do.........	...do....	14	...do.......	.....	Flood, 1.19 knots per hr. Cable out 7-4-6½ fms.
58.5	54.00	......	....	....	3' Tnr.; 19" dr.	botm...	27 20	82°.........	1.8	Flood. Operations conducted from launch.
67	62.00	......	....	....	3' Tnr.; 19" dr.	botm...	73	316°.......	4.2	Ebb. Operations conducted from launch.
55	52.63	54.41	26.91	29.50	Ek. bot.; 4' inter.; Tnr. cse.; #12, #20; Pr. m.	surf. and botm.	10	Against tide.	.....	Flood, 1.33 knots per hr.
59	54.03	53.96	28.79	29.34	.....do.........	...do....	10	...do.......	.....	Flood, 2.63 knots per hr.
61	53.83	53.81	29.50	30.11	.....do.........	...do....	10	...do.......	.....	Flood, 2.27 knots per hr.
61	53.73	53.81	30.28	30.37	.....do.........	...do....	10	...do.......	.....	Flood, 2 knots per hr.
57	53.63	53.71	29.80	30.59	.....do.........	...do....	10	...do.......	.....	Flood, 1.33 knots per hr.
57	54.23	54.66	29.65	30.63	.....do.........	...do....	10	...do.......	.....	Flood, 0.40 knot per hr.
58	54.73	53.81	28.79	30.28	.....do.........	...do....	10	...do.......	.....	Ebb, 1.59 knots per hr.
56	56.03	53.86	27.33	28.47	.....do.........	...do....	10	...do.......	.....	Ebb, 2 knots per hr.
59	56.03	54.26	26.67	29.65	.....do.........	...do....	10	...do.......	.....	Ebb, 2.23 knots per hr.
59	57.53	54.16	25.92	28.88	.....do.........	...do....	10	...do.......	.....	Ebb, 1.55 knots per hr.
59	57.53	54.86	25.46	28.72	.....do.........	...do....	10	...do.......	.....	Ebb, 1.01 knots per hr.
59	57.53	55.21	25.00	28.56	.....do.........	...do....	10	...do.......	.....	Flood, 0.60 knot per hr.
....	......	......	....	....	Ek. smp.......	botm...	....	....	.....	Ebb. Operations conducted from launch.
....	......	......	....	....	.....do.........	...do....	....	....	.....	Do.
....	......	......	....	....	.....do.........	...do....	....	....	.....	Do.
....	......	......	....	....	.....do.........	...do....	....	....	.....	Do.
61	61.00	......	....	....	19" dr.........	botm...	47	220°.......	1.85	Ebb. Operations conducted from launch.
60	61.00	......	....	....	.....do.........	...do....	2	Circle.....	.3	Ebb. Operations conducted from launch. Made a circle in oyster bed and finished at starting pt.

DREDGING AND HYDROGRAPHIC RECORDS SECURED IN SAN

Station number.	Position.	Chart.	Date.	Time of day.	Depth.	Character of bottom.
	Lower section of bay—Con.	*C. S.*	1912.		*Fms.*	
D. 5783	San Mateo Pt., S. 70° W., 2.67 miles.	5531	May 28	12.36 p. m.	2 2	....
D. 5784	No. 2 Beacon, S. 36½° W., 0.95 mile.	5531	...do....	....	1½ 1¼	....
	Middle section of bay.					
....	Bonita Pt.	....	June 3	....	....	....
....	Halfway between Sausalito and Angel Id.	....	...do....	1.30 p. m.	....	....
....	Halfway between Angel Id. and Southampton Lt.	....	...do....	2.30 p. m.	....	....
....	Halfway between Sausalito and Angel Id.	....	June 10	1.20 p. m.	....	....
....	Halfway between Angel Id. and Southampton Lt.	....	...do....	2.25 p. m.	....	....
....	Halfway between Sausalito and Angel Id.	....	June 14	9.45 a. m.	....	....
....	Halfway between Angel Id. and Southampton Lt.	....	...do....	10.45 a. m.	....	....
....	Halfway between Sausalito and Angel Id.	....	June 17	2.00 p. m.	....	....
....	Halfway between Angel Id. and Southampton Lt.	....	...do....	3.00 p. m.	....	....
....	Halfway between Sausalito and Angel Id.	....	June 24	2.00 p. m.	....	....
....	Halfway between Angel Id. and Southampton Lt.	....	...do....	3.00 p. m.	....	....
....	Halfway between Sausalito and Angel Id.	....	June 27	2.00 p. m.	....	....
....	....do....	....	June 29	2.00 p. m.	....	....
....	Halfway between Angel Id. and Southampton Lt.	....	July 6	10.00 a. m.	....	....
....	Halfway between Sausalito and Angel Island.	....	...do....	11.30 a. m.	....	....
....	Off Golden Gate.	....	July 8	....	28 30	S.
....	Halfway between Sausalito and Angel Id.	....	July 14	9.45 p. m.	....	....
....	Halfway between Angel Id. and Southampton Lt.	....	...do....	10.25 p. m.	....	....
....	Off Golden Gate.	....	July 21	....	28 30	S.
H. 5130	Lime Pt. Lt., S. 58° W. Alcatraz Lt., S. 54° E. Angel Id. Lt., N. 16½° E.	5532	July 22	9.29 a. m.	13	hrd. S.
H. 5131	Southampton Lt., N. 14° E. Alcatraz Lt., S. 24° W. Blunt Pt., N. 49° W.	5532	...do....	10.04 a. m.	25	....do....
H. 5132	Southampton Lt., N. 11° E. Rt. Tang. Angel Id., N. 53° W. Lft. Tang. Angel Id., S. 54½° W.	5532	...do....	10.49 a. m.	19	....do....
H. 5133	Rt. Tang. Angel Id., S. 82° W. Rt. Tang. Red Rk., N. 14° W. Southampton Lt., N. 51° E.	5532	...do....	11.20 a. m.	9½	....do....
H. 5134	Rt. Tang. Red Rk., N. 4° W. Lft. Tang. Bluff Pt., S. 56° W. Southampton Lt., S. 75° E.	5532	...do....	11.49 a. m.	11½	S.
H. 5135	Rt. Tang. Red Rk., N. 2° E. Southampton Lt., S. 49½° E. Lft. Tang. Bluff Pt., S. 13½° W.	5532	...do....	1.01 p. m.	8	M.
H. 5136	Rt. Tang. Red Rk., N. 59° E. Southampton Lt., S. 47° E. Brothers Lt., N. 14° E.	5532	...do....	1.30 p. m.	7½	....do....
H. 5137	Rt. Tang. Red Rk., S. 65½° E. Brothers Lt., N. 26° E. Southampton Lt., S. 36° E.	5532	...do....	2.02 p. m.	8	hrd. S.

FRANCISCO BAY, CALIF., 1912–13, AND MARCH, 1914—Continued.

Temperature.			Salinity.		Apparatus.	Trial.		Drift.		Remarks.
Air.	Surf.	Botm.	Surf.	Botm.		Depth.	Duration.	Direction.	Distance.	
°F.	°F.	°F.					Min.		Mi.	
68	63.00	......	......	......	19" dr.	botm.	31	S. 54° E.	2.35	Ebb. Operations conducted from launch.
......	......	......	......	......	do.	do.	......	N. 59° E.	2.5	Do.
......	......	......	......	......	......	......	......	......	......	On piles between high and low tides.
......	......	......	......	......	4' inter.; #12, #20.	surf.	30	Against tide.	......	
......	......	......	......	......	do.	do.	30	do.	......	
......	......	......	......	......	do.	do.	20	do.	......	
......	......	......	......	......	do.	do.	30	do.	......	
......	......	......	......	......	do.	do.	20	do.	......	
......	......	......	......	......	do.	do.	20	do.	......	
......	......	......	......	......	do.	do.	20	do.	......	
......	......	......	......	......	do.	do.	20	do.	......	
......	......	......	......	......	do.	do.	20	do.	......	
......	......	......	......	......	do.	do.	20	do.	......	
......	......	......	......	......	do.	do.	20	do.	......	
......	......	......	......	......	do.	do.	20	do.	......	
......	......	......	......	......	do.	do.	20	do.	......	
......	......	......	......	......	do.	do.	20	do.	......	
......	......	......	......	......	seine	botm.	95	......	6.0	Trip made with Paladini Fish Co.; 4 hauls.
......	......	......	......	......	4' inter.; #12, #20.	surf.	20	Against tide.	......	
......	......	......	......	......	do.	do.	25	do.	......	
......	......	......	......	......	seine	botm.	90	......	6.0	Trip made with Paladini Fish Co.; 3 hauls.
57	57.73	57.71	31.05	31.36	Tnr. cse.; 4' inter.; #12, #20; Ek. bot.	surf. and botm.	15	Against tide.	......	Ebb. After getting under way net was towed 5 min.
57	60.73	57.86	29.47	31.10	do.	do.	14	do.	......	Ebb. Cable out 10 fms., towed 5 min.
59	60.23	58.11	30.11	31.05	do.	do.	11	do.	......	Ebb. Cable out 20 fms., towed 5 min. at 10 fms.
59	62.73	58.56	27.54	30.98	do.	do.	12½	do.	......	Ebb. Cable out 15 fms., towed 4 min.
66	64.63	58.56	24.39	30.33	do.	do.	18	do.	......	Ebb. Cable out 16 fms., towed 8 min.
66	64.73	60.36	28.07	28.88	do.	do.	16	do.	......	Ebb. Cable out 5-10 fms., towed 6 min.
67.5	64.13	60.86	27.21	28.79	do.	do.	17	do.	......	Ebb. Towed 2 min.
69	63.73	60.86	25.49	28.56	do.	do.	18½	do.	......	Ebb. Towed 8½ min.

DREDGING AND HYDROGRAPHIC RECORDS SECURED IN SAN

Station number.	Position.	Chart.	Date.	Time of day.	Depth.	Character of bottom.
	Lower section of bay.	*C. S.*	1912.		*Fms.*	
H. 5138	Goat Id. Lt., N. 23° E....... Ferry Bldg., N. 81° W. Rt. Tang. Mission Rk., N. 34½° W.	5531	July 23	10.03 a. m.	12	M..............
H. 5139	Goat Id. Lt., N. 17° W...... Ferry Bldg., N. 56° W. Rt. Tang. Mission Rk., N. 86° W.	5531	...do.....	10.36 a. m.	12	.....do..........
H. 5140	Goat Id. Lt., N. 16° W...... Shag Rk., S. 63½° W. San Bruno Lt., S. 17° W.	5531	...do.....	11.15 a. m.	9	.....do..........
H. 5141	Shag Rk., N. 52° W......... Candlestick Pt., N. 72° W. San Bruno Lt., S. 22° W.	5531	...do.....	11.54 a. m.	6½	.....do..........
H. 5142	Shag Rk., N. 36° W......... San Bruno Lt., S. 39½° W. No. 2 Beacon, S. 28° E.	5531	...do.....	1.02 p.m.	5¾	.....do..........
H. 5143	San Bruno Lt., S. 66° W..... No. 2 Beacon, S. 32° E. Shag Rk., N. 31½° W.	5531	...do.....	1.29 p. m.	5	sft. M..........
H. 5144	San Bruno Lt., W........... No. 2 Beacon, S. 31° E. Pt. Avisadero, N. 19° W.	5531	...do.....	1.57 p. m.	5	.....do..........
H. 5145	San Bruno Lt., N. 71° W.... No. 2 Beacon, S. 33° E. San Mateo Pt., S. 10° W.	5531	...do.....	2.28 p. m.	6½	M..............
	Upper section of bay.					
H. 5146	Brothers Lt., S. 2° W........ Lft. Tang. Sisters, N. 36° W. Pinole Pt., N. 58° E.	5533	July 24	10.08 a. m.	14	M..............
	.....do.....................	5533	...do.....	11.01 a. m.	....	....
	.....do.....................	5533	...do.....	11.49 a. m.	....	....
	.....do.....................	5533	...do.....	12.51 p. m.	....	....
H. 5147	Brothers Lt., S. 27° W....... Pinole Pt., S. 73° E. Rt. Tang. Sisters, S. 49° W.	5533	...do.....	1.39 p. m.	6½	M..............
H. 5148	Mare Id. Lt., N. 64° E....... Lone Tree Whf., S. 39½° E. Pinole Pt., S. 50° W.	5533	...do.....	2.44 p. m.	6	.....do..........
H. 5149	Carquinez Lt., N. 45° W..... Lft. Tang. Crockett Whf., S. 72° E. Rt. Tang. Selby Whf., S. 60½° W.	5533	...do.....	3.32 p. m.	13	hrd..............
	Middle section of bay.					
H. 5150	Rt. Tang. Red Rk., N. 62° E. Brothers Lt., N. 18½° E. Lft. Tang. Sisters, N. 2° E.	5532	July 29	9.05 a. m.	8½	M..............
H. 5151	Rt. Tang. Red Rk., N. 65° E.. Brothers Lt., N. 15½° E. Southampton Lt., S. 46° E.	5532	...do.....	9.28 a. m.	7½	.....do..........
H. 5152	Rt. Tang. Red Rk., N. 9½° E.. Southampton Lt., S. 52° E. Bluff Pt., S. 8½° W.	5532	...do.....	9.52 a. m.	7½	.....do..........
H. 5153	Bluff Pt., S. 45° W......... Southampton Lt., S. 59° E. Rt. Tang. Red Rk., N. 9° W.	5532	...do.....	10.16 a. m.	7½	.....do..........
H. 5154	Southampton Lt., N. 75° W. Rt. Tang. Angel Id., S. 63° W. Rt. Tang. Red Rk., N. 15½° W.	5532	...do.....	10.39 a. m.	8½	hrd. S..........
H. 5155	Southampton Lt., N. 12½° E.. Rt. Tang. Angel Id., N. 72° W. Lft. Tang. Angel Id., S. 40° W.	5532	...do.....	11.02 a. m.	13	.....do..........
H. 5156	Southampton Lt., N. 8° E... Alcatraz Lt., S. 28° W. Blunt Pt., N. 83° W.	5532	...do.....	11.22 a. m.	16	m. S..........

FRANCISCO BAY, CALIF., 1912–13, AND MARCH, 1914—Continued.

Temperature.			Salinity.		Apparatus.	Trial.		Drift.		Remarks.
Air.	Surf.	Botm.	Surf.	Botm.		Depth.	Duration.	Direction.	Distance.	
°F.	°F.	°F.					Min.		Mi.	
61	62.63	59.11	28.14	30.37	Trn. cse.; 4' inter.; #12, #20; Ek. bot.	surf. and botm.	16	Against tide.	.....	Ebb. Cable out 9 fms., towed 5 min.
61	62.73	60.86	28.47	29.34	.....do.........	...do....	18	...do......	.....	Ebb. Cable out 9 fms., towed 6 min. Nets filled with sand. Haul discarded.
61.5	63.23	62.21	28.26	28.74	.....do.........	...do....	18	...do......	.....	Ebb. Cable out 6-8-10 fms., because of small ebb; after getting under way towed 5 min.
63	64.73	62.86	27.98	28.23	.....do.........	...do....	19	...do......	.....	Ebb. Cable out 4-10 fms., towed 5 min.
63	65.53	63.71	27.68	27.98	.....do.........	...do....	17½	...do......	.....	Ebb. Cable out 3 fms., towed 5 m.
63.5	65.23	64.86	27.70	27.59	.....do.........	...do....	20	...do......	.....	Ebb. Cable out 3 fms., towed 4 m.
64	65.33	64.86	27.74	27.68	.....do.........	...do....	20	...do......	.....	Ebb. Cable out 3 fms., towed 5 m.
64	65.93	65.66	27.40	27.45	.....do.........	...do....	18	...do......	.....	Ebb. Cable out 3½ fms., towed 5 m.
66	63.23	61.36	25.18	28.35	Trn. cse.; 4' inter.; #12, #20; Ek. bot.	surf. and botm.	......	....	.....	Flood.
69	63.03	61.06	25.77	28.62	.....do.........	...do....	......	....	.....	Do.
69.5	65.03	60.96	25.39	28.79	.....do.........	...do....	......	....	.....	Slack.
69.5	63.23	......	26.39	28.79	.....do.........	...do....	18	Against tide.	.....	Ebb. Cable out 10 fms., towed 5 m.
68.5	64.53	62.86	25.39	26.23	.....do.........	...do....	16	...do......	.....	Ebb. Cable out 3-10 fms., towed 4 m.
69	67.23	65.06	18.60	22.07	.....do.........	...do....	18	...do......	.....	Ebb. Cable out 4-16 fms., towed 5 m.
69	66.73	66.01	15.16	18.63	.....do.........	...do....	16	...do......	.....	Ebb. Cable out 10 fms., towed 5 m.
57	64.33	62.86	22.32	26.49	Trn. cse.; 4' inter.; #12; #20; Ek. bot.	surf. and botm.	11	Against tide.	.....	Flood. Cable out 6 fms.
57	63.73	62.91	25.77	26.54	.....do.........	...do....	11½	...do......	.....	Do.
57	62.73	62.86	26.39	26.39	.....do.........	...do....	11	...do......	.....	Flood. Cable out 5 fms.
57	61.73	60.11	27.65	29.43	.....do.........	...do....	11	...do......	.....	Do.
57.5	62.03	60.16	27.30	29.56	.....do.........	...do....	11	...do......	.....	Flood. Cable out 6 fms.
58	60.43	58.81	28.95	30.50	.....do.........	...do....	11	...do......	.....	Flood. Cable out 12 fms.
58	58.23	58.01	30.96	30.98	.....do.........	...do....	11½	...do......	.....	Flood. Cable out 13-15 fms.

DREDGING AND HYDROGRAPHIC RECORDS SECURED IN SAN

Station number.	Position.	Chart.	Date.	Time of day.	Depth.	Character of bottom.
	Middle section of bay—Con.	*C. S.*	1912.		*Fms.*	
H. 5157	Alcatraz Lt., S. 46° E. Angel Id. Lt., N. 8° E. Lime Pt. Lt., S. 55° W.	5532	July 29	12.01 p. m.	13	hrd. S.
	Lower section of bay.					
H. 5158	San Bruno Lt., N. 65° W. No. 2 Beacon, S. 36° E. San Mateo Pt., S. 15½° W.	5531	July 30	8.53 a. m.	6	sft. M.
H. 5159	San Bruno Lt., N. 85° W. No. 2 Beacon, S. 32° E. Pt. Avisadero, N. 23° W.	5531	...do...	9.20 a. m.	5	...do...
H. 5160	San Bruno Lt., S. 69½° W. No. 2 Beacon, S. 30° E. Shag Rk., N. 33° W.	5531	...do...	9.43 a. m.	4¾	M.
H. 5161	Shag Rk., N. 35° W. San Bruno Lt., S. 43° W.	5531	...do...	10.08 a. m.	5	...do...
H. 5162	Shag Rk., N. 47° W. San Bruno Lt., S. 18° W. Candlestick Pt., N. 72° W.	5531	...do...	10.38 a. m.	6¾	hrd. M.
H. 5163	Goat Id. Lt., N. 21° W. Shag Rk., S. 60° W. San Bruno Lt., S. 19° W.	5531	...do...	11.10 a. m.	8	M.
H. 5164	Goat Id. Lt., N. 18½° W. Ferry Bldg., N. 50° W. Rt. Tang. Mission Rk., N. 83° W.	5531	...do...	11.46 a. m.	10	...do...
H. 5165	Goat Id. Lt., N. 27° W. Ferry Bldg., N. 67° W. Rt. Tang. Mission Rk., S. 26½° E.	5531	...do...	12.26 p. m.	12½	...do...
	Upper section of bay.					
H. 5166	Carquinez Lt., N. 34° W. Lft. Tang. Crockett Whf., S. 79° E. Rt. Tang. Selby Whf., S. 66° W.	5533	July 31	11.58 a. m.	10½	gy. S.
H. 5167	Mare Id. Lt., N. 53½° W. Carquinez Lt., N. 43° E. Lone Tree Whf., S. 35½° W.	5533	...do...	12.19 p. m.	7	M.
H. 5168	Mare Id. Lt., N. 60° E. Lone Tree Whf., S. 40½° E. Pinole Pt., S. 53° W.	5533	...do...	12.57 p. m.	6	...do...
H. 5169	Lone Tree Whf., S. 83½° E. Pinole Pt., S. 35½° W. Mare Id. Lt., N. 67° E.	5533	...do...	1.30 p. m.	5	...do...
H. 5170	Brothers Lt., S. 30° W. Rt. Tang. Sisters, S. 53° W. Pinole Pt., S. 73° E.	5533	...do...	2.21 p. m.	7	...do...
H. 5171	Pinole Pt., N. 74½° E. Brothers Lt., S. 26° W. Rt. Tang. Sisters, S. 63° W.	5533	...do...	2.48 p. m.	6¾	...do...
H. 5172	Rt. Tang. Marin Ids., S. 65½° W. Lft. Tang. Sisters, N. 41½° E. Brothers Lt., S.	5533	...do...	3.21 p. m.	13	...do...
	Middle section of bay.					
......	Bonita Pt.	......	Aug. 1	......	......	......
......	Presidio shore (west of Fort Pt.).	......	...do...	......	......	......
......	Key Route Pier (mud flats north of).	......	Aug. 2	......	......	......
......	Key Route Pier (cement sewer).	......	...do...	......	......	......
......	Red Rk.	......	Aug. 3	......	......	......
......	Richmond (Standard Oil Pier).	......	...do...	......	......	......
......	Halfway between Angel Id. and Southampton Lt.	......	Aug. 21	9.10 a. m.	......	......
......	...do...	......	...do...	10.10 a. m.	......	......
......	300 yds. SE. Pt. Diablo.	......	Aug. 30	2.00 p. m.	......	......
......	Between Angel Id. and Sausalito.	......	Sept. 6	9.30 a. m.	......	......

FRANCISCO BAY, CALIF., 1912–13, AND MARCH, 1914—Continued.

Temperature.			Salinity.		Apparatus.	Trial.		Drift.		Remarks.
Air.	Surf.	Botm.	Surf.	Botm.		Depth.	Duration.	Direction.	Distance.	
°F.	°F.	°F.					Min.		Mi.	
58	56.63	56.71	31.79	31.90	Trn. cse.; 4′ inter.; #12, #20; Ek. bot.	surf. and botm.	12½	Against tide.	.....	Flood. Cable out 11 fms.
60	66.83	66.86	27.85	27.87	Trn. cse.; 4′ inter.; #12, #20; Ek. bot.	surf. and botm.	12	Against tide.	.....	Flood. Cable out 4 fms.
61.5	66.53	66.76	27.91	27.82	.....do.........	...do....	12	...do.......	.....	Flood. Cable out 4½ fms.
62	65.73	65.81	27.94	27.87	.....do.........	...do....	9	...do.......	.....	Flood. Cable out 3½ fms.
63	64.03	63.91	28.33	28.33	.....do.........	...do....	8½	...do.......	.....	Do.
63.5	63.83	62.71	28.49	28.79	.....do.........	...do....	10	...do.......	.....	Flood. Cable out 4 fms.
64	63.33	63.31	28.51	28.64	.....do.........	...do....	10½	...do.......	.....	Flood. Cable out 6 fms.
65.5	61.73	61.56	29.10	29.18	.....do.........	...do....	8	...do.......	.....	Flood. Cable out 8 fms.
65.5	60.63	58.81	30.11	30.83	.....do.........	...do....	11	...do.......	.....	Flood. Cable out 10 fms.
65	65.03	65.71	9.96	12.89	Trn. cse.; 4′ inter.; #12. #20; Ek. bot.	surf. and botm.	19½	Against tide.	.....	Flood. Cable out 8–11 fms., towed 9½ min. under way. Surf. 10 min. later because therm. did not trip.
65	65.23	65.36	11.35	16.11	.....do.........	...do....	14	...do.......	.....	Flood. Cable out 11 fms., towed 3 min. under way.
67	65.53	65.56	16.63	16.94	.....do.........	...do....	10	...do.......	.....	Flood. Cable out 4 fms.
66	65.03	64.86	21.91	22.05	.....do.........	...do....	10	...do.......	.....	Flood. Cable out 6 fms.
64.5	63.73	62.91	24.85	25.94	.....do.........	...do....	11	...do.......	.....	Flood. Cable out 5 fms.
64	62.93	62.41	26.47	27.01	.....do.........	...do....	11½	...do.......	.....	Do.
64	62.73	60.56	28.25	29.23	.....do.........	...do....	10½	...do.......	.....	Do.
....	.....	......	......	......	....	....	......	....	.....	On piles between high and low tides.
....	.....	......	......	......	....	....	......	....	.....	On beach between high and low tides.
....	.....	......	......	......	....	....	......	....	.....	Between high and low tides.
....	.....	......	......	......	....	....	......	....	.....	Do.
....	.....	......	......	......	....	....	......	....	.....	Do.
....	.....	......	......	......	....	....	......	....	.....	Do.
....	.....	......		......	4′ inter.; #12, #20.	surf....	30	Against tide.	.....	
....	.....	......		......	.....do.........	...do....	30	...do.......	.....	
....	.....	......		......	.....do.........	...do....	30	...do.......	.....	
....	.....	......		......	.....do.........	...do....	25	...do.......	.....	

DREDGING AND HYDROGRAPHIC RECORDS SECURED IN SAN

Station number.	Position.	Chart.	Date.	Time of day.	Depth.	Character of bottom.
	Middle section of bay—Con.	*C. S.*	1912.		*Fms.*	
....	Off Golden Gate	....	Sept. 9	....	28 30	S.
....	Between Angel Id. and Sausalito.	....	Sept. 12	1.30 p. m.	....	....
....	Off Golden Gate	....	Sept. 17	....	28 30	S.
....	Between Angel Id. and Sausalito.	....	Sept. 19	1.30 p. m.	....	....
....	.....do	....	Sept. 25	8.45 a. m.	....	....
....	Off Golden Gate	....	Oct. 2	....	28 30	S.
	Upper section of bay.					
H. 5173	Brothers Lt., S. 1° E. Lft. Tang. Marin Ids., N. 48° W. Lft. Tang. Sisters, S. 56½° W.	5533	Oct. 7	10.15 a. m.	12¾	M.
	.....do	5533	...do	11.15 a. m.	....	....
	.....do	5533	...do	12.30 p. m.	....	....
H. 5174	Brothers Lt., S. 24½° W. Pinole Pt., N. 74° E. Rt. Tang. Sisters, S. 64° W.	5533	...do	1.15 p. m.	6½	M.
H. 5175	Brothers Lt., S. 33° W. Rt. Tang. Sisters, S. 56½° W. Pinole Pt., S. 76½° E.	5533	...do	1.35 p. m.	7	.....do
H. 5176	Lone Tree Pt., S. 83½° E. Pinole Pt., S. 36½° W. Mare Id. Lt., N. 66° E.	5533	...do	2.23 p. m.	5	.....do
H. 5177	Lone Tree Whf., S. 45° E. Pinole Pt., S. 52° W. Mare Id. Lt., N. 62° E.	5533	...do	3.07 p. m.	6	.....do
H. 5178	Mare Id. Lt., N. 40° W. Carquinez Lt., N. 59½° E. Crockett Whf., S. 71° E.	5533	...do	3.53 p. m.	8½	.....do
H. 5179	Carquinez Lt., N. 28½° W. Lft. Tang. Crockett Whf., S. 80½° E. Rt. Tang. Selby Whf., S. 69° W.	5533	...do	4.16 p. m.	11	S.
	Lower section of bay.					
H. 5180	Ferry Bldg., N. 77° W. Goat Id. Lt., N. 11° E. Rt. Tang. Mission Rk., S. 38° W.	5531	Oct. 8	9.55 a. m.	13	M.
	.....do	5531	...do	11.15 a. m.	....	....
H. 5181	Goat Id. Lt., N. 15° W. Ferry Bldg., N. 54° W. Rt. Tang. Mission Rk., N. 80° W.	5531	...do	12.01 p. m.	11	M.
H. 5182	Goat Id. Lt., N. 22° W. Shag Rk., S. 63° W. San Bruno Lt., S. 21½° W.	5531	...do	12.45 p. m.	8½	.....do
H. 5183	Shag Rk., N. 55° W. San Bruno Lt., S. 17° W. Candlestick Pt., N. 78° W.	5531	...do	1.19 p. m.	7	.....do
H. 5184	Shag Rk., N. 40½° W. San Bruno Lt., S. 40½° W. No. 2 Beacon, S. 28° E.	5531	...do	1.52 p. m.	5	.....do
H. 5185	San Bruno Lt., S. 67° W. No. 2 Beacon, S. 29° E. Shag Rk., N. 35° W.	5531	...do	2.18 p. m.	4¾	.....do
H. 5186	No. 2 Beacon, S. 32° E. San Bruno Lt., N. 88° W. Shag Rk., N. 28½° W.	5531	...do	2.42 p. m.	5	.....do

FRANCISCO BAY, CALIF., 1912–13, AND MARCH, 1914—Continued.

Temperature.			Salinity.		Apparatus.	Trial.		Drift.		Remarks.
Air.	Surf.	Botm.	Surf.	Botm.		Depth.	Duration.	Direction.	Distance.	
°F.	°F.	°F.					Min.		Mi.	
					seine	botm.	90		6.0	3 hauls. Trip made with Paladini Fish Co.
					4′ inter.; #12, #20.	surf.	20	Against tide.		
					seine	botm.	90		6.0	Do.
					4′ inter.; #12, #20.	surf.	20	Against tide.		
					do.	do.	20	do.		
					seine	botm.	90		6.0	Do.
66	59.97	59.68			Tnr. cse.; 4′ inter.; #12, #20; Ek. bot.; Pr. m.	surf. and botm.		Against tide.		Flood, 1.78 knots per hr.
63	61.88	59.68	27.19	32.45	do.	do.		do.		Flood, 0.72 knot per hr.
64	61.38	59.68	30.20	31.09	do.	do.	11	do.		Ebb, 0.60 knot per hr. Cable out 8–10 fms.
68	60.68	59.83	27.15	30.01	do.	do.	14	do.		Ebb, 1.26 knots per hr. Cable out 4–8 fms.
67	61.98	60.83	26.23	28.40	do.	do.	12	do.		Ebb, 1.59 knots per hr. Cable out 5 fms.
65.5	62.48	61.53	21.24	26.99	do.	do.	10	do.		Ebb, 2.03 knots per hr. #20 came up muddy.
65	62.38	61.78	20.51	23.32	do.	do.	11	do.		Ebb, 2.98 knots per hr.
66.5	62.78	62.53	18.02	18.34	do.	do.	12	do.		Ebb, 1.79 knots per hr. Cable out 6 fms.
68	62.78	61.78	20.78	21.21	do.	do.	11½	do.		Ebb, 2.63 knots per hr.
56.5	57.48	57.13	32.67	32.53	Tnr. cse.; 4′ inter.; #12, #20; Ek. bot.; Pr. m.	surf. and botm.				Flood, 1.50 knots per hour. Rubber packing from top of Ek. bot. lost; water sample not purely bot. water.
60	57.68	57.33	32.21	32.60			13	Against tide.		Ebb, 0.41 knot per hr.
56.5	59.88	57.68	31.89	32.45	Tnr. cse.; 4′ inter., #12, #20; Ek. bot.; Pr. m.	surf. and botm.	12	do.		Ebb, 1.18 knots per hr.
57.5	59.88	59.78	31.36	31.66	do.	do.	12	do.		Ebb, 1.45 knots per hr.
59	61.88	60.83	31.27	31.36	do.	do.	12	do.		Ebb, 1.92 knots per hr.
58.5	63.08	63.03	31.29	31.27	do.	do.	12	do.		Ebb, 1.88 knots per hr.
58	63.38	62.93	31.60	31.36	do.	do.	12	do.		Ebb, 1.89 knots per hr.
57	62.88	62.73	31.27	31.33	do.	do.	11½	do.		Ebb, 1.88 knots per hr.

DREDGING AND HYDROGRAPHIC RECORDS SECURED IN SAN

Station number.	Position.	Chart.	Date.	Time of day.	Depth.	Character of bottom.
	Lower section of bay—Con.					
		C. S.	1912.		*Fms.*	
H. 5187	No. 2 Beacon, S. 33° E. San Bruno Lt., N. 66° W. San Mateo Pt., S. 19° W.	5531	Oct. 8	3.15 p. m.	6½	M.
	Middle section of bay.					
H. 5188	Angel Id. Lt., N. 7° E. Alcatraz Lt., S. 43° E. Lime Pt. Lt., S. 54° W.	5532	Oct. 9	10.19 a. m.	12	hrd. S.
	....do.	5532	...do.	11.04 a. m.	12	
	....do.	5532	...do.	12.31 p. m.	12	hrd. S.
H. 5189	Southampton Lt., N. 7° E. Alcatraz Lt., S. 32° W. Blunt Pt., N. 68° W.	5532	...do.	1.13 p. m.	16½	m. S.
H. 5190	Southampton Lt., N. 15½° E. Rt. Tang. Angel Id., N. 59° W. Lft. Tang. Angel Id., S. 45° W.	5532	...do.	1.45 p. m.	15	....do
H. 5191	Southampton Lt., N. 65° E. Rt. Tang. Angel Id., S. 72° W. Lft. Tang. Angel Id., S. 7½° W.	5532	...do.	2.14 p. m.	7½	....do
H. 5192	Bluff Pt., S. 54° W Southampton Lt., S. 70½° E. Rt. Tang. Red Rk., N. 7° W.	5532	...do.	2.41 p. m.	9	M.
H. 5193	Southampton Lt., S. 71° E. Bluff Pt., S. 12° E. Lft. Tang. Red Rk., N. 2° E.	5532	...do.	3.05 p. m.	10	....do.
H. 5194	Bluff Pt., S. 16° E. Lft. Tang. Red Rk., N. 42° E. Southampton Lt., S. 50½° E.	5532	...do.	3.47 p. m.	7	....do.
H. 5195	Brothers Lt., N. 13° E. Lft. Tang. Red Rk., S. 72° E. Southampton Lt., S. 34° E.	5532	...do.	4.16 p. m.	7	....do.
	Upper section of bay.					
H. 5196	Carquinez Lt., N. 33° W. Lft. Tang. Crockett Whf., S. 75½° E. Rt. Tang. Selby Whf., S. 57° W.	5533	Oct. 10	8.54 a. m.	10	M.
	....do.	5533	...do.	9.22 a. m.		
H. 5197	Mare Id. Lt., N. 56½° W. Carquinez Lt., N. 31° E. Tang. Crockett Whf., S. 67½° E.	5533	...do.	9.50 a. m.	8	M.
H. 5198	Lone Tree Whf., S. 43° E. Mare Id. Lt., N. 57° E. Pinole Pt., S. 54° W.	5533	...do.	10.31 a. m.	7	....do.
H. 5199	Lone Tree Whf., S. 83° E. Pinole Pt., S. 37° W. Mare Id. Lt., N. 65½° E.	5533	...do.	11.08 a. m.	5	....do.
H. 5200	Brothers Lt., S. 30° W. Rt. Tang. Sisters, S. 52° W. Pinole Pt., S. 68¼° E.	5533	...do.	11.56 a. m.	7	....do.
H. 5201	Brothers Lt., S. 29° W. Rt. Tang. Sisters, S. 65° W. Pinole Pt., N. 74° E.	5533	...do.	12.20 p. m.	6½	....do.
H. 5202	Brothers Lt., S. 4° W. Lft. Tang. Sisters, N. 44½° W. Lft. Tang. Marin Ids., S. 60° W.	5533	...do.	12.53 p. m.	12	hrd. M.

FRANCISCO BAY, CALIF., 1912-13, AND MARCH, 1914—Continued.

Temperature.			Salinity.		Apparatus.	Trial.		Drift.		Remarks.
Air.	Surf.	Botm.	Surf.	Botm.		Depth.	Duration.	Direction.	Distance.	
°F.	°F.	°F.					Min.		Mi.	
57	62.68	61.88	31.44	31.36	Tnr. cse.; 4' inter., #12, #20; Ek. bot.; Pr. m.	surf. and botm.	12	Against tide.	.....	Ebb, 2.30 knots per hr. As grit gauze lining ripped, outer bag was used as 4' inter. townet (1-inch mesh) at this station.
64	56.38	56.03	31.36	32.92	Tnr. cse.; 4' inter., #12, #20; Ek. bot.; Pr. m.	surf. and botm.	......	....	.....	Flood, 1.70 knots per hr.
61	55.78	55.38	33.22	33.22	.....do.........	...do....	......	....	.....	Flood, 1.31 knots per hr.
58	55.78	54.93	33.22	33.27	.....do.........	...do....	13	Against tide.	.....	Ebb, 0.225 knot per hr. #20 bag filled with sand. Towed 5 min. under way.
58	56.48	55.83	32.67	33.18	.....do.........	...do....	20	...do.......	.....	Ebb, 0.94 knot per hr. Towed 5 min. under way.
60	57.88	56.68	32.80	32.60	.....do.........	...do....	18½	...do.......	.....	Ebb, 0.99 knot per hr.
66	57.88	56.98	32.83	32.60	.....do.........	...do....	15	...do.......	.....	Ebb, 1.31 knots per hr.
64	58.68	57.08	32.28	32.67	.....do.........	...do....	9	...do.......	.....	Ebb, 1.53 knots per hr.
71	58.88	57.78	31.90	32.27	.....do.........	...do....	11½	...do.......	.....	Ebb, 0.96 knot per hr.
71	60.18	59.53	30.24	30.43	.....do.........	...do....	12	...do.......	.....	Ebb, 2.92 knots per hr.
69.5	60.18	59.83	30.11	......	.....do.........	...do....	11	...do.......	.....	Ebb, 2.63 knots per hr.
59	61.38	60.98	14.84	18.51	Tnr. cse.; 4' inter., #12, #20; Ek. bot.; Pr. m.	surf. and botm.	......	....	.....	Ebb, 0.46 knot per hr.
59	61.18	61.03	14.03	17.08	.....do.........	...do....	10	Against tide.	.....	Flood, 0.50 knot per hr.
71	61.08	60.83	15.85	19.66	.....do.........	...do....	10½	...do.......	.....	Flood, 1.55 knots per hr.
70	61.08	60.83	20.56	21.78	.....do.........	...do....	10	...do.......	.....	Flood, 1.86 knots per hr.
70	60.88	60.83	24.77	25.16	.....do.........	...do....	12	...do.......	.....	Flood, 1.18 knots per hr.
68	60.38	59.83	28.26	28.95	.....do.........	...do....	10	...do.......	.....	Flood, 1.52 knots per hr.
67	59.68	59.23	29.18	30.11	.....do.........	...do....	10	...do.......	.....	Flood, 1.13 knots per hr.
67	59.98	58.53	29.43	31.05	.....do.........	...do....	9½	...do.......	.....	Flood, 0.45 knot per hr.

DREDGING AND HYDROGRAPHIC RECORDS SECURED IN SAN

Station number.	Position.	Chart.	Date.	Time of day.	Depth.	Character of bottom.
	Lower section of bay.					
		C. S.	1912.		*Fms.*	
H. 5203	Goat Id. Lt., N. 21° E. Ferry Bldg., N. 66° W. Rt. Tang. Mission Rk., S. 33° W.	5531	Oct. 11	7.50 a. m.	11	M.
H. 5204	Goat Id. Lt., N. 13° W. Ferry Bldg., N. 48° W. Rt. Tang. Mission Rk., N. 73° W.	5531	...do....	8.19 a. m.	10½	s. M.
H. 5205	Goat Id. Lt., N. 17½° W. Shag Rk., S. 64½° W. San Bruno Lt., S. 19½° W.	5531	...do....	8.49 a. m.	7	M.
H. 5206	Shag Rk., N. 45° W. San Bruno Lt., S. 25° W. Candlestick Pt., N. 66½° W.	5531	...do....	9.18 a. m.	5¾	....do....
H. 5207	Shag Rk., N. 32° W. San Bruno Lt., S. 40½° W. No. 2 Beacon, S. 31° E.	5531	...do....	9.42 a. m.	5	....do....
H. 5208	Shag Rk., N. 29° W. No. 2 Beacon, S. 31° E. San Bruno Lt., S. 72° W.	5531	...do....	10.04 a. m.	5	....do....
H. 5209	Shag Rk., N. 26° W. No. 2 Beacon, S. 35° E. San Bruno Lt., N. 82° W.	5531	...do....	10.27 a. m.	5¾	....do....
H. 5210	No. 2 Beacon, S. 36° E. San Bruno Lt., N. 62° W. San Mateo Pt., S. 19° W.	5531	...do....	10.54 a. m.	6¾	....do....
	Middle section of bay.					
H. 5211	Brothers Lt., N. 15° W. Lft. Tang. Red Rk., S. 73° E. Southampton Lt., S. 35° E.	5532	Oct. 12	8.27 a. m. 9.20 a. m.	7	M.
H. 5212	Bluff Pt., S. 17° E. Lft. Tang. Red Rk., N. 40° E. Southampton Lt., S. 52° E.	5532	...do....	9.42 a. m.	7	....do....
H. 5213	Southampton Lt., S. 58° E. Bluff Pt., S. 10° W. Rt. Tang. Red Rk., N. 6° W.	5532	...do....	10.06 a. m.	10	....do....
H. 5214	Rt. Tang. Red Rk., N. 7° W. Southampton Lt., S. 66° E. Bluff Pt., S. 45½° E.	5532	...do....	10.38 a. m.	8	....do....
H. 5215	Lft. Tang. Angel Id., S. 6½° W. Southampton Lt., N. 70° E. Rt. Tang. Red Rk., N. 14° W.	5532	...do....	11.04 a. m.	9	m. S.
H. 5216	Southampton Lt., N. 10° E. Rt. Tang. Angel Id., N. 63° W. Lft. Tang. Angel Id., N. 51° E.	5532	...do....	11.26 a. m.	16	....do....
H. 5217	Southampton Lt., N. 10° E. Blunt Pt., N. 65° W. Alcatraz Lt., S. 28° W.	5532	...do....	11.49 a. m.	22½	....do....
H. 5218	Angel Id. Lt., N. 12° E. Alcatraz Lt., S. 57½° E. Lime Pt. Lt., S. 57° W.	5532	...do....	12.22 p. m.	14½	hrd. S.
	Outside Golden Gate.					
D. 5785 H. 5219	Pt. Montara Lt., N. 74½° E., 8.9 miles.	5500	Oct. 15	....	39 40	dk. gn. S.
D. 5786	Pt. Montara Lt., N. 80½° E., 9.1 miles.	5500	...do....	....	40 40	....do....
D. 5787 H. 5220	Pt. Montara Lt., N. 97½° E., 8.25 miles.	5500	...do....	....	40 41	....do....
	Middle section of bay.					
....	Between Angel Id. and Sausalito.	....	Oct. 19	9.40 a. m.	....	....

FRANCISCO BAY, CALIF., 1912–13, AND MARCH, 1914—Continued.

Temperature.			Salinity.		Apparatus.	Trial.		Drift.		Remarks.
Air.	Surf.	Botm.	Surf.	Botm.		Depth.	Duration.	Direction.	Distance.	
°F.	°F.	°F.					Min.		Mi.	
59	60.18	59.83	31.44	31.51	Tnr. cse.; 4′ inter., #12, #20; Ek. bot., Pr. m.	surf. and botm.	10	Against tide.	.....	Flood, 1.46 knots per hr. In sta. of this date ship went with tide owing to foggy weather.
61	60.88	60.68	31.51	31.51	.....do.........	...do....	10	...do......	.....	Flood, 1.92 knots per hr.
62	61.88	61.78	31.36	31.36	.....do.........	...do....	......	...do......	.....	Flood, 1.95 knots per hr.
65	61.78	61.83	30.89	31.05	.....do.........	...do....	11	...do......	.....	Flood, 2.16 knots per hr.
66	62.08	61.83	31.18	30.91	.....do.........	...do....	10½	...do......	.....	Flood, 1.46 knots per hr.
67	62.08	62.03	31.00	31.21	.....do.........	...do....	10½	...do......	.....	Flood, 1.39 knots per hr.
70	62.18	62.23	30.94	31.05	.....do.........	...do....	11	...do......	.....	Flood, 1.44 knots per hr.
70	62.18	62.13	30.87	31.09	.....do.........	...do....	......	...do......	.....	Flood, 1.59 knots per hr.
59	60.18 60.18	59.53 58.83	28.25 28.02	29.50 30.11	Tnr. cse. ;4′ inter., #12, #20; Ek. bot.; Pr. m.	surf. and botm.	4½	Against tide.	.....	Preliminary reading. Slack, 0.15 knot per hr.
59	59.88	58.28	28.68	30.06	.....do.........	...do....	10	...do......	.....	Flood, 0.68 knot per hr.
59	57.78	57.53	....	28.58	.....do.........	...do....	9	...do......	.....	Flood, 1.48 knots per hr.
60	57.98	57.48	31.53	31.66	.....do.........	...do....	10	...do......	.....	Flood, 1.46 knots per hr.
61	58.48	57.68	31.12	31.66	.....do.........	...do....	10	...do......	.....	Flood, 1.18 knots per hr.
62	67.08	56.48	32.08	32.18	.....do.........	...do....	10	...do......	.....	Flood, 1.36 knots per hr.
63	56.78	56.13	32.29	31.99	.....do.........	...do....	10	...do......	.....	Flood, 1.39 knots per hr.
64	55.68	56.13	33.06	32.53	.....do.........	...do....	10	...do......	.....	Flood, 1.25 knots per hr.
53	53.68	49.66	33.81	34.14	12′ Ag.; 19″ dr.; Ek. bot. Tnr. cse.; 4′ inter.; #12, #20.	surf. and botm.	26	266½°......	1.5	Ebb. On fishing grounds. Cable out 120 fms. Inter. temp., 52.21; inter. sal., 34.17.
53	.....	......	....	....	12′ Ag.; 19″ dr.	botm...	20	266½°......	1.5	Ebb. On fishing grounds. Cable out 130 fms.
56	53.88	53.21	....	....	12′ Ag.; 19″ dr.; Ek. bot.; Tnr. cse., 4′ inter.; #12, #20.	botm. and surf.	34½	260½°......	1.5	Flood. On fishing grounds. Inter. temp., 51.76; inter. sal., 34.08.
....	.....	......	....	....	4′ inter.; #12, #20.	surf....	20	Against tide.	.....	

DREDGING AND HYDROGRAPHIC RECORDS SECURED IN SAN

Station number.	Position.	Chart.	Date.	Time of day.	Depth.	Character of bottom.
	Outside Golden Gate.	*C. S.*	1912.		*Fms.*	
D. 5788 H. 5221	Farallones Lt., N. 11½° E., 3.8 miles.	5500	Oct. 21	....	68 60	fne. gn. S........
D. 5789 H. 5222	Farallones Lt., N. 42½° W., 3.9 miles.	5500	...do.....	....	46 33	.....do............
D. 5790 H. 5223	Farallones Lt., N. 80½° W., 5.4 miles.	5500	Oct. 22	....	35 33	S.................
D. 5791 H. 5224	Farallones Lt., S. 87½° W., 8.8 miles.	5500	...do.....	....	36 29	....
D. 5792 H. 5225	San Francisco Lt. Ship, N. 37° E., 1 mile.	5500	...do.....	....	26 19	S.................
	Upper section of bay.					
D. 5793	Carquinez Lt., N. 24½° W.... Rt. Tang. Selby Whf., S. 48° W. Lft. Tang. Crockett Whf., S. 76° E.	5533	Oct. 28	....	10 14	bk. M., gy. bn. S..
D. 5794	N. W. corner Crockett Whf., N. 27½° W., 0.25 mi.	5533	...do.....	....	14½ 11	bn. S., gy. bk. M..
	Middle section of bay.					
D. 5795	Rt. Tang. Angel Id., S. 27° W. Lft. Tang. Angel Id., S. 78½° E. Southampton Lt., N. 75° E.	5532	Oct. 29	....	13 19	St................
D. 5796	Rt. Tang. Angel Id., S. 33½° W. Lft. Tang. Angel Id., S. 80½° E. Bluff Pt., N. 8½° W.	5532	...do.....	....	19 13½	S., Sh............
D. 5797	Rt. Tang. Angel Id., S. 78° W. Lft. Tang. Angel Id., S. 7° W. Southampton Lt., N. 61½° E.	5532	...do.....	....	8½ 7½	S.................
D. 5798	Rt. Tang. Angel Id., N. 41° E. Lft. Tang. Angel Id., N. 4° W. Southampton Lt., N. 81½° W.	5532	...do.....	....	8 7½	M.................
D. 5799	Rt. Tang. Angel Id., S. 70° W. Lft. Tang. Angel Id., S. 3½° W. Southampton Lt., N. 67° E.	5532	...do.....	....	8½ 12½	fne. gy. m. S......
D. 5800	Alcatraz Lt., S. 66° E........ Angel Id. Lt., N. 14° E. Lime Pt. Lt., S. 66½° W.	5532	...do.....	....	16½ 16½	crs. S., St.........
D. 5801	Alcatraz Lt., S. 70½° E....... Angel Id. Lt., N. 32½° E. Lime Pt. Lt., S. 57½° W.	5532	...do.....	....	16½ 17	G., S., St.........
	Lower section of bay.					
D. 5802	Rt. Tang. Mission Rk., N. 82° W. Goat Id. Lt., N. 2° W. Ferry Bldg., N. 48½° W.	5531	Oct. 30	....	10 10½	Sh., M............
D. 5803	Rt. Tang. Mission Rk., N. 47° W. Goat Id. Lt., N. 18° W. Pt. Avisadero, S. 54½° W.	5531	...do.....	....	9½ 8	M.................
D. 5804	Shag Rk., S. 89½° W......... San Bruno Lt., S. 21½° W. Pt. Avisadero, N. 62° W.	5531	...do.....	....	7½ 6½	sft. M.............

FRANCISCO BAY, CALIF., 1912–13, AND MARCH, 1914—Continued.

Temperature.			Salinity.		Apparatus.	Trial.		Drift.		Remarks.
Air.	Surf.	Botm.	Surf.	Botm.		Depth.	Duration.	Direction.	Distance.	
°F.	°F.	°F.					Min.		Mi.	
55	52.38	48.76	34.16	33.99	12′ Ag.; 19″ dr.; 4′ inter.; Tnr. cse.; #12, #20; Ek. bot.	botm. and surf.	20	N. 56½° W.	1.0	Messenger on inter. therm. failed to release till brought to surf. Botm. sample and readings approximate. Inter. temp., 49.71; inter. sal., 33.99. Ebb.
55	52.58	48.86	34.16	34.31	....do....	...do....	20	N. 69° W.	1.0	Inter. sal., 33.83; inter. temp., 52.31. Ebb.
55	52.68	......	33.89	......	....do....	...do....	20	S. 61° E.	1.0	Ebb. Botm. therm. did not trip. Inter. temp. 49.51; inter. sal., 33.92.
54	52.38	49.56	33.87	34.27	....do....	...do....	20	...do....	1.0	Ebb. Lost sounding lead after lifting from water. Inter. temp., 49.31; inter. sal., 34.01.
53	51.88	......	34.08	......	....do....	...do....	20	...do....	1.0	Botm. Ek. bot. failed to trip. Ebb. Inter. temp., 51.81; inter. sal., 34.03.
....	....	....	......	......	oys. dr....	botm...	6	S. 81° E.	.45	Flood. Towed astern.
....	....	....	......	......	....do....	...do....	11	S. 87° E.	.7	Do.
53	56.00	......	......	......	oys. dr....	botm...	13	N. 31° E.	.5	Do.
55	56.00	......	......	......	....do....	...do....	9	N. 31° E.	.55	Flood.
56	58.00	......	......	......	5′ sldg....	...do....	7½	N. 34° W.	.58	Do.
58	57.00	......	......	......	5′ sldg.; m. b.	...do....	20	N. 27½° W.	1.3	Do.
59	57.00	......	......	......	....do....	...do....	20	N. 36½° E.	.8	Do.
59	....	......	......	......	oys. dr....	...do....	5½	S. 25° W.	.45	Ebb. Dr. caught several times registering over 5 tons.
....	....	......	......	......	....do....	...do....	4	S. 35° W.	.5	Ebb. Accumulator registered 5 tons.
....	....	......	......	......	5′ sldg.; m. b.	botm...	2	S. 84½° E.	.4	Flood. Towed astern. Bridle lashed to frame 1′ on each side.
....	....	......	......	......	....do....	...do....	12	S. 47° E.	.65	Flood. Towed astern.
....	....	......	......	......	5′ sldg....	...do....	20	S. 54° E.	1.2	Do.

DREDGING AND HYDROGRAPHIC RECORDS SECURED IN SAN

Station number.	Position.	Chart.	Date.	Time of day.	Depth.	Character of bottom.
	Lower section of bay—Con.	*C. S.*	1912.		*Fms.*	
D. 5805	Shag Rk., N. 56½° W. San Bruno Lt., S. 35° W. Candlestick Pt., N. 71° W.	5531	Oct. 30	....	5½ 5	slt. M.
	Outside Golden Gate.					
D. 5806 H. 5226	San Francisco Lt. Ship, S. 75½° W., 2.5 miles.	5500	Nov. 4	....	14½ 13	S.
D. 5807 H. 5227	Mile Rk. Lt., N. 79° E., 3.6 miles.	5500	...do....	....	8½ 9	....
	Middle section of bay.					
D. 5808 H. 5228	Bonita Pt. Lt., N. 82° W. Fort Pt. Lt., S. 86° E. Lime Pt. Lt., N. 44° E.	5532	Nov. 4	....	43 27	S., G., St.
D. 5809	Bonita Pt. Lt., N. 88° W. Fort Pt. Lt., S. 76½° E. Lime Pt. Lt., N. 50½° E.	5532	...do....	....	53 21½	.....do.
....	Off Pt. Reyes	....	Nov. 6	....	28 30	S.
	Lower section of bay.					
D.5810A H5229A	San Bruno Lt., N. 44½° W. No. 2 Beacon, S. 87° E. San Mateo Pt., N. 84° W.	5531	Nov. 11	....	1¾	Sh., M.
D 5810B H 5229B	No. 2 Beacon, S. 87° E. San Mateo Pt., N. 84° W. San Bruno Lt., N. 44½° W.	5531	...do....	....	1½	....
D.5810C H.5229C	.....do.	5531	...do....	....	1½	....
H. 5230	No. 2 Beacon, S. 87° E. San Mateo Pt., N. 84° W. San Bruno Lt., N. 44½° W.	5531	...do....	....	1½	M.
D.5811A H.5231A	San Mateo Pt., N. 63° W. San Bruno Lt., N. 33½° W. No. 2 Beacon, East.	5531	...do....	....	1	Sh., M.
D.5811B H.5231B	San Mateo Pt., N. 52° W. San Bruno Lt., N. 32° W. No. 2 Beacon, N. 87½° W.	5531	...do....	....	1	.....do.
D.5811C H.5331C	San Mateo Pt., N. 53° W. San Bruno Lt., N. 31° W. No. 2 Beacon, S. 89° E.	5531	...do....	....	½	Sh., M., S.
H. 5232	San Mateo Pt., N. 86½° W. San Bruno Lt., N. 33° W. No. 2 Beacon, S. 85° E.	5531	...do....	....	1½	M.
	Middle section of bay.					
H. 5233	Brothers Lt., N. 17½° E. Lft. Tang. Red Rk., S. 67° E. Southampton Lt., S. 33° E.	5532	Nov. 25	8.02 a. m.	7	M.
H. 5234	Bluff Pt., S. 32° E. Lft. Tang. Red Rk., N. 49° E. Southampton Lt., S. 49° E.	5532	...do....	8.34 a. m.	7	.....do.
H. 5235	Bluff Pt., S. 18½° W. Rt. Tang. Red Rk., N. ½° E. Southampton Lt., S. 54½° E.	5532	...do....	9.03 a. m.	7½	.....do.

FRANCISCO BAY, CALIF., 1912-13, AND MARCH, 1914—Continued.

Temperature.			Salinity.		Apparatus.	Trial.		Drift.		Remarks.
Air.	Surf.	Botm.	Surf.	Botm.		Depth.	Duration.	Direction.	Distance.	
°F.	°F.	°F.					Min.		Mi.	
59	59.00	......	......	......	5' sldg.	botm.	20	S. 58° E.	0.46	Flood. Towed astern.
56	53.88	51.91	33.09	34.03	12' Ag.; m. b.; Ek. bot.; Tnr. cse.; 4' inter.; #12, #20.	botm. and surf.	20	S. 28½° W.	1.0	Ebb. Vertical tow-net haul. Inter. temp., 53.51; inter. sal., 33.35.
62	54.08	53.36	32.81	32.93	....do.	..do.	21	S. 69½° W.	1.3	Ebb. Vertical tow-net haul.
....	......	......	......	......	oys. dr.; 4' inter.; #12, #20.	botm. and surf.	9	S. 44° W.	.95	Ebb. Vertical tow-net haul.
....	......	......	......	......	....do.	botm.	15	S. 54° W.	1.15	Do.
....	......	......	......	......	seine.	..do.	90	......	6.0	2 hauls. Trip made with Paladini Fish Co.
....	57.83	56.93	31.40	31.21	oyster tongs; Ek. bot.; Tnr. cse.	botm. and surf.	......	Anchored.	......	On oyster beds, Eaton beds, southern beds. Operations conducted from scow.
....	57.13	56.18	31.42	31.36	....do.	..do.	......	..do.	......	Do.
....	57.33	56.53	31.40	......	....do.	..do.	......	..do.	......	Do.
....	......	......	......	......	Ek. bot.; Tnr. cse.; #12, #20. 4' inter.	surf. and botm.	10	Circle.	......	Ebb. Towed around Eaton oyster bed. Operations conducted from launch.
....	57.53	57.18	31.51	31.44	oyster tongs; Ek. bot.; Tnr. cse.	botm. and surf.	......	Anchored.	......	Ebb. On Moraghan bed; N. E. fence. Operations conducted from scow.
....	57.63	57.93	31.51	31.60	....do.	..do.	......	..do.	......	Ebb. On Moraghan bed; S. fence. Operations conducted from scow.
....	57.83	57.93	31.50	......	....do.	..do.	......	..do.	......	Ebb. On Moraghan bed; W. fence. Operations conducted from scow.
....	......	......	......	......	Ek. bot.; Tnr. cse.; #12, #20; 4' inter.	surf. and botm.	10	S. 57° E.	.33	Ebb. Down NE. fence of Moraghan bed. Operations conducted from launch.
52	54.03	54.48	27.26	28.60	Ek. bot.; Tnr. cse.; 4' inter.; #12, #20; Pr. m.	surf. and botm.	21	Against tide.	......	Flood, 0.19 knot per hr. Towed 8 min. under way. Tow-net #20 was fouled on inter. and did not function.
52	53.83	54.33	26.66	29.82	....do.	..do.	16	..do.	......	Flood, 0.79 knot per hr. Towed 5 min. under way. Tow-net #20 badly torn.
53	53.93	53.98	29.10	31.07	Ek. bot.; Tnr. cse.; 4' inter.; #12; Pr. m.	..do.	11	..do.	......	Flood, 1.07 knots per hr. Lost the water-sample dipper.

DREDGING AND HYDROGRAPHIC RECORDS SECURED IN SAN

Station number.	Position.	Chart.	Date.	Time of day.	Depth.	Character of bottom.
	Middle section of bay—Con.	*C. S.*	1912.		*Fms.*	
H. 5236	Bluff Pt., S. 40½° W. Rt. Tang. Red Rk., N. 7° W. Southampton Lt., S. 62° E.	5532	Nov. 25	9.22 a. m.	7½	M.
H. 5237	Southampton Lt., N. 60° E. Rt. Tang. Red Rk., N. 17° W. Lft. Tang. Angel Id., S. 14° W.	5532	...do...	9.46 a. m.	8½	m. S.
H. 5238	Southampton Lt., N. 19° E. Rt. Tang. Angel Id., N. 67° W. Lft. Tang. Angel Id., S. 35° W.	5532	...do...	10.06 a. m.	14	...do...
H. 5239	Southampton Lt., N. 5° E. Blunt Pt., N. 81° W. Alcatraz Lt., S. 30° W.	5532	...do...	10.28 a. m.	21	...do...
H. 5240	Angel Id. Lt., N. 11° E. Alcatraz Lt., S. 56° E. Lime Pt. Lt., S. 62° W.	5532	...do...	11.04 a. m.	11½	...do...
	Upper section of bay.					
H. 5241	Carquinez Lt., N. 26½ W. Lft. Tang. Crockett Whf., S. 73° E. Rt. Tang. Selby Whf., S. 39° W.	5533	Nov. 26	10.37 a. m.	9¾	S.
H. 5242	Mare Id. Lt., N. 50° W. Carquinez Lt., N. 23° E. Lft. Tang. Crockett Whf., S. 71° E.	5533	...do...	11.07 a. m.	8½	M.
H. 5243	Lone Tree Pt., S. 40° E. Mare Id. Lt., N. 65° E. Pinole Pt., S. 49½ W.	5533	...do...	11.46 a. m.	6	...do...
H. 5244	Lone Tree Pt., S. 83° E. Pinole Pt., S. 38° W. Mare Id. Lt., N. 64° E.	5533	...do...	12.19 p. m.	5	...do...
H. 5245	Brothers Lt., S. 28½° W. Pinole Pt., S. 75° E. Rt. Tang. Sisters, S. 51½° W.	5533	...do...	1.04 p. m.	6½	...do...
H. 5246	Brothers Lt., S. 27½° W. Rt. Tang. Sisters, S. 61° W. Pinole Pt., N. 74½° E.	5533	...do...	1.26 p. m.	7	...do...
H. 5247	Brothers Lt., S. 4° E. Lft. Tang. Sisters, N. 34½° W. Lft. Tang. Marin Ids., S. 57½° W.	5533	...do...	1.58 p. m.	12½	hrd. M.
	Lower section of bay.					
H. 5248	No. 2 Beacon, S. 31° E. San Bruno Lt., N. 69° W. San Mateo Pt., S. 17° W.	5531	Nov. 27	10.29 a. m.	6½	M.
H. 5249	Shag Rk., N. 28° W. No. 2 Beacon, S. 33° E. San Bruno Lt., S. 85° W.	5531	...do...	11.05 a. m.	5	...do...
H. 5250	Shag Rk., N. 39° W. No. 2 Beacon, S. 33° E. San Bruno Lt., S. 59° W.	5531	...do...	11.26 a. m.	6	...do...
H. 5251	Shag Rk., N. 33° W. No. 2 Beacon, S. 30° E. San Bruno Lt., S. 31° W.	5531	...do...	11.51 a. m.	6	...do...
H. 5252	Shag Rk., N. 55° W. San Bruno Lt., S. 23° W. Candlestick Pt., N. 72° W.	5531	...do...	12.18 p. m.	6¾	...do...
H. 5253	Goat Id. Lt., N. 17° W. Shag Rk., S. 60° W. San Bruno Lt., S. 18° W.	5531	...do...	12.51 p. m.	9¾	...do...
H. 5254	Goat Id. Lt., N. 15° W. Ferry Bldg., N. 50° W. Rt. Tang. Mission Rk., N. 70° W.	5531	...do...	1.23 p. m.	10½	...do...
H. 5255	Goat Id. Lt., N. 20° E. Ferry Bldg., N. 56° W. Rt. Tang. Mission Rk., S. 83° W.	5531	...do...	1.58 p. m.	12¾	...do...

FRANCISCO BAY, CALIF., 1912-13, AND MARCH, 1914—Continued.

Temperature.			Salinity.		Apparatus.	Trial.		Drift.		Remarks.
Air.	Surf.	Botm.	Surf.	Botm.		Depth.	Duration.	Direction.	Distance.	
°F.	°F.	°F.					Min.		Mi.	
54	53.73	53.98	28.60	....	Ek. bot.; Tnr. cse.; 4' inter.; #12.	surf. and botm.	11	Against tide.	.....	Flood, 1.30 knots per hr.
58	54.03	53.98	28.68	30.98	.....do.........	...do....	12	...do......	.....	Flood, 0.87 knot per hr. Ek. bot. not opened before lowering.
55	54.03	53.93	30.15	31.51	Ek. bot.; Tnr. cse.; 4' inter.; #12, #20; Pr. m.	...do....	10	...do......	.....	Flood, 0.92 knot per hr.
55	53.83	53.88	31.09	31.82	.....do.........	...do....	11	...do......	.....	Flood, 1.17 knots per hr.
56	53.73	53.58	32.14	32.28	.....do.........	...do....	10	...do......	.....	Flood, 2.39 knots per hr.
51	53.23	53.98	14.29	20.38	Ek. bot.; Tnr. cse.; 4' inter.; #12, #20; Pr. m.	surf. and botm.	6½	Against tide.	.....	Flood, 0.09 knot per hr. Inter. towed while under way.
56	53.53	53.73	14.62	21.35	.....do.........	...do....	10	...do......	.....	Flood, 1.27 knots per hr.
56	54.63	54.18	17.40	22.92	.....do.........	...do....	9½	With tide.	.....	Flood, 1.54 knots per hr.
54	54.33	54.38	22.83	25.62	.....do.........	...do....	10	Against tide.	.....	Flood, 1.31 knots per hr.
58	54.33	54.18	26.49	28.42	.....do.........	...do....	10	...do......	.....	Flood, 0.75 knot per hr.
58	54.73	54.08	25.85	28.26	.....do.........	...do....	10	...do......	.....	Slack, 0.44 knot per hr.
57	54.03	53.98	26.87	30.20	.....do.........	...do....	15	With tide.	.....	Ebb, 1.31 knots per hr. Net towed for 5 min. with tide.
69	55.53	55.18	29.60	30.11	Ek. bot.; Tnr. cse.; 4' inter.; #12, #20; Pr. m.	surf. and botm.	10	Against tide.	.....	Flood, 0.67 knot per hr.
69.5	55.43	55.28	29.50	29.16	.....do.........	...do....	9	...do......	.....	Flood, 0.87 knot per hr.
69	55.23	55.18	28.28	29.16	.....do.........	...do....	14	...do......	.....	Flood, 0.86 knot per hr. Net towed 4 min.
68	55.03	54.98	28.77	28.40	.....do.........	...do....	10½	...do......	.....	Flood, 0.657 knot per hr.
70	54.53	54.43	28.72	29.16	.....do.........	...do....	17	...do......	.....	Flood, 0.87 knot per hr. Net towed 7 min.
68	54.53	54.08	29.56	30.11	.....do.........	...do....	13	...do......	.....	Flood, 0.79 knot per hr. Net towed 3 min.
65	54.53	53.93	29.43	30.43	.....do.........	...do....	14	...do......	.....	Flood (nearly slack), 0.26 knot per hr. Net towed 4 min.
63	54.63	53.88	30.35	30.82	.....do.........	...do....	13	With tide.	.....	Beginning of ebb, 0.56 knot per hr. Net towed 3 min.

DREDGING AND HYDROGRAPHIC RECORDS SECURED IN SAN

Station number.	Position.	Chart.	Date.	Time of day.	Depth.	Character of bottom.
	Lower section of bay—Con.	*C. S.*	1912.		*Fms.*	
D.5812A H.5256A	No. 7 Beacon, S. 73° E., 0.7 mile.	5531	Nov. 27	10.59 a. m.	1	Sh., M...........
D.5812B H.5256B	No. 7 Beacon, N. 63° E., 0.85 mile.	5531	...do.....	11.20 a. m.	1	M................
H.5257	No. 7 Beacon, N. 63° E., 0.79 mile.	5531	...do.....	11.33 a. m.	1	.....do............
D.5813 H.5258	No. 7 Beacon, S. 2½° W., 0.46 mile.	5531	...do.....	12.48 p. m.	1½	.....do............
H.5259	No. 7 Beacon, S. 2° E., 0.5 mile.	5531	...do.....	1.02 p. m.	1½	.....do............
D.5814A H.5260A	No. 4 Beacon, N. 55° E., 0.98 mile.	5531	...do.....	2.47 p. m.	1½	M., Sh...........
D.5814B H.5260B	No. 4 Beacon, N. 55° E., 0.81 mile.	5531	...do.....	3.02 p. m.	1	M................
H.5261	No. 4 Beacon, N. 51½° E., 0.81 mile.	5531	...do.....	3.16 p. m.	1	.....do............
	Upper section of bay.					
H.5262	Brothers Lt., S. 9½° E....... Lft. Tang. Sisters, N. 29° W. Lft. Tang. Marin Ids., S. 56° W.	5533	Dec. 3	10.16 a. m.	12	hrd. M...........
H.5263	Brothers Lt., S. 23° W....... Rt. Tang. Sisters, S. 64½° W. Pinole Pt., N. 72½° E.	5533	...do.....	10.49 a. m.	7	M................
H.5264	Brothers Lt., S. 30° W....... Pinole Pt., S. 77° E. Rt. Tang. Sisters, S. 53½° W.	5533	...do.....	11.18 a. m.	7	.....do............
H.5265	Lone Tree Pt., S. 84½° E..... Pinole Pt., S. 36° W. Mare Id. Lt., N. 64° E.	5533	...do.....	12.05 p. m.	5½	.....do............
H.5266	Lone Tree Pt., S. 37° E...... Mare Id. Lt., N. 62½° E. Pinole Pt., S. 50½° W.	5533	...do.....	12.44 p. m.	5½	.....do............
H.5267	Mare Id. Lt., N. 42° W...... Carquinez Lt., N. 69½° E. Lft. Tang. Crockett Whf., S. 70° E.	5533	...do.....	1.25 p. m.	8½	.....do............
H.5268	Carquinez Lt., N. 34½° W.... Lft. Tang. Crockett Whf., S. 72° E. Rt. Tang. Selby Whf., S. 48° W.	5533	...do.....	1.48 p. m.	12½	S................
	Lower section of bay.					
H.5269	Goat Id. Lt., N. 15° E....... Ferry Bldg., N. 73° W. Rt. Tang. Mission Rk., S. 35½° W.	5531	Dec. 4	9.59 a. m.	10	s. M.............
H.5270	Goat Id. Lt., N. 16½° W..... Ferry Bldg., N. 52½° W. Rt. Tang. Mission Rk., N. 76½° W.	5531	...do.....	10.40 a. m.	9½	.....do............

FRANCISCO BAY, CALIF., 1912-13, AND MARCH, 1914—Continued.

Temperature.			Salinity.		Apparatus.	Trial.		Drift.		Remarks.
Air.	Surf.	Botm.	Surf.	Botm.		Depth.	Duration.	Direction.	Distance.	
°F.	°F.	°F.					Min.		Mi.	
68	54.23	54.41	30.89	31.27	oyster tongs; Ek.bot.; Tnr. cse.	botm. and surf.	....	Anchored.	.....	Flood. Dumbarton No. 2 oyster bed, near camp. Operations conducted from launch.
68	54.23	54.31	31.36	31.27	.....do.........	...do....	....	...do......	.....	Dumbarton No. 2 at some distance. Operations conducted from launch.
68.5	.....	.....	......	......	4' inter.; #12, #20.	surf. and botm.	10	....	.....	Flood. Townet haul between A and B. Operations conducted from launch.
67	54.93	54.76	31.05	31.18	oyster tongs; Ek.bot.; Tnr. cse.	botm. and surf.	....	Anchored.	.....	Flood. Mowry oyster bed. Operations conducted from launch.
67	55.73	.....	......	......	4' inter.; Ek. bot.; Tnr. cse.; #12, #20.	surf. and botm.	10	....	.....	Flood. Townet haul in Mowry oyster bed. Operations conducted from launch.
61	55.23	55.31	30.11	30.11	oyster tongs; Ek.bot.;Tnr. cse.	botm. and surf.	....	Anchored.	.....	Ebb. South Belmont oyster bed. Operations conducted from launch.
60	55.13	55.26	30.74	30.74	.....do.........	...do....	....	...do......	.....	Ebb. South Belmont oyster bed; another point. Operations conducted from launch.
60	.....	.....	......	......	4' inter.; #12, #20.	surf. and botm.	10	....	.....	Ebb. Townet haul in South Belmont oyster bed. Operations conducted from launch.
51	52.73	53.03	26.71	28.95	Ek. bot.; Tnr. cse.; 4' inter.; #12, #20; Pr. m.	surf. and botm.	11	Against tide.	.....	Ebb, 1.80 knots per hr.
51	52.73	52.98	25.97	28.02	.....do.........	...do....	10	...do......	.....	Ebb, 1.23 knots per hr.
51	52.73	52.98	24.03	26.32	.....do.........	...do....	11	...do......	.....	Ebb, 1.31 knots per hr.
68	52.73	52.98	17.33	24.52	.....do.........	...do....	9½	...do......	.....	Ebb, 1.50 knots per hr.
69	52.63	52.83	17.47	22.13	.....do.........	...do....	8½	...do......	.....	Ebb, 1.74 knots per hr.
70	51.73	52.23	13.75	14.29	.....do.........	...do....	11	...do......	.....	Ebb, 1.88 knots per hr.
69	52.33	53.23	13.37	17.40	.....do.........	...do....	10	...do......	.....	Ebb, 2.89 knots per hr.
51	52.83	51.98	29.04	31:12	Ek. bot.; Tnr. cse.; 4' inter.; #12, #20; Pr. m.	surf. and botm.	13	Against tide.	.....	Ebb, 1.39 knots per hr.
51	52.93	52.98	29.50	28.88	.....do.........	...do....	12	...do......	.....	Ebb, 2.05 knots per hr.

Station number.	Position.	Chart.	Date.	Time of day.	Depth.	Character of bottom.
	Lower section of bay—Con.	*C. S.*	1912.		*Fms.*	
H. 5271	Goat Id. Lt., N. 14½° W..... Shag Rk., S. 60° W. San Bruno Lt., S. 17° W.	5531	Dec. 4	11.19 a. m.	8	M................
H. 5272	Shag Rk., N. 51° W......... San Bruno Lt., S. 17° W. Candlestick Pt., N. 76½° W.	5531	...do.....	11.48 a. m.	7¼	.....do............
H. 5273	Shag Rk., N. 34° W......... San Bruno Lt., S. 39½° W. No. 2 Beacon, S. 29° E.	5531	...do.....	12.20 p. m.	5	.....do............
H. 5274	Shag Rk., N. 26½° W........ San Bruno Lt., S. 70° W. No. 2 Beacon, S. 34° E.	5531	...do.....	12.48 p. m.	5	.....do............
H. 5275	Shag Rk., N. 26½° W........ San Bruno Lt., N. 86° W. No. 2 Beacon, S. 35° E.	5531	...do.....	1.11 p. m.	5	.....do............
H. 5276	No. 2 Beacon, S. 34° E....... San Bruno Lt., N. 67° W. San Mateo Pt., S. 10½° W.	5531	...do.....	1.38 p. m.	7	.....do............
	Middle section of bay.					
H. 5277	Angel Id. Lt., N. 11½° E..... Alcatraz Lt., S. 53½° E. Lime Pt. Lt., S. 60° W.	5532	Dec. 5	9.49 a. m.	14½	hrd. S............
H. 5278	Southampton Lt., N. 9° E... Blunt Pt., N. 44° W. Alcatraz Lt., S. 31° W.	5532	...do.....	10.25 a. m.	19¾	m. S..............
H. 5279	Southampton Lt., N. 17½° E.. Rt. Tang. Angel Id., N. 57° W. Lft. Tang. Angel Id., S. 41½° W.	5532	...do.....	10.56 a. m.	16	.....do............
H. 5280	Southampton Lt., N. 63½° E.. Rt. Tang. Red Rk., N. 11° W. Lft. Tang. Angel Id., S. 1° W.	5532	...do.....	11.23 a. m.	8½	.....do............
H. 5281	Southampton Lt., S. 74° E... Bluff Pt., S. 44½° W. Rt. Tang. Red Rk., N. 1½° W.	5532	...do.....	11.52 a. m.	8	M................
H. 5282	Southampton Lt., S. 60½° E.. Bluff Pt., S. 9½° W. Rt. Tang. Red Rk., N. 6° E.	5532	...do.....	12.11 p m.	9½	.....do............
H. 5283	Southampton Lt., S. 52° E... Bluff Pt., S. 19° E. Lft. Tang. Red Rk., N. 48° E.	5532	...do.....	12.41 p. m.	7	.....do............
H. 5284	Brothers Lt., N. 16° E....... Southampton Lt., S. 33½° E. Lft. Tang. Red Rk., S. 63° E.	5532	...do.....	1.12 p. m.	9	.....do............
	Upper section of bay.					
D. 5815A	Lft. Tang. Crockett Whf., S. 77° E. Curquinez Lt., N. 4° E. Rt. Tang. Selby Whf., S. 20° W.	5533	Dec. 9	11.23 a. m.	7	s. M., M..........
....	A to B.....................	5533	...do.....	11.33 a. m.	....	....
D. 5815B	Lft. Tang. Crockett Whf., S. 72° E. Carquinez Lt., N. 49° W. Rt. Tang. Selby Whf., S. 59½° W.	5533	...do.....	12.09 p. m.	13	m. S., Sh..........
D. 5816A	Carquinez Lt., N. 63° E..... Oleum Pt., S. 32° E. Mare Id. Lt., N. 33° E.	5533	...do.....	1.00 p. m.	9½	M , Sh............
....	A to B.....................	5533	...do.....	1.08 p. m.	....	....

FRANCISCO BAY, CALIF., 1912–13, AND MARCH, 1914—Continued.

Temperature. Air.	Temperature. Surf.	Temperature. Botm.	Salinity. Surf.	Salinity. Botm.	Apparatus.	Trial. Depth.	Trial. Duration.	Drift. Direction.	Drift. Distance.	Remarks.
°F. 51	°F. 53.23	°F. 53.18	29.50	28.56	Ek. bot.; Tnr. cse.; 4′ inter.; #12, #20; Pr. m.	surf and botm.	Min. 11	Against tide.	Mi.	Ebb, 2.04 knots per hr.
52	53.33	53.23	29.50	29.50	.....do.........	...do....	11	...do......	.....	Ebb, 1.95 knots per hr.
52	53.73	53.78	29.95	29.95	.....do.........	...do....	10	...do......	.....	Ebb, 1.66 knots per hr.
52	53.63	53.73	30.50	29.89	.....do.........	...do....	11	...do......	.....	Ebb, 1.74 knots per hr.
53	54.53	52.93	30.20	30.28	.....do.........	...do....	10½	...do......	.....	Ebb, 1.88 knots per hr. Ek. bot. fouled, failed to trip, lowered immediately, tripped, and readings taken.
53	53.53	53.68	30.43	30.43	.....do.........	...do....	11	...do......	.....	Ebb, 1.59 knots per hr.
53	51.93	52.08	32.28	32.37	Ek. bot.; Tnr. cse.; 4′ inter.; #12, #20 Pr. m.	surf. and botm.	10	Against tide.	.....	Ebb, 0.517 knot per hr.
54	52.23	52.28	32.28	32.37	.....do.........	...do....	9½	...do......	.....	Ebb, 0.784 knot per hr.
58	52.43	52.38	31.75	32.14	.....do.........	...do....	17	...do......	.....	Ebb, 0.8 knot per hr.
58	52.53	52.88	31.66	31.66	.....do.........	...do....	15	...do......	.....	Ebb, 0.82 knot per hr.
61	52.53	52.63	29.34	31.51	.....do.........	...do....	10	...do......	.....	Ebb, 1.48 knots per hr.
62	52.63	52.68	30.66	31.21	.....do.........	...do....	11½	...do......	.....	Ebb, 2.04 knots per hr.
66	52.53	52.63	28.40	30.35	.....do.........	...do....	10½	...do......	.....	Ebb, 2.33 knots per hr.
66	52.03	52.48	27.33	29.04	.....do.........	...do....	10	...do	.....	Ebb, 2.71 knots per hr.
50	52.00	......	....	....	o. p. dr.......	botm...	....	....	.....	O. p. dr. used at each end, sledge trawl through intervening distance, 0.56 mi. Flood. M. 4 inches over top of o. p. dr.
....	......	......	....	....	5′ sldg.........	...do....	15	95°........	0.54	No M. Cable out 30 fms.
....	......	......	....	....	o. p. dr.; 5′ sldg	...do....	....	....	.....	O. p. dr. ¾ full; rest washed out.
52	52.00	......	....	....	.....do.........	...do....	....	....	.....	O. p. dr. used at each end, sledge trawl through intervening distance, 0.88 mi. Flood. M. 6 inches over top.
....	......	......	....	....	5′ sldg.........	...do....	15	76°........	0.88	No M. Cable out 30 fms.

DREDGING AND HYDROGRAPHIC RECORDS SECURED IN SAN

Station number.	Position.	Chart.	Date.	Time of day.	Depth.	Character of bottom.
	Upper section of bay—Contd.	*C. S.*	1912.		*Fms.*	
D. 5816B	Carquinez Lt., N. 31° E. Mare Id. Lt., N. 28° W. Lft. Tang. Crockett Whf., S. 78° E.	5533	Dec. 9	1.32 p. m.	10½	M., Mi.
D. 5817A	Lone Tree Pt., S. 72° E. Mare Id. Lt., N. 61½° E. Pt. Pinole, S. 51½° W.	5533	...do....	2.06 p. m.	5½	s. M.
....	A to B	5533	...do....	2.11 p. m.	....	....
D. 5817B	Selby Wharf, S. 36° E. Mare Id. Lt., N. 59° E. Pt. Pinole, S. 54° W.	5533	...do....	2.43 p. m.	5½	M., S.
	Off Pt. Reyes	....	...do....	....	28 30	S.
	Upper section of bay.					
D. 5818A	Pt. Pinole, S. 10° E. Mare Id. Lt., N. 67° E. Lone Tree Pt., N. 89½° E.	5533	Dec. 10	10.37 a. m.	5½	M.
....	A to B	5533	...do....	10.50 a. m.	....	....
D. 5818B	Pt. Pinole, S. 20½° W. Mare Id. Lt., N. 69½° E. Lone Tree Pt., S. 83° E.	5533	...do....	11.12 a. m.	4¾	s. M., Sh.
D. 5819A	Pt. Pinole, N. 81½° E. Brothers Lt., S. 16° W. Rt. Tang. Sisters, S. 47° W.	5533	...do....	11.57 a. m.	7	....do.
....	A to B	5533	...do....	12.52 p. m.	....	....
D. 5819B	Pt. Pinole, S. 69½° E. Brothers Lt., S. 23½° W. Rt. Tang. Sisters, S. 45½° W.	5533	...do....	1.17 p. m.	6	s. M., Sh.
D. 5820A	Brothers Lt., S. 5° E. Rt. Tang. Sisters, N. 30° W. Lft. Tang. Marin Ids., S. 60° W.	5533	...do....	1.51 p. m.	12½	....do.
....	A to B	5533	...do....	1.57 p. m.	....	....
D. 5820B	Brothers Lt., S. 15° W. Rt. Tang. Sisters, S. 69½° W. Lft. Tang. Marin Ids., S. 48° W.	5533	...do....	2.21 p. m.	8	S., M.
	Middle section of bay.					
D. 5821A	Rt. Tang. Red Rk., N. 43° W. Brothers Lt., N. 17° E. Southampton Lt., S. 62½° E.	5532	Dec. 17	12.45 p. m.	8	S., M., Sh.
....	A to B	5532	...do....	1.15 p. m.	....	....
D. 5821B	Rt. Tang. Red Rk., N. 14° E. Brothers Lt., N. 5° E. Southampton Lt., S. 71° E.	5532	...do....	1.38 p. m.	9¾	S., M., Sh.
D. 5822A	Brothers Lt., N. 57½° E. Southampton Lt., S. 38½° E. Rt. Tang. Red Rk., S. 58° E.	5532	...do....	2.05 p. m.	5	....do.
....	A to B	5532	...do....	2.09 p. m.	....	....

FRANCISCO BAY, CALIF., 1912-13, AND MARCH, 1914—Continued.

Temperature.			Salinity.		Apparatus.	Trial.		Drift.		Remarks.
Air.	Surf.	Botm.	Surf.	Botm.		Depth.	Duration.	Direction.	Distance.	
°F.	°F.	°F.					Min.		Mi.	
					o. p. dr.	botm.				O. p. dr. 8 inches over full.
53	53.00				o. p. dr.; 5' sldg.	do.				O. p. dr. used at each end, sledge trawl through intervening distance, 1.16 mi. Ebb. More than filled.
					5' sldg.	do.	23	64°	1.16	Flood. Cable out 20 fms. Large tub M. landed.
					o. p. dr.	do.				M. 1 foot above top.
					seine.	do.	90		6.00	Trips made with Paladini Fish Co.
51	50.50				o. p. dr.	botm.				O. p. dr. used at each end, sledge trawl through intervening distance, 1.16 mi. M. 6 inches above edge.
					5' sldg.	do.	15½	58°	1.16	Slack. Cable out 20 fms. No M. except on trawl runners.
					o. p. dr.	do.				O. p. dr. 6 inches over full.
52	50.00				o. p. dr.; 5' sldg.	do.				O. p. dr. used at each end, sledge trawl through intervening distance, 1.25 mi.; 6 inches over full.
					5' sldg.	do.	16½	42°	1.25	Flood. Clean haul. Cable out 25 fms.
					o. p. dr.	do.				Full.
53	52.00				do.	do.				O. p. dr. used at each end, sledge trawl through intervening distance, 1.1 mi.; 6 inches over full.
					5' sldg.	do.	17	30½°	1.1	Clean haul. Flood. Cable out 40 fms.
					o. p. dr.	do.				
54	53.00				o. p. dr.	botm.				O. p. dr. used at each end, sledge trawl through intervening distance, 1 mi. Off California City. Level full.
					5' sldg.	do.	12	134°	1.0	Ebb. No M. taken.
					o. p. dr.	do.				
55	53.00				do.	do.				O. p. dr. used at each end, sledge trawl through intervening distance, 1.17 mi.; 6 inches over full.
					5' sldg.	do.	14	182°	1.17	Ebb. Cable out 25 fms.

DREDGING AND HYDROGRAPHIC RECORDS SECURED IN SAN

Station number.	Position.	Chart.	Date.	Time of day.	Depth.	Character of bottom.
	Middle section of bay—Con.	*C. S.*	1912.		*Fms.*	
D. 5822B	Brothers Lt., N. 36½° E. Rt. Tang. Red Rk., S. 88° E. Southampton Lt., S. 48° E.	5532	Dec. 17	2.28 p. m.	6	M
D. 5823A	Brothers Lt., N. 35° E. Rt. Tang. Red Rk., N. 85° E. Southampton Lt., S. 51° E.	5532	...do....	3.14 p. m.	7	M., Sh
....	A to B	5532	...do....	3.19 p. m.	....	....
D. 5823B	Brothers Lt., N. 23½° E. Rt. Tang. Red Rk., N. 59° E. Southampton Lt., S. 58° E.	5532	...do....	3.52 p. m.	10½	M., Sh
D. 5824A	Rt. Tang. Red Rk., S. 44° E. Brothers Lt., N. 48° E. Lft. Tang. Marin Id., N. 41° W.	5532	Dec. 18	10.02 a. m.	12½	gy. M
....	A to B	5532	...do....	10.07 a. m.	....	....
D. 5824B	Rt. Tang. Red Rk., S. 68½° E. Brothers Lt., N. 13° E. Lft. Tang. Marin Id., N. 36° W.	5532	...do....	10.29 a. m.	7	Sh., S
D. 5825A	Rt. Tang. Angel Id., S. 60½° W. Southampton Lt., N. 79½° E. Lft. Tang. Angel Id., S. 6° W.	5532	...do....	10.56 a. m.	8½	S
....	A to B	5532	...do....	11.01 a. m.	....	....
D. 5825B	Rt. Tang. Angel Id., N. 75° W. Southampton Lt., N. 7° E. Lft. Tang. Angel Id., S. 43½° W.	5532	...do....	11.35 a. m.	12½	S
D. 5826A	Rt. Tang. Red Rk. N. 20° E. Southampton Lt., S. 45½° E. Bluff Pt., S. 1° E.	5532	...do....	12.44 p. m.	7	S., Sh
....	A to B	5532	...do....	12.55 p. m.	....	....
D. 5826B	Rt. Tang. Red Rk., N. 8° W. Southampton Lt., S. 52° E. Bluff Pt., S. 38° W.	5532	...do....	1.16 p. m.	9	S., Sh
	Upper section of bay.		1913.			
H. 5285	Brothers Lt., S. 9½° E. Lft. Tang. Sisters, N. 27° W. Lft. Tang. Marin Ids., S. 59° W.	5533	Jan. 13	9.53 a. m.	12½	M
H. 5286	Brothers Lt., S. 23° W. Rt. Tang. Sisters, S. 67½° W. Pinole Pt., N. 71½° E.	5533	...do....	10.28 a. m.	7	....do
H. 5287	Brothers Lt., S. 31° W. Pinole Pt., S. 75° E. Rt. Tang. Sisters, S. 54° W.	5533	...do....	11.01 a. m.	6½	....do
H. 5288	Lone Tree Pt., S. 83° E. Pinole Pt., S. 35° W. Mare Id. Lt., N. 65° E.	5533	...do....	11.44 a. m.	5	....do
H. 5289	Lone Tree Pt., S. 31° E. Pinole Pt., S. 50½° W. Mare Id. Lt., N. 64° E.	5533	...do....	12.39 p. m.	5¾	S
H. 5290	Mare Id. Lt., N. 83° W. Carquinez Lt., N. 68° E. Lft. Tang. Crockett Whf., S. 72° E.	5533	...do....	1.14 p. m.	9½	M

FRANCISCO BAY, CALIF., 1912–13, AND MARCH, 1914—Continued.

Temperature.			Salinity.		Apparatus.	Trial.		Drift.		Remarks.
Air.	Surf.	Botm.	Surf.	Botm.		Depth.	Duration.	Direction.	Distance.	
°F.	°F.	°F.					Min.		Mi.	
......	......	......	......	......	o. p. dr........	botm...	......	......	......	Rather more than level full.
54	53.00	......	......	......	.....do........	...do...	......	......	......	O. p. dr. used at each end, sledge trawl through interveníng distance, 0.8 mi. Level full.
......	......	......	......	......	5′ sldg........	...do...	19	163°.......	0.8	Slack. Cable out 30 fms.; ½ full M.
......	......	......	......	......	o. p. dr........	...do...	......	......	......	Much more than full.
63	53.00	......	......	......	.....do........	...do...	......	......	......	O. p. dr. used at each end, sledge trawl through interveníng distance, 1.16 mi.; 6–8 inches above edge.
......	......	......	......	......	5′ sldg........	...do...	14½	150°.......	1.16	Ebb. Cable out 40 fms.
......	......	......	......	......	o. p. dr........	...do...	......	......	......	Level full.
63	53.00	......	......	......	.....do........	...do...	......	......	......	O. p. dr. used at each end, sledge trawl through interveníng distance, 1.1 mi. Level full.
......	......	......	......	......	5′ sldg........	...do...	15	143°.......	1.1	Ebb. Cable out 30 fms. Landed wrong side up. Full M.
......	......	......	......	......	o. p. dr........	...do...	......	......	......	
57	53.00	......	......	......	.....do........	...do...	......	......	......	O. p. dr. used at each end, sledge trawl through interveníng distance, 1.2 mi.; 2/3 full.
......	......	......	......	......	5′ sldg........	...do...	15	142°.......	1.2	Ebb. Cable out 25 fms.
......	......	......	......	......	o. p. dr........	...do...	......	......	......	Level full.
48	44.83	45.43	24.39	25.31	Ek. bot.; Tnr. cse.; 4′ inter.; #12, #20; Alb. smp.	surf. and botm.	19	Against tide.	......	Net towed 3 min. Ebb.
50	44.83	44.93	23.68	24.30	.....do........	...do...	10	...do......	......	Ebb.
50	44.73	44.83	22.68	22.90	.....do........	...do...	10	...do......	......	Net towed 3½ min. Ebb.
51	43.73	44.18	18.56	22.83	.....do........	...do...	29½	...do......	......	Net towed 3 min. Ebb.
51	43.23	43.93	14.45	20.12	.....do........	...do...	16	...do......	......	Net towed 3½ min. Ebb.
53	42.73	42.98	14.00	15.92	.....do........	...do...	16	...do......	......	Ebb. Net towed 3 min.

DREDGING AND HYDROGRAPHIC RECORDS SECURED IN SAN

Station number.	Position.	Chart.	Date.	Time of day.	Depth.	Character of bottom.
	Upper section of bay—Con.	C. S.	1913.		Fms.	
H. 5291	Carquinez Lt., N. 43° W. Lft. Tang. Crockett Whf., S. 69° E. Rt. Tang. Selby Whf., S. 42° W.	5533	Jan. 13	1.38 p. m.	12	m. S.
H. 5292	Carquinez Lt., N. 43° W. Lft. Tang. Crockett Whf., S. 69° E. Rt. Tang. Selby Whf., S. 45° W.	5533	...do...	1.48 p. m.	12	...do...
H. 5293	Lone Tree Pt., S. 28° E. Pinole Pt., S. 52° W. Mare Id. Lt., N. 61° E.	5533	...do...	2.31 p. m.	5	S.
H. 5294	Lone Tree Pt., S. 82½° E. Pinole Pt., S. 37½° W. Mare Id. Lt., N. 66½° E.	5533	...do...	3.06 p. m.	4¾	M.
H. 5295	Brothers Lt., S. 31½° W. Pinole Pt., S. 70° E. Rt. Tang. Sisters, S. 53½° W.	5533	...do...	3.54 p. m.	7	...do...
H. 5296	Brothers Lt., S. 25° W. Rt. Tang. Sisters, S. 65° W. Pinole Pt., N. 70½° E.	5533	...do...	4.28 p. m.	7	...do...
	Middle section of bay.					
D. 5827A	Lime Pt. Lt., N. 81½° W. Alcatraz Lt., N. 80½° E. Angel Id. Lt., N. 11½° E.	5532	Jan. 20	9.19 a. m.	17	S., Sh., G.
....	A to B.	5532	...do...	9.33 a. m.	....	....
D. 5827B	Lime Pt. Lt., N. 89° W. Alcatraz Lt., N. 76½° E. Angel Id. Lt., N. 18° W.	5532	...do...	9.52 a. m.	6¾	S., G.
D. 5828A	Southampton Lt., N. 3° E. Alcatraz Lt., S. 32½° W. Lft. Tang. Angel Id., N. 87° W.	5532	...do...	10.18 a. m.	16½	M., S.
....	A to B.	5532	...do...	10.27 a. m.	....	....
D. 5828B	Southampton Lt., N. 28° E. Rt. Tang. Angel Id., N. 76° W. Lft. Tang. Angel Id., S. 25½° W.	5532	...do...	10.47 a. m.	10¼	M., S., Sh.
D. 5829A	Angel Id. Lt., N. 18° E. Alcatraz Lt., S. 48½° E. Lime Pt. Lt., S. 53° W.	5532	...do...	11.40 a. m.	10½	S., fne. G., Sh.
....	A to B.	5532	...do...	11.46 a. m.	....	....
D. 5829B	Angel Id. Lt., N. 38° E. Alcatraz Lt., S. 78½° E. Lime Pt. Lt., S. 53° W.	5532	...do...	12.09 p. m.	15½	S., fne., G., Sh.
H. 5297	Angel Id. Lt., N. 7° E. Alcatraz Lt., S. 51° E. Lime Pt. Lt., S. 60½° W.	5532	...do...	12.51 p. m.	10	m. S.

FRANCISCO BAY, CALIF., 1912-13, AND MARCH, 1914—Continued.

Temperature.			Salinity.		Apparatus.	Trial.		Drift.		Remarks.
Air.	Surf.	Botm.	Surf.	Botm.		Depth.	Duration.	Direction.	Distance.	
°F.	°F.	°F.					Min.		Mi.	
53	42.73	43.43	12.28	17.20	Ek. bot.; Tnr. cse., 4' inter.; #12, #20; Alb. smp.	surf. and botm.	10	Against tide.	.....	Ebb.
53	42.73	43.43	12.67	17.40	Ek. bot.; Tnr. cse.; 4' inter.; #12, #20.	...do....	15	...do......	.....	Flood. Net towed 5 min.
52	43.23	43.93	15.23	20.43	.....do.........	...do....	13½	...do......	.....	Flood. Net towed 3 min.
52	43.83	44.78	18.41	22.74	.....do.........	...do....	16	...do......	.....	Do.
51	44.93	45.58	24.13	26.62	.....do.........	...do....	14	...do......	.....	Flood. Net towed 4 min.
51	45.53	45.93	27.72	24.39	.....do.........	...do....	10	...do......	.....	Flood. Net towed 2 min.
48	49.00	......	......	......	o. p. dr.......	botm...	......	....	.....	O. p. dr. used at each end, sledge trawl through intervening distance, 1.06 mi. Flood. Cable out 40 fms.
....	......	......	......	......	5' sldg........	...do....	14	81°.......	1.06	"A" includes two dips with o. p. dr. Neither gave full load. Net of trawl almost completely ripped from frame. Contents caught in folds saved. At "B" o. p. dr. more than full.
48	49.00	......	......	......	o. p. dr.......	...do....	......	....	.....	More than level full.
48	49.00	......	......	......	.....do.........	...do....	......	....	.....	O. p. dr. used at each end, sledge trawl through intervening distance, 1.07 mi. Ebb. O. p. dr. more than full.
....	......	......	......	......	5' sldg........	...do....	27	340°.......	1.07	Cable out 30 fms.
48	49.00	......	......	......	o. p. dr.......	...do....	......	....	.....	O. p. dr. 8-10 ins. over full.
52	50.00	......	......	......	.....do.........	...do....	......	....	.....	O. p. dr. used at each end, sledge trawl through intervening distance, 1.06 mi. Ebb. O. p. dr., 3 dips; last, ½ full, only lot sifted.
....	......	......	......	......	5' sldg........	...do....	10	232½°......	1.06	Cable out 30 fms. Coaster meager haul.
52	50.00	......	......	......	o. p. dr.......	...do....	......	....	.....	O. p. dr. practically empty, nothing saved.
59	47.73	47.93	28.97	29.82	Alb. smp.; Ek. bot.; Tnr. cse.; 4' inter.; #12, #20.	surf. and botm.	5	Against tide.	.....	Ebb.

DREDGING AND HYDROGRAPHIC RECORDS SECURED IN SAN

Station number.	Position.	Chart.	Date.	Time of day.	Depth.	Character of bottom.
	Middle section of bay—Con.	C. S.	1913.		Fms.	
H. 5298	Southampton Lt., N. 10½° E. Alcatraz Lt., S. 30½° W. Blunt Pt., N. 51° W.	5532	Jan. 20	1.38 p. m.	20½	m. S.
H. 5299	Southampton Lt., N. 18° E. Rt. Tang. Angel Id., N. 61½° W. Lft. Tang. Angel Id., S. 41° W.	5532	...do...	2.26 p. m.	15½	...do...
H. 5300	Southampton Lt., S. 57° E. Rt. Tang. Red Rk., N. 15½° W. Lft. Tang. Angel Id., S. 16° W.	5532	...do...	2.56 p. m.	7	...do...
H. 5301	Southampton Lt., S. 71° E. Bluff Pt., S. 49½° W. Rt. Tang. Red Rk., N. 4° W.	5532	...do...	3.27 p. m.	10	M.
H. 5302	Southampton Lt., S. 61° E. Bluff Pt., S. 11½° W. Rt. Tang. Red Rk., N. 5½° E.	5532	...do...	4.03 p. m.	10	...do...
H. 5303	Southampton Lt., S. 49° E. Bluff Pt., S. 13½° E. Lft. Tang. Red Rk., N. 44° E.	5532	...do...	4.33 p. m.	7	m. S.
H. 5304	Brothers Lt., N. 18° E. Southampton Lt., S. 36° E. Lft. Tang. Red Rk., S. 70° E.	5532	...do...	5.03 p. m.	7	M.
D. 5830A	Alcatraz Lt., S. 76½° W. Southampton Lt., N. 4° W. Rt. Tang. Goat Id., S. 41½° E.	5532	Jan. 21	9.40 a. m.	11	S.
	A to B	5532	...do...	9.46 a. m.		
D. 5830B	Alcatraz Lt., W. Southampton Lt., N. 14° W. Rt. Tang. Goat Id., S. 27° E.	5532	...do...	10.00 a. m.	8½	S., M.
	Lower section of bay.					
D. 5831	Ferry Bldg., N. 88° E. Goat Id. Lt., N. 43½° E. Rt. Tang. Mission Rk., S. 15° W	5532	Jan. 21	10.22 a. m.	13	M., S., Sh.
H. 5305	Goat Id. Lt., N. 20° E. Ferry Bldg., N. 72° W. Rt. Tang. Mission Rk., S. 31½° W.	5531	...do...	11.34 a. m.	12½	S., M.
H. 5306	Goat Id. Lt., N. 16½° W. Ferry Bldg., N. 53° W. Rt. Tang. Mission Rk., N. 79° W.	5531	...do...	12.17 p. m.	8	M.
H. 5307	Goat Id. Lt., N. 13° W. Shag Rk., S. 60½° W. San Bruno Lt., S. 16° W.	5531	...do...	1.01 p. m.	9	...do...
H. 5308	Shag Rk., N. 55° W. San Bruno Lt., S. 17° W. Candlestick Pt., N. 78° W.	5531	...do...	1.32 p. m.	7½	...do...
H. 5309	Shag Rk., N. 38° W. San Bruno Lt., S. 43° W. No. 2 Beacon, S. 27½° E.	5531	...do...	2.09 p. m.	4¾	...do...
H. 5310	Shag Rk., N. 34° W. San Bruno Lt., S. 64° W. No. 2 Beacon, S. 29° E.	5531	...do...	2.32 p. m.	4¾	...do...
H. 5311	Shag Rk., N. 31° W. San Bruno Lt., W. No. 2 Beacon, S. 30½° E.	5531	...do...	2.55 p. m.	5	...do...

FRANCISCO BAY, CALIF., 1912–13, AND MARCH, 1914—Continued.

Temperature.			Salinity.		Apparatus.	Trial.		Drift.		Remarks.
Air.	Surf.	Botm.	Surf.	Botm.		Depth.	Duration.	Direction.	Distance.	
°F.	°F.	°F.					Min.		Mi.	
62	47.63	48.18	29.06	30.74	Alb. smp.; Ek. bot.; Tnr. cse. 4' inter.; #12, #20.	surf. and botm.	22½	Against tide.	.....	Ebb.
59	47.63	47.78	28.56	29.50	.....do.........	...do....	9	...do.......	.....	Do.
56	47.23	47.63	25.31	28.72	.....do.........	...do....	9	...do.......	.....	Do.
58	47.03	47.18	26.78	26.32	.....do.........	...do....	10	...do.......	.....	Do.
55	46.73	47.08	24.30	25.31	.....do.........	...do....	7	...do.......	.....	Do.
52	46.23	46.88	17.40	22.99	.....do.........	...do....	9	...do.......	.....	Ebb. Tide slacked suddenly for a few minutes; 4' inter. touched botm.
50	46.13	46.68	17.86	22.83	.....do.........	...do....	7½	...do.......	.....	Ebb. O. p. dr. used at each end, sledge trawl through intervening distance, 0.65 mi.
47	50.00	......	......	......	o. p. dr........	botm...	......	....	.....	O. p. dr., two dips aggregated 1 bucket full. Flood.
....	......	......	......	......	5' sldg.........	...do....	10	117°.......	0.65	Flood. O. p. dr. 10–12 ins. more than full. Undoubtedly one of the richest spots in the bay in respect to total number of living organisms.
....	......	......	......	......	o. p. dr........	...do....	......	....	.....	
48	50.00	......	......	......	o. p. dr........	botm...	......	Single spot.	.....	Flood. O. p. dr. much more than full. One of series of three in Berkeley ferry track. Very little life, in marked contrast to last station.
48	47.23	48.18	28.02	30.59	Alb. smp.; Ek. bot.; Tnr. cse.; 4' inter.; #12, #20.	surf. and botm.	12	Against tide.	.....	Ebb.
44	47.73	47.78	28.02	29.50	.....do.........	...do....	10	...do.......	.....	Do.
45	46.83	47.08	27.87	27.87	.....do.........	...do....	11	...do.......	.....	Do.
47	46.63	46.68	27.79	27.94	.....do.........	...do....	10	...do.......	.....	Do.
48	45.83	45.93	28.26	28.49	.....do.........	...do....	10	...do.......	.....	Do.
49	45.83	45.93	28.40	28.56	.....do.........	...do....	10½	...do.......	.....	Do.
51	45.73	45.98	28.84	29.08	.....do.........	...do....	10	...do.......	.....	Do.

DREDGING AND HYDROGRAPHIC RECORDS SECURED IN SAN

Station number.	Position.	Chart.	Date.	Time of day.	Depth.	Character of bottom.
	Lower section of bay—Con.	*C. S.*	1913.		*Fms.*	
H. 5312	No. 2 Beacon, S. 32½° E. San Bruno Lt., N. 69° W. San Mateo Pt., S. 13° W.	5531	Jan. 21	3.20 p. m.	5	M.
D. 5832	Goat Id. Lt., N. 19½° W. Ferry Bldg., S. 81° W. Rt. Tang. Mission Rk., S. 30° W.	5531	Jan. 27		9½	S., M.
H. 5313	No. 2 Beacon, S. 39° E. San Bruno Lt., N. 62° W. San Mateo Pt., S. 10° W.	5531	...do....	12.17 p. m.	5½	M.
H. 5314	Shag Rk., N. 32° W. San Bruno Lt., W. No. 2 Beacon, S. 29½° E.	5531	...do....	12.48 p. m.	5½	....do.
H. 5315	Shag Rk., N. 35° W. San Bruno Lt., S. 66° W. No. 2 Beacon, S. 28½° E.	5531	...do....	1.11 p. m.	5½	....do.
H. 5316	Shag Rk., N. 39° W. San Bruno Lt., S. 45½° W. No. 2 Beacon, S. 27° E.	5531	...do....	1.33 p. m.	5	....do.
H. 5317	Shag Rk., N. 50½° W. San Bruno Lt., S. 18½° W. Candlestick Pt., N. 74° W.	5531	...do....	2.02 p. m.	6	....do.
H. 5318	Goat Id. Lt., N. 18° W. Shag Rk., S. 62° W. San Bruno Lt., S. 19° W.	5531	...do....	2.33 p. m.	7	....do.
H. 5319	Goat Id. Lt., N. 18° W. Ferry Bldg., N. 53° W. Rt. Tang. Mission Rk., S. 77° W.	5531	...do....	3.08 p. m.	9½	....do.
H. 5320	Goat Id. Lt., N. 1° E. Ferry Bldg., N. 67° W. Rt. Tang. Mission Rk., S. 35° W.	5531	...do....	3.44 p. m.	13	m. S.
D. 5833	Goat Id. Lt., N. 58° W. Ferry Bldg., S. 86½° W. Rt. Tang. Mission Rk., S. 52½° W.	5531	...do....	4.17 p. m.	6½	S., Sh.
	Middle section of bay.					
H. 5321	Brothers Lt., N. 20° E. Southampton Lt., S. 37½° E. Lft. Tang. Red Rk., S. 78° E.	5532	Jan. 28	2.11 p. m.	8	M.
H. 5322	Southampton Lt., S. 49° E. Bluff Pt., S. 18° E. Lft. Tang. Red Rk., N. 50° E.	5532	...do....	2.38 p. m.	6½	m. S.
H. 5323	Southampton Lt., S. 58° E. Bluff Pt., S. 11° W. Rt. Tang. Red Rk., N. 5° E.	5532	...do....	3.02 p. m.	7½	M.
H. 5324	Southampton Lt., S. 70° E. Bluff Pt., S. 40° W. Rt. Tang. Red Rk., N. 3½° W.	5532	...do....	3.24 p. m.	10	....do.
H. 5325	Southampton Lt., N. 66½° E. Rt. Tang. Angel Id., S. 69½° W. Lft. Tang. Angel Id., S. 14° W.	5532	...do....	3.46 p. m.	7	m. S.
H. 5326	Southampton Lt., S. 20° E. Rt. Tang. Angel Id., N. 69½° W. Lft. Tang. Angel Id., S. 35° W.	5532	...do....	4.08 p. m.	13	....do.
H. 5327	Southampton Lt., N. 9° E. Alcatraz Lt., S. 29½° E. Blunt Pt., N. 65° W.	5532	...do....	4.29 p. m.	19	hrd. M.
H. 5328	Angel Id. Lt., N. 6° E. Alcatraz Lt., S. 47° E. Lime Pt. Lt., S. 57½° W.	5532	...do....	5.00 p. m.	10	hrd. S.

FRANCISCO BAY, CALIF., 1912–13, AND MARCH, 1914—Continued.

Temperature.			Salinity.		Apparatus.	Trial.		Drift.		Remarks.
Air.	Surf.	Botm.	Surf.	Botm.		Depth.	Duration.	Direction.	Distance.	
°F.	°F.	°F.					Min.		Mi.	
48	45.73	45.88	28.37	29.18	Alb. smp.; Ek. bot.; Tnr. cse.; 4' inter.; #12, #20.	surf. and botm.	10	Against tide.	.....	Ebb.
.....	.....	.....	.....	.....	o. p. dr.	botm.	.....	.....	.....	Ebb. 2 dips each rather more than half full. Second of series of three in Ferry track.
53	46.53	46.68	28.56	28.84	Alb. smp.; Ek. bot.; 4' inter.; #12, #20; Tnr. cse.; Pr. m.	surf. and botm.	18	Against tide.	.....	Flood, 0.75 knot per hr.
67	46.93	46.93	28.33	28.49	do	do	12	do	.....	Flood, 0.90 knot per hr.
68	47.03	51.08	28.02	27.94	do	do	11	do	.....	Flood, 1.03 knots per hr.
66	47.53	47.43	27.33	27.40	do	do	11	do	.....	Flood.
64	47.83	47.23	26.62	27.01	do	do	11	do	.....	Flood, 1.52 knots per hr.
65	47.93	47.18	25.55	26.94	do	do	11	do	.....	Flood, 1.70 knots per hr.
66	47.73	47.78	26.10	26.73	do	do	12	do	.....	Flood, 0.78 knot per hr.
64	48.23	48.33	26.39	28.33	do	do	11	do	.....	Flood, 0.74 knot per hr.
63	48.00	.....	.....	.....	o. p. dr.	botm.	.....	.....	.....	Flood. o. p. dr. considerably more than half full. Third of series in Ferry track.
56.5	47.03	47.38	15.23	21.60	Alb. smp.; Ek. bot.; 4' inter.; #12, #20; Tnr. cse.; Pr. m.	surf. and botm.	4	Against tide.	.....	Flood, 0.65 knot per hr. Towed 4 min.
56	46.93	47.53	14.91	23.29	do	do	14½	do	.....	Flood, 0.21 knot per hr. Towed 3 min.
55	47.93	48.28	18.02	27.10	do	do	13½	do	.....	Flood, 0.18 knot per hr. Towed 3 min.
55	47.93	48.33	25.85	27.13	do	do	10	do	.....	Flood, 0.61 knot per hr.
55	48.23	48.43	19.66	28.11	do	do	15	do	.....	Flood, 0.79 knot per hr. Towed 5 min.
55	48.13	48.88	25.70	28.55	do	do	10	do	.....	Flood, 1.53 knots per hr.
52.5	48.23	48.93	26.62	29.50	do	do	10	do	.....	Flood.
50	48.73	48.98	29.04	29.95	do	do	10½	do	.....	Flood, 1.05 knots per hr.

DREDGING AND HYDROGRAPHIC RECORDS SECURED IN SAN

Station number.	Position.	Chart.	Date.	Time of day.	Depth.	Character of bottom.
	Lower section of bay.	*C. S.*	1913.		*Fms.*	
D. 5834	Goat Id. Lt., N. 15½° W. Rt. Tang. Mission Rk., N. 83½° W. Ferry Bldg., N. 56° W.	5531	Feb. 3	10.06 a. m.	11	m. S., Sh.
D. 5835	Goat Id. Lt., N. 9½° W. Shag Rk., N. 58½° W. San Bruno Lt., S. 21° W.	5531	...do...	10.38 a. m.	7½	s. M., Sh.
D. 5836	No. 2 Beacon, S. 31½° E. San Bruno Lt., S. 69½° W. Candlestick Pt., N. 44° W.	5531	...do...	11.04 a. m.	6	M.
D. 5837	No. 2 Beacon, S. 35° E. San Bruno Lt., N. 68° W. San Mateo Pt., S. 9° W.	5531	...do...	11.23 a. m.	6½	...do...
D. 5838	San Bruno Pt., N. 89° W. No. 2 Beacon, S. 32° E. Shag Rk., N. 30° W.	5531	...do...	11.39 a. m.	5½	...do...
D. 5839	Shag Rk., N. 36° W. San Bruno Lt., S. 45° W. No. 2 Beacon, S. 28° E.	5531	...do...	11.54 a. m.	5¾	M., Sh.
D. 5840	Goat Id. Lt., N. 15½° W. Shag Rk., S. 60° W. San Bruno Lt., S. 16° W.	5531	...do...	12.23 p. m.	9½	M.
D. 5841	Goat Id. Lt., N. 19° E. Rt. Tang. Mission Rk., S. 34° W. Ferry Bldg., N. 78° W.	5531	...do...	12.48 p. m.	12	S., M., Sh.
	Middle section of bay.					
....	Between Angel Id. and Sausalito.	....	Feb. 8	9.15 a. m.	....	....
....	...do...	....	Feb. 15	8.50 a. m.	....	....
....	...do...	....	Mar. 1	9.15 a. m.	....	....
....	...do...	....	Mar. 8		....	....
....	Fort Baker Beach.	....	Mar. 14	2.00 p. m.	0 3	S.
....	Between Angel Id. and Sausalito.	....	Mar. 15	9.30 a. m.	....	....
....	Angel Id., Raccoon Str.	....	Mar. 20	9.00 a. m.	0 3	M., E. G.
....	Between Angel Id. and Sausalito.	....	Mar. 24	930 a. m.	....	....
....	Angel Id., near Blunt Pt.	....	Mar. 27	2.00 p. m.	0 3	S.
....	Between Angel Id. and Sausalito.	....	Mar. 31	9.35 a. m.	....	....
....	Sausalito; Fisherman's Beach	....	Apr. 5	9.00 a. m.	0 3	S.
D. 5842	Mile Rk. Lt., S. 51° W. Bonita Pt. Lt., N. 57° W. Fort Pt. Lt., N. 59° E.	5532	Apr. 7	10.00 a. m.	25 28	Sh., St.
D. 5843	Mile Rk. Lt., S. 3½° E. Bonita Pt. Lt., N. 43° W. Fort Pt. Lt., N. 65° E.	5532	...do...	10.40 a. m.	25 27	...do...
D. 5844	Mile Rk. Lt., S. 23° E. Bonita Pt. Lt., N. 44° W. Fort Pt. Lt., N. 81½° E.	5532	...do...	11.10 a. m.	22 31	...do...
D. 5845	Bonita Pt. Lt., N. 74° W. Lime Pt. Lt., N. 45° E. Fort Pt. Lt., N. 81° E.	5532	...do...	11.39 a. m.	33 49	...do...
D. 5846	Bonita Pt. Lt., N. 89° W. Lime Pt. Lt., N. 45° E. Fort Pt. Lt., S. 73½° E.	5532	...do...	12.10 p. m.	45 50	...do...
....	Between Angel Id. and Sausalito.	....	Apr. 14	10.00 a. m.	....	....
....	Fort Baker Beach.	....	Apr. 18	9.00 a. m.	0 3	S.

FRANCISCO BAY, CALIF., 1912-13, AND MARCH, 1914—Continued.

Temperature.			Salinity.		Apparatus.	Trial.		Drift.		Remarks.
Air.	Surf.	Botm.	Surf.	Botm.		Depth.	Duration.	Direction.	Distance.	
°F.	°F.	°F.					Min.		Mi.	
47	49.00				o. p. dr.	botm.		Single spot		Flood, 4 inches over level full.
47.5	49.00				do.	do.		do.		Slightly fuller than preceding. Flood.
48	49.00				do.	do.		do.		6-8 inches over level full. Flood.
51	49.00				do.	do.		do.		Flood. Over 8 inches more than level full.
52	49.50				do.	do.		do.		Flood, 12 inches over level full.
53	50.00				do.	do.		do.		Ebb, 8 inches over level full.
56.5	50.00				do.	do.		do.		Ebb, 10 inches over level full.
57	50.00				do.	do.		do.		Ebb, ¾ full.
					4' inter.; #12, #20.	surf.	20	Against tide.		
					do.	do.	20	do.		
					do.	do.	20	do.		
					do.	do.	20	do.		
					250' seine.	do.	150			3 hauls.
					4' inter.; #12, #20.	do.	20	Against tide.		
					250' seine.	do.	120			2 hauls.
					4' inter.; #12, #20.	do.	20	Against tide.		
					250' seine.	do.	120			3 hauls.
					4' inter.; #12, #20.	do.	20	Against tide.		
					250' seine.	do.	120			Do.
55					oys. dr. without lining.	botm.	6	49°.	0.52	Cable out 75 fms. Flood.
56					do.	do.	4½	49°.	.30	Do.
54					do.	do.	4	50°.	.53	Flood. Cable out 65 fms.
					do.	do.	5	49°.	.5	Flood. Cable out 125 fms.
					do.	do.	3	71°.	.53	Flood. Cable out 125 fms. Chain bag torn in several places and all but 4 teeth of dr. carried away.
					4' inter.; #12, #20.	surf.	20	Against tide.		
					250' seine.	do.	90			2 hauls.

DREDGING AND HYDROGRAPHIC RECORDS SECURED IN SAN

Station number.	Position.	Chart.	Date.	Time of day.	Depth.	Character of bottom.
	Middle section of bay—Con.	*C. S.*	1913.		*Fms.*	
....	Between Angel Id. and Sausalito.	....	Apr. 19	9.00 a. m.	....	....
	Lower section of bay.					
D. 5847A	Beacon No. 4, S. 80½° E. Beacon No. 3, S. 62° E. Beacon No. 1, S. 14½° W.	5531	Apr. 22	11.09 a. m.	8½	M.
....	A to B	5531	...do...	11.19 a. m.	....	....
D. 5847B	Beacon No. 4, S. 35° W. Beacon No. 1, S. 22½° E. Beacon No. 3, S. 59° E.	5531	...do...	11.49 a. m.	9	Sh., m. S.
D. 5848A	Beacon No. 2, N. 72½° W. Little Coyote Knoll, S. 67° W. Beacon No. 4, S. 50½° E.	5531	...do...	12.47 p. m.	9	M.
....	A to B	5531	...do...	12.55 p. m.	....	....
D. 5848B	Beacon No. 2, S. 75° W. Little Coyote Knoll, S. 11° W. Beacon No. 4, S. 52½° E.	5531	...do...	1.41 p. m.	9½	M., Sh., G.
D. 5849A	Beacon No. 2, S. 28° E. Pt. San Mateo, S. 63° W. San Bruno Lt., N. 55½° W.	5531	...do...	2.09 p. m.	10	M.
....	A to B	5531	...do...	2.14 p. m.	....	....
D. 5849B	Beacon No. 2, S. 30° E. Pt. San Mateo, S. 37° W. San Bruno Lt., N. 60° W.	5531	...do...	2.39 p. m.	9	M.
	Middle section of bay.					
....	Between Angel Id. and Sausalito.	....	Apr. 26	9.30 a. m.	....	....
....	Tiburon, Raccoon Strait	....	Apr. 29	2.00 p. m.	0 3	M.
....	Angel Id. near Blunt Pt.	....	May 5	9.00 a. m.	0 3	S.
....	Between Angel Id. and Sausalito.	....	..do...	1.15 p. m.	....	....
....	.....do	....	May 12	9.00 a. m.	....	....
....	Fort Baker Beach	....	May 13	2.00 p. m.	0 3	....
....	Between Angel Id. and Sausalito.	....	May 19	9.30 a. m.	....	....
....	.....do	....	May 26	1.30 p. m.	....	....
....	.....do	....	June 2	10.00 a. m.	....	....
....	.....do	....	June 9	9.30 a. m.	....	....
....	.....do	....	June 16	9.30 a. m.	....	....
....	.....do	....	June 23	9.30 a. m.	....	....
....	.....do	....	July 2	11.30 a. m.	....	....
....	.....do	....	July 7	9.30 a. m.	....	....
H. 5329	Lime Pt. Lt., S. 72° W. Alcatraz Lt., S. 78° E. Pt. Knox, N. 39° E.	5532	July 18	7.00 a. m.	28	rky. S.
	.....do	5532	...do...	8.00 a. m.	28	.....do
	.....do	5532	...do...	9.00 a. m.	28	.....do
	.....do	5532	...do...	10.00 a. m.	28	.....do
	.....do	5532	...do...	11.00 a. m.	28	.....do

FRANCISCO BAY, CALIF., 1912-13, AND MARCH, 1914—Continued.

Temperature.			Salinity.		Apparatus.	Trial.		Drift.		Remarks.
Air.	Surf.	Botm.	Surf.	Botm.		Depth.	Duration.	Direction.	Distance.	
°F.	°F.	°F.					Min.		Mi.	
					4' inter.; #12, #20.	surf.	20	Against tide.		O. p. dr. used at each end, Alb. smp. at "A," sledge trawl through intervening distance, 0.83 mi.
					o. p. dr.; Alb. smp.	botm.				Flood. Rather more than level full, with surface layer washed off.
					5' sldg.	do.	19	310°	0.83	Cable out 35 fms.
					o. p. dr.; Alb. smp.	do.				Level full.
					do.	do.				O. p. dr. used at each end, Alb. smp. at "A," sledge trawl through intervening distance, 1.1 mi. More than level full. Flood.
					5' sldg.	do.	32½	304°	1.1	Cable out 30 fms.
					o. p. dr.; Alb. smp.	do.				
					do.	do.				Flood. More than level full.
					5' sldg.	do.	17½	325°	.95	Cable out 30 fms.
					o. p. dr.; Alb. smp.	do.				Rather more than full.
					4' inter.; #12, #20.	surf.	20	Against tide.		
					250' seine.		150			2 hauls.
					do.		120			3 hauls.
					4' inter.; #12, #20.	surf.	20	Against tide.		
					do.	do.	20	do.		
					250' seine.		120			Do.
					4' inter.; #12, #20.	surf.	20	Against tide.		
					do.	do.	20	do.		
					do.	do.	20	do.		
					do.	do.	20	do.		
					do.	do.	20	do.		
					do.	do.	20	do.		
					do.	do.	20	do.		
					do.	do.	20	do.		
	60.00	58.30	29.33	30.01	Ek. bot.; Tur. cse.; 4' inter.; #12, #20; Pr. m.	surf and botm.		do		Ship at anchor. Flood, 0.50 knot per hr. Ship headed S. by W.
	59.40	58.55	29.38	29.97	do.	do.		do.		Flood, 1.22 knots per hr. Ship headed S. 24° W.
	58.10	61.95	30.19	30.53	do.	do.		do.		Flood, 1.91 knots per hr. Ship headed S. 10° E.
	57.10	56.70	30.90	31.27	do.	do.		do.		Flood, 1.87 knots per hr.
	57.20	56.00	30.24	31.65	do.	do.		do.		Flood, 0.89 knot per hr. Ship headed S. 54° W. Ship started to swing, did swing a bit, then stopped at position noted.

DREDGING AND HYDROGRAPHIC RECORDS SECURED IN SAN

Station number.	Position.	Chart.	Date.	Time of day.	Depth.	Character of bottom.
	Middle section of bay—Con.	C. S.	1913.		Fms.	
H. 5329	Lime Pt. Lt., S. 72° W. Alcatraz Lt., S. 78° E. Pt. Knox, N. 39° E.	5532	July 18	12.00 noon.	28	rky. S.
	....do	5532	...do	1.00 p. m.	28	....do
	....do	5532	...do	2.00 p. m.	28	....do
	....do	5532	...do	3.00 p. m.	28	....do
	....do	5532	...do	4.00 p. m.	28	....do
	....do	5532	...do	5.00 p. m.	28	....do
	....do	5532	...do	6.00 p. m.	28	....do
	....do	5532	...do	7.00 p. m.	28	....do
	....do	5532	...do	7.30 p. m.	28	....do
	Upper section of bay.					
H. 5330	Pinole Pt., N. 56° E. Brothers Lt., S. Rt. Tang. Sisters, N. 28° W.	5533	July 21	10.00 a. m.	11	M.
	....do	5533	...do	11.00 a. m.	11	....do
	....do	5533	...do	12.00 noon.	11	....do
	....do	5533	...do	1.00 p. m.	11	....do
	....do	5533	...do	2.00 p. m.	11	....do
	....do	5533	...do	3.00 p. m.	11	....do
	....do	5533	...do	4.00 p. m.	8	....do
	....do	5533	...do	5.00 p. m.	8	....do
	....do	5533	...do	6.00 p. m.	8	....do
	....do	5533	...do	7.00 p. m.	8	....do
H. 5331	San Pablo Bay, off mouth of Petaluma Creek, Lt. R (6), N. 41° W., 0.59 mile.	5533	...do	2.51 p. m.	1	....do
H. 5332	San Pablo Bay, off mouth of Petaluma Creek, Lt. R (6), N. 41° W., 2.26 miles.	5533	...do	3.32 p. m.	1½	....do
H. 5333	San Pablo Bay, off mouth of Petaluma Creek, Lt. R (2), N. 71° W., 0.75 mile.	5533	...do	4.07 p. m.	2	....do
H. 5334	San Pablo Bay; Pt. Pinole, S. 26° E., 2.03 miles.	5533	...do	4.52 p. m.	3	....do

FRANCISCO BAY, CALIF., 1912-13, AND MARCH, 1914—Continued.

Temperature.			Salinity.		Apparatus.	Trial.		Drift.		Remarks.
Air.	Surf.	Botm.	Surf.	Botm.		Depth.	Duration.	Direction.	Distance.	
°F.	°F.	°F.					Min.		Mi.	
....	58.10	55.30	30.41	32.10	Ek. bot.; Tnr. cse.; 4' inter.; #12, #20; Pr. m.	surf. and botm.	....	Against tide.	.....	Flood, 0.76 knot per hr. Ship headed S. 81° W.
....	57.60	55.20	30.61	32.50	.....do.........	...do...	....	..do......	.....	Flood, nearly slack, 0.50 knot per hr. Ship headed S. 81° W.
....	58.00	55.60	30.72	32.00	.....do.........	...do...	....	..do......	.....	Ebb, 0.66 knot per hr. Ship headed W.
....	58.00	55.25	30.91	32.41	.....do.........	...do...	....	..do......	.....	Ebb, 1.20 knots per hr. Ship headed N. 60° W.
....	56.90	55.50	31.58	32.05	.....do.........	...do...	....	..do......	.....	Ebb, 1.15 knots per hr. Ship headed NNW.
....	57.10	55.85	31.00	31.87	.....do.........	...do...	....	..do......	.....	Ebb, 1.01 knots per hr. Ship headed N. 10° W.
....	56.70	56.55	31.42	31.62	.....do.........	...do...	....	..do......	.....	Ebb, 0.76 knot per hr. Ship headed N. 18° W. Ship swung to tide completely at 6.30.
....	57.10	56.55	31.18	31.53	.....do.........	...do...	....	..do......	.....	Flood, 0.74 knot per hr. Ship headed S. 51° E.
....	57.10	56.60	31.13	31.49	.....do.........	...do...	....	..do......	.....	Flood, 0.66 knot per hr. Wire broke, repaired, but current meter did not register properly.
....	64.10	63.05	21.44	24.83	Ek. bot.; Tnr. cse.; 4' inter.; #12, #20; Pr. m.	surf. and botm.	....	Against tide.	.....	Ship at anchor Flood, 0.77 knot per hr. Ship headed S. 65° W.
....	62.90	62.50	22.05	26.13	.....do.........	...do...	....	..do......	.....	Flood, 0.89 knot per hr. Ship headed S. 6° W.
....	62.80	62.05	23.03	26.47	.....do.........	...do...	....	..do......	.....	Flood, 1.56 knots per hr. Ship headed S. 8° E.
....	63.20	61.80	23.80	26.74	.....do.........	...do...	....	..do......	.....	Flood, 2.18 knots per hr. Ship headed S.
....	62.30	60.70	25.28	28.40	.....do.........	...do...	....	..do......	.....	Flood, 1.99 knots per hr. Ship headed S. 16° W.
....	61.30	60.15	26.31	28.84	.....do.........	...do...	....	..do......	.....	Flood, 1.45 knots per hr. Ship headed S. 6° W.
....	61.10	59.85	28.10	29.34	.....do.........	...do...	....	..do......	.....	Flood, 1.10 knots per hr. Ship headed S.
....	62.10	59.85	27.25	29.34	.....do.........	...do...	....	..do......	.....	Flood, 0.32 knot per hr. Ship headed S. 12° E.
....	62.10	60.00	26.94	29.25	.....do.........	...do...	....	..do......	.....	Slack, 0.16 knot per hr. Ship headed S. 72° E.
....	62.20	60.75	26.64	28.64	.....do.........	...do...	....	..do......	.....	Ebb, 1.35 knots per hr. Ship headed N. 1° E.
....	.....	68.80	18.85	18.83	Ek. bot........	botm...	....	....	.....	Flood. Launch used.
....	.....	66.25	21.02	21.02	.....do.........	...do...	....	....	.....	Do.
....	.....	64.10	24.07	24.14	.....do.........	...do...	....	....	.....	Do.
....	.....	63.20	25.46	25.53	.....do.........	...do...	....	....	.....	Do.

DREDGING AND HYDROGRAPHIC RECORDS SECURED IN SAN

Station number.	Position.	Chart.	Date.	Time of day.	Depth.	Character of bottom.
	Upper section of bay—Con.					
		C. S.	1913.		*Fms.*	
H. 5335	San Pablo Bay; Pt. Pinole, S. 72° W., 0.73 mile.	5533	July 21	5.32 p. m.	1¾	M.
	Middle section of bay.					
H. 5336	Fort Pt. Lt., S. 73½° W. Lime Pt. Lt., N. 71° W. Angel Id. Lt., N. 9° E.	5532	July 22	7.30 a. m.	8	S.
H. 5337	Southampton Lt., N. 15° W. Alcatraz Lt., N. 69° W. Lft. Tang. Goat Id., N. 83½° E.	5532	...do...	8.20 a. m.	13	...do...
H. 5338	Southampton Lt., N. 9° E. Alcatraz Lt., S. 33° W. Blunt Pt., N. 41° W.	5532	...do...	9.05 a. m.	16	...do...
H. 5339	Southampton Lt., S. 68° E. Bluff Pt., S. 48° W. Rt. Tang. Red Rk., N. 5° W.	5532	...do...	10.00 a. m.	9¾	M.
	...do...	5532	...do...	11.00 a. m.	12	
H. 5340	Southampton Lt., N. 8° E. Alcatraz Lt., S. 33° W. Blunt Pt., N. 56° W.	5532	...do...	11.45 a. m.	23¾	S.
H. 5341	Southampton Lt., N. 15° W. Alcatraz Lt., N. 66° W. Lft. Tang. Goat Id., N. 55° E.	5532	...do...	12.25 p. m.	8½	...do...
H. 5342	Fort Pt. Lt., S. 76° W. Lime Pt. Lt., N. 72° W. Angel Id. Lt., N. 7° E.	5532	...do...	1.25 p. m.	11	...do...
	Lower section of bay.					
H. 5343	Goat Id. Lt., N. 17° W. Ferry Bldg., N. 55° W. Rt. Tang. Mission Rk., N. 83° W.	5531	July 23	8.50 a. m.	10	M.
H. 5344	Candlestick Pt., N. 51° W. Shag Rk., N. 35° W. San Bruno Lt., S. 42° W.	5531	...do...	10.00 a. m.	4½	...do...
H. 5345	No. 2 Beacon, S. 33° E. San Bruno Lt., N. 70° W. San Mateo Pt., S. 13° W.	5531	...do...	10.40 a. m.	5¾	...do...
	...do...	5531	...do...	11.40 a. m.		
H. 5346	Candlestick Pt., N. 53° W. Shag Rk., N. 36° W. San Bruno Lt., S. 44° W.	5531	...do...	1.05 p. m.	5	M.
H. 5347	Goat Id. Lt., N. 19½° W. Ferry Bldg., N. 55° W. Rt. Tang. Mission Rk., N. 79½° W.	5531	...do...	2.14 p. m.	9½	...do...
H. 5348	No. 2 Beacon, S. 31½° W., 6 miles.	5531	...do...	10.54 a. m.	¾	...do...
H. 5349	No. 2 Beacon, S. 13° W., 4.33 miles.	5531	...do...	11.27 a. m.	2	...do...
H. 5350	No. 2 Beacon, S. 22° E., 3.3 miles.	5531	...do...	12.00 noon.	3½	...do...
	Middle section of bay.					
	Between Angel Id. and Sausalito.		Sept. 15	6.45 a. m.		
	...do...		Sept. 24	6.45 a. m.		
	...do...		Oct. 1	1.00 p. m.		
	...do...		Oct. 9	9.30 a. m.		
	...do...		Oct. 20	2.30 p. m.		
			1914.			
H. 5351	Angel Id. Lt., N. 18° E. Alcatraz Lt., S. 54° E. Lime Pt. Lt., S. 57° W.	5532	Mar. 5	9.17 a. m.	10	S.
H. 5352	Southampton Lt., N. 73° E. Rt. Tang. Angel Id., S. 64° W. Lft. Tang. Angel Id., S. 18° W.	5532	...do...	11.02 a. m.	7	m. S.

FRANCISCO BAY, CALIF., 1912-13, AND MARCH, 1914—Continued.

Temperature.			Salinity.		Apparatus.	Trial.		Drift.		Remarks.
Air.	Surf.	Botm.	Surf.	Botm.		Depth.	Duration.	Direction.	Distance.	
°F.	°F.	°F.					Min.		Mi.	
....	.....	64.60	24.36	24.42	Ek. bot.......	botm...	....	....	.....	Flood. Launch used.
....	59.10	59.30	30.41	30.37	Ek. bot.; Pr. m.	botm...	....	....	.....	Ebb, 1.74 knots per hr.
....	62.90	62.05	29.02	29.23	.....do.........	...do....	....	....	.....	Ebb, 1.13 knots per hr.
....	61.00	58.70	28.26	28.77	.....do.........	...do....	....	....	.....	Ebb, 1.68 knots per hr.
....	61.80	59.55	26.73	29.74	.....do.........	...do....	....	....	.....	Ebb, 0.65 knot per hr.
....	62.10	59.15	....	30.03	.....do.........	...do....	....	....	.....	Flood, 0.37 knot per hr.
....	60.30	58.70	29.16	30.26	.....do.........	...do....	....	....	.....	Flood, 1.05 knots per hr. Bow midway in Golden Gate.
....	60.30	59.30	28.35	30.08	.....do.........	...do....	....	....	.....	Flood, 1.56 knots per hr. Ship headed N. 42° W.
....	59.10	59.90	....	31.49	.....do.........	...do....	....	....	.....	Flood, 1.97 knots per hr. Headed toward Mt. Diablo.
....	64.10	62.60	28.42	29.04	Ek. bot.; Tnr. cse.; 4' inter.; #12, #20; Pr. m.	surf. and botm.	....	Against tide.	.....	Ebb, 0.95 knot per hr.
....	69.20	62.05	27.92	27.92	.....do.........	...do....	....	...do......	.....	Flood, 0.22 knot per hr. Net towed 3 min.
....	69.10	63.95	27.85	27.81	.....do.........	...do....	....	...do......	.....	Flood, 0.27 knot per hr.
....	69.20	68.95	27.83	27.83	.....do.........	...do....	....	...do......	.....	Flood, 1.05 knots per hr.
....	67.20	63.90	28.75	28.78	.....do.........	...do....	....	...do......	.....	Flood, 1.21 knots per hr.
....	62.20	60.85	28.91	29.74	.....do.........	...do....	....	Against tide.	.....	Flood, 1.35 knots per hr.
....	.....	68.75	27.61	27.56	Ek. bot.......	botm...	....	....	.....	Flood. Launch used.
....	.....	69.15	27.34	27.34	.....do.........	...do....	....	....	.....	Do.
....	.....	69.10	27.77	27.79	.....do.........	...do....	....	....	.....	Do.
....	.....	......	......	......	4' inter.; #12, #20.	surf....	20	Against tide.	.....	
....	.....	......	......	......	.....do.........	...do....	20	...do......	.....	
....	.....	......	......	......	.....do.........	...do....	20	...do......	.....	
....	.....	......	......	......	.....do.........	...do....	20	...do......	.....	
....	.....	......	......	......	.....do.........	...do....	20	...do......	.....	
63	*54.2	53.2	12.81	29.04	Ek. bot.; Tnr. cse.; 4' inter.; #12, #20; NZ; Pr. m.	...do....	8¾	Anchored.	.....	Ebb tide. 1.83 knots per hr. NZ Surf., #98523; L, #71738; R, #98260.
59	*54.5	53.5	11.78	18.35	.....do.........	...do....	9½	...do......	.....	Ebb tide. 2.43 knots per hr.

DREDGING AND HYDROGRAPHIC RECORDS SECURED IN SAN

Station number.	Position.	Chart.	Date.	Time of day.	Depth.	Character of bottom.
	Middle section of bay—Con.					
H. 5353	Brothers Lt., N. 22½° E. Southampton Lt., S. 36½° E. Rt. Tang. Red Rk., S. 67° E.	C. S. 5532	1914. Mar. 5	11.45 a. m.	*Fms.* 8½	S.
	Upper section of bay.					
H. 5354	Brothers Lt., S. 27° W. Pinole Pt., N. 69½° E. Rt. Tang. Sisters Id., S. 68° W.	5533	Mar. 5	1.11 p. m.	6½	M.
H. 5355	Pinole Pt., S. 36½° W. Lone Tree Pt., S. 79° E. Mare Id. Lt., N. 68° E.	5533	...do.....	1.57 p. m.	6	.....do.
H. 5356	Carquinez Lt., N. 45½° W. Lft. Tang. Crockett Whf., S. 68° E. Rt. Tang. Selbe Whf., S. 50° W.	5533	...do.....	2.44 p. m.	13	m. S.
	Middle section of bay.					
H. 5357	Angel Id. Lt., N. 26° E. Alcatraz Lt., S. 54° E. Lime Pt. Lt., S. 53° W.	5532	Mar. 5	4.41 p. m.	9½	S.
H. 5358	Fort Pt. Lt., S. 64° W. Lime Pt. Lt., N. 69½° W. Angel Id. Lt., N. 18° E.	5532	Mar. 6	10.18 a. m.	17	.....do.
H. 5359	Southampton Lt., N. 14° W. Alcatraz Lt., N. 71½° W. Lft. Tang. Goat Id., N. 89° E.	5532	...do.....	11.04 a. m.	16½	
	Lower section of bay.					
H. 5360	Goat Id. Lt., N. 23½° E. Ferry Bldg., N. 74° W. Rt. Tang. Mission Rk., S. 25° W.	5531	Mar. 6	11.33 a. m.	12	
H. 5361	Shag Rk., N. 53½° W. San Bruno Lt., S. 17½° W. Candlestick Pt., N. 76° W.	5531	...do.....	12.21 p. m.	6½	
H. 5362	No. 2 Beacon, S. 35½° E. San Bruno Lt., N. 68° W. San Mateo Pt., S. 8° E.	5531	...do.....	1.29 p. m.	6	M.
H. 5363	Goat Id. Lt., N. 12° E. Ferry Bldg., N. 71½° W. Rt. Tang. Mission Rk., S. 40° W.	5531	...do.....	2.52 p. m.	10½	m. S.
	Middle section of bay.					
H. 5364	Southampton Lt., N. 14° W. Lft. Tang. Goat Id., N. 77° E. Alcatraz Lt., N. 67° W.	5532	Mar. 6	3.21 p. m.	21	S., M.
H. 5365	Fort Pt. Lt., S. 72½° W. Lime Pt. Lt., N. 67° W. Angel Id. Lt., N. 13° E.	5532	...do.....	3.57 p. m.	12½	S.

FRANCISCO BAY, CALIF., 1912-13, AND MARCH, 1914—Continued.

Temperature.			Salinity.		Apparatus.	Trial.		Drift.		Remarks.
Air.	Surf.	Botm.	Surf.	Botm.		Depth.	Duration.	Direction.	Distance.	
°F.	°F.	°F.					Min.		Mi.	
63	*54.1	53.4	....	24.65	Ek. bot.; Tnr. ose.; 4' inter.; #12, #20; NZ; Pr. m.	surf....	9¾	Anchored.	.....	Salinity too low to be secured from Knudsen's Tables. Ebb tide 3.40 knots per hr.
66	*53.8	53.55	7.65	11.04	Ek. bot.; Tnr. ose.; 4' inter.; #12, #20; NZ; Pr. m.	surf....	8½	Anchored.	.....	Ebb tide, 0.90 knot per hr.
72	*55.7	53.8	4.02	13.42	.....do.........	...do....	10	...do.......	.....	Ebb tide, 2.06 knots per hr.
79	*54.2	54.35	....	3.77	.....do.........	...do....	8	...do.......	.....	Salinity too low to be secured from Knudsen's Tables. Ebb tide 2.19 knots per hr.
58	*54.8	53.05	11.62	30.34	Ek. bot.; Tnr. ose.; 4' inter.; #12, #20; NZ; Pr. m.	surf....	10½	Anchored.	.....	Flood tide, 0.51 knot per hr.
59	*54.7	53.15	15.12	30.52	.....do.........	...do....	11	...do.......	.....	Ebb tide, 3.02 knots per hr.
60	*55.1	53.2	14.72	29.60	.....do.........	...do....	11½	...do.......	.....	Ebb tide, 2.79 knots per hr.
59	*55.5	53.15	12.32	30.07	Ek. bot.; Tnr. ose.; 4' inter.; #12, #20; NZ; Pr. m.	surf....	11	Anchored.	.....	Ebb tide, 1.01 knots per hr.
64	*56.1	54.15	11.85	20.32	.....do.........	...do....	31	...do.......	.....	Ebb tide, 0.95 knot per hr.
62	*56.7	53.7	12.27	23.17	.....do.........	...do....	11	...do.......	.....	Ebb tide, 1.61 knots per hr.
66	*56.3	53.25	11.46	29.23	.....do.........	...do....	13	...do.......	.....	Flood tide, 0.32 knot per hr.
66	*55.5	53.2	10.03	30.57	Ek. bot.; Tnr. ose.; 4' inter.; #12, #20; NZ; Pr. m.	surf....	8½	Anchored.	.....	Flood tide, 2.73 knots per hr.
70	*55.8	53.25	12.45	30.05	.....do.........	...do....	9	...do.......	.....	Flood tide, 0.84 knot per hr.

DREDGING AND HYDROGRAPHIC RECORDS SECURED DURING HALIBUT

Station number.	Position.	Chart.	Date.	Time of day.	Depth.	Character of bottom.
		G. S.	1914.		*Fms.*	
H. 5366	Heceta Head Lt., N. 69½° E., 27.3 miles.	6000	Apr. 29	5.00 a. m.	68	Shl., rky
H. 5367	Heceta Head Lt., N. 68° E., 28.2 miles.	6000	...do.....	5.22 a. m.	79	fne. bk. S
H. 5368	Heceta Head Lt., N. 66½° E., 28.8 miles.	6000	...do.....	5.33 a. m.	84	.....do
H. 5369	Umpqua River Lt., S. 56½° E., 29 miles.	6000	...do.....	5.47 a. m.	110	.....do
H. 5370	Heceta Head Lt., N. 67° E., 30.3 miles.	6000	...do.....	6.04 a. m.	80	Shl., rky
H. 5371	Heceta Head Lt., N. 69° E., 31 miles.	6000	...do.....	6.15 a. m.	84	Shl., gran
H. 5372	Heceta Head Lt., N. 70½° E., 31.6 miles.	6000	...do.....	6.35 a. m.	90	fne. G
H. 5373	Heceta Head Lt., N. 72° E., 32.3 miles.	6000	...do.....	6.50 a. m.	165	fne. bk. S
H. 5374	Heceta Head Lt., N. 73½° E., 32.2 miles.	6000	...do.....	7.10 a. m.	100	
H. 5375	Heceta Head Lt., N. 75° E., 31.7 miles.	6000	...do.....	7.30 a. m.	84	crs. G
H. 5376	Heceta Head Lt., N. 76½° E., 31.3 miles.	6000	...do.....	7.50 a. m.	80	Shl., hrd. M
H. 5377	Heceta Head Lt., N. 78½° E., 31.5 miles.	6000	...do.....	8.05 a. m.	88	Shl., rky, gran., bk. S., G.
H. 5378	Heceta Head Lt., N. 79½° E., 31.7 miles.	6000	...do.....	8.15 a. m.	92	G
H. 5379	Heceta Head Lt., N. 85° E., 32.7 miles.	6000	...do.....	12.25 p. m.	182	fne. bk. S
H. 5380	Heceta Head Lt., E., 31.8 miles.	6000	...do.....	1.05 p. m.	130	Shl., rky
H. 5381	Heceta Head Lt., S. 85° E., 30.9 miles.	6000	...do.....	1.50 p. m.	81	.....do
H. 5382	Heceta Head Lt., S. 82° E., 30.6 miles.	6000	...do.....	2.18 p. m.	80	
H. 5383	Heceta Head Lt., S. 78½° E., 30.5 miles.	6000	...do.....	3.20 p. m.	76	Shl., rky
H. 5384	Heceta Head Lt., S. 76° E., 30.8 miles.	6000	...do.....	3.45 p. m.	60	.....do
H. 5385	Heceta Head Lt., S. 73° E., 30.3 miles.	6000	...do.....	4.05 p. m.	61	M
H. 5386	Heceta Head Lt., S. 70½° E., 30.2 miles.	6000	...do.....	4.32 p. m.	67	fne. bk. S., fne G
H. 5387	Heceta Head Lt., S. 69° E., 28.2 miles.	6000	...do.....	5.10 p. m.	63	Shl
H. 5388	Heceta Head Lt., S. 66° E., 26 miles.	6000	...do.....	6.00 p. m.	55	
H. 5389	Heceta Head Lt., S. 76° E., 24.5 miles.	6000	Apr. 30	1.00 p. m.	61	Shl., hrd. M
H. 5390	Heceta Head Lt., S. 76° E., 26.2 miles.	6000	...do.....	1.37 p. m.	67	Shl., rky
H. 5391	Heceta Head Lt., S. 75½° E., 27.1 miles.	6000	...do.....	2.04 p. m.	64	bk. S., M
H. 5392	Heceta Head Lt., S. 75° E., 28.3 miles.	6000	...do.....	2.24 p. m.	62	Shl., gran
H. 5393	Heceta Head Lt., S. 75° E., 29.9 miles.	6000	...do.....	2.46 p. m.	71	Shl., hrd. M
H. 5394	Heceta Head Lt., S. 72° E., 29.9 miles.	6000	...do.....	3.22 p. m.	79	gn. M
H. 5395	Heceta Head Lt., S. 69½° E., 29.7 miles.	6000	...do.....	3.49 p. m.	81	.....do
H. 5396	Heceta Head Lt., S. 65° E., 29.7 miles.	6000	...do.....	4.52 p. m.	82	Shl., gran
H. 5397	Heceta Head Lt., S. 61° E., 30 miles.	6000	...do.....	5.51 p. m.	85	gn. M.; fne. bk. S
H. 5398	Yaquina Lt., S. 89½° E., 19.6 miles.	6000	May 2	12.00 noon.	95	.....do
H. 5399	Yaquina Lt., S. 87° E., 19.5 miles.	6000	...do.....	12.17 p. m.	83	.....do
H. 5400	Yaquina Lt., S. 83½° E., 19.1 miles.	6000	...do.....	12.34 p. m.	90	.....do
H. 5401	Yaquina Lt., S. 84° E., 19.9 miles.	6000	...do.....	12.52 p. m.	98	.....do

INVESTIGATIONS OFF OREGON-WASHINGTON COASTS, 1914 AND 1915.

Temperature.			Salinity.		Apparatus.	Trial.		Drift.		Remarks.
Air.	Surf.	Botm.	Surf.	Botm.		Depth.	Duration.	Direction.	Distance.	
°F.	°F.	°F.					Min.		Mi.	
51	47.0				Tnr.-Blish sdr.; 30-lb. lead.					
51	47.0				do.					
51.5	48.0				do.					
51.5	49.0				do.					
52	50.0				do.					
52	50.0				do.					
52	50.0				do.					
52	50.0				do.					
52	50.0				do.					Lead dropped twice. No sample.
53	50.0				do.					
54	50.0				do.					
54	50.0				Tnr.-Blish sdr.; 30-lb. lead; 1 skate.	botm.	60			Salt herring used as bait.
54	50.0				do.	do.	60			Do.
54	51.5				Tnr.-Blish sdr.; 30-lb. lead.					
56	53.0				do.					
57	53.0				do.					
57	53.0				do.					Sounding wire fouled propeller; 61 fms. cable cut away. No sample.
57	52.0				Tnr.-Blish sdr.; 28-lb. lead.					
58	51.0				do.					
58	51.0				do.					
58	50.5				do.					
58	50.0				do.					
56	50.0				do.					Lead lost on haul in.
54	52.0				do.					
55	52.0				do.					
53.6	52.0				do.					
53.5	52.0				do.					
53	52.0				do.					
52	52.0				do.					
52	52.0				do.					
54	52.0				do.					
53	52.0				do.					
54	52.0				Tnr.-Blish sdr.; 25-lb. lead.					
54	52.0				do.					
54	52.0				do.					
53.5					do.					

DREDGING AND HYDROGRAPHIC RECORDS SECURED DURING HALIBUT

Station number.	Position.	Chart.	Date.	Time of day.	Depth.	Character of bottom.
		C. S.			Fms.	
H. 5402	Yaquina Lt., S. 82° E., 19.8 miles.	6000	1914. May 2.	1.15 p. m.	96	gn. M.; fne. bk. S..
H. 5403	Yaquina Lt., S. 80½° E., 19.8 miles.	6000	...do.....	1.28 p. m.	96	.....do.............
H. 5404	Yaquina Lt., S. 77° E., 19.5 miles.	6000	...do.....	4.49 p. m.	84	Shl., hrd. M.......
H. 5405	Yaquina Lt., S. 74° E., 19.4 miles.	6000	...do.....	5.05 p. m.	82	Shl., rky..........
H. 5406	Yaquina Lt., S. 71½° E., 19.2 miles.	6000	...do.....	5.27 p. m.	89	gn. M.............
H. 5407	Yaquina Lt., S. 68½° E., 19.2 miles.	6000	...do.....	5.38 p. m.	96	.....do.............
H. 5408	Yaquina Lt., S. 60° E., 19.3 miles.	6000	...do.....	6.18 p. m.	96	.....do.............
H. 5409	Yaquina Lt., S. 50½° E., 19.2 miles.	6000	...do.....	6.56 p. m.	96	.....do.............
H. 5410	Yaquina Lt., S. 43° E., 20.9 miles.	6000	...do.....	7.35 p. m.	93	.....do.............
H. 5411	Yaquina Lt., S. 33° E., 19.6 miles.	6000	May 3	9.29 a. m.	101	.....do.............
H. 5412	Yaquina Lt., S. 28° E., 20 miles.	6000	...do.....	10.07 a. m.	96	.....do.............
H. 5413	Yaquina Lt., S. 21½° E., 20.3 miles.	6000	...do.....	10.45 a. m.	88	.....do.............
H. 5414	Yaquina Lt., S. 15½° E., 21.5 miles.	6000	...do.....	11.20 a. m.	83	.....do.............
H. 5415	Yaquina Lt., S. 15½° E., 22.2 miles.	6000	...do.....	11.40 a. m.	88	.....do.............
H. 5416	Yaquina Lt., S. 15½° E., 22.8 miles.	6000	...do.....	11.57 a. m.	92	.....do.............
H. 5417	Yaquina Lt., S. 13° E., 23.3 miles.	6000	...do.....	12.22 p. m.	85	.....do.............
H. 5418	Yaquina Lt., S. 15½° E., 24.4 miles.	6000	...do.....	12.58 p. m.	92	.....do.............
H. 5419	Yaquina Lt., S. 15° E., 26.6 miles.	6000	...do.....	1.40 p. m.	100	.....do.............
H. 5420	Yaquina Lt., S. 15° E., 28.8 miles.	6000	...do.....	2.20 p. m.	112	.....do.............
H. 5421	Yaquina Lt., S. 15° E., 31 miles.	6000	...do.....	3.00 p. m.	109	.....do.............
H. 5422	Yaquina Lt., S. 15° E., 34 miles.	6000	...do.....	3.55 p. m.	103	.....do.............
H. 5423	Cape Kiwanda, S. 77° E., 14 miles.	6000	...do.....	4.56 p. m.	99	.....do.............
H. 5424	Cape Meares Lt., N. 54½° E., 17.1 miles.	6100	...do.....	5.46 p. m.	108	.....do.............
H. 5425	Cape Meares Lt., N. 70° E., 17 miles.	6100	...do.....	6.28 p. m.	99	.....do.............
H. 5426	Cape Meares Lt., N. 80° E., 16.6 miles.	6100	...do.....	7.07 p. m.	106	.....do.............
H. 5427	Cape Meares Lt., N. 86° E., 16.4 miles.	6100	May 4	6.09 a. m.	100	.....do.............
H. 5428	Cape Meares Lt., N. 86° E., 15.1 miles.	610C	...do.....	6.29 a. m.	98	.....do.............
H. 5429	Cape Meares Lt., S. 84° E., 16.3 miles.	6100	...do.....	7.36 a. m.	100	.....do.............
H. 5430	Cape Meares Lt., S. 76° E., 17.9 miles.	6100	...do.....	8.34 a. m.	98	Shl., hrd. M.......
H. 5431	Cape Meares Lt., S. 74° E., 18.3 miles.	6100	...do.....	8.49 a. m.	100	gn. M.............

INVESTIGATIONS OFF OREGON-WASHINGTON COASTS, 1914 AND 1915—Continued.

Temperature.			Salinity.		Apparatus.	Trial.		Drift.		Remarks.
Air.	Surf.	Botm.	Surf.	Botm.		Depth.	Duration.	Direction.	Distance.	
°F.	°F.	°F.					Min.		Mi.	
54	51.0				Tnr.-Blish sdr.; 25-lb lead.					
54	51.0				Tnr.-Blish sdr.; 25-lb lead; o. p. dr., Alb. smp.; 2 skates.	botm	60			Dories lowered at 1.35 p. m. O. p. dr. dropped at 2.01 p. m.; hauled in 2.07; empty. Alb. smpl. down 2.29; up 2.33; upper part slightly bent; struck by weight (520 lbs.) rigged 4 fms. above sampler. Salt herring bait.
50	53.0				Tnr.-Blish sdr.; 25-lb. lead.					
50	53.0				do					
50	53.0				do					
51	53.0				do					
52	52.0				do					
52	52.0				do					
52	52.0				do					
53	51.0				do					
54	52.0				do					
55	52.0				do					
55	52.0				do					
54.5	52.0				do					
54.5	52.0				do					
55	52.0				do					
54	52.0				do					
56	52.0				do					
56	52.0				do					
56	51.0				do					
55	51.0				do					
55	51.0				do					
54	50.0				do					
52	50.0				do					
52	50.0				Tnr.-Blish sdr.; 25-lb. lead; Alb. smp.					
53	52.0				Tnr.-Blish sdr.; 25-lb. lead.					
53	52.0				Tnr.-Blish sdr.; 25-lb. lead; 4' inter.					Cable on small winch parted; 6 fms. cable, 1 wt. (150 lbs.), 1 ball-bearing swivel and 4' inter. net lost.
54	52.0				Tur. Blish sdr.; 25-lb. lead.					
55	52.0				do					
55	52.0				do					

DREDGING AND HYDROGRAPHIC RECORDS SECURED DURING HALIBUT

Station number.	Position.	Chart.	Date.	Time of day.	Depth.	Character of bottom.
		C. S.	1914.		*Fms.*	
H. 5432	Cape Meares Lt., S. 67½° E., 20.4 miles.	6100	May 4	9.25 a. m.	97	gn. M
H. 5433	Tillamook Lt., N. 46½° E., 25.5 miles.	6100	...do.....	9.56 a. m.	95	.....do
H. 5434	Tillamook Lt., N. 52° E., 25 miles.	6100	...do.....	10.35 a. m.	95	.....do
H. 5435	Tillamook Lt., N. 59° E., 24.9 miles.	6100	...do....	11.08 a. m.	95	.....do
H. 5436	Tillamook Lt., N. 66½° E., 24.9 miles.	6100	...do.....	11.41 a. m.	97	.....do
H. 5437	Tillamook Lt., N. 73½° E., 25.4 miles.	6100	...do.....	12.11 p. m.	87	.....do
H. 5438	Heceta Head Lt., S. 68° E., 25.2 miles.	6000	May 5	5.01 a. m.	51	Shl., hrd. M
H. 5439	Heceta Lt., S. 69° E., 25.9 miles.	6000	...do.....	5.21 a. m.	47	fne. bk. S
H. 5440	Heceta Lt., S. 70° E., 26.6 miles.	6000	...do.....	5.35 a. m.	49	.....do
H. 5441	Heceta Lt., S. 70½° E., 27.2 miles.	6000	...do.....	5.45 a. m.	43	Shl., gran., fne. bk. S.
H. 5442	Heceta Lt., S. 71½° E., 27.9 miles.	6000	...do.....	5.56 a. m.	49	Shl., rky
H. 5443	Heceta Lt., S. 72° E., 28.6 miles.	6000	...do.....	6.08 a. m.	50	.....do
H. 5444	Heceta Lt., S. 74° E., 28.9 miles.	6000	...do.....	6.21 a. m.	61	Shl., gran., fne. G.
H. 5445	Heceta Lt., S. 75° E., 29.5 miles.	6000	...do.....	6.32 a. m.	62	
H. 5446	Heceta Lt., S. 75° E., 28.7 miles.	6000	...do.....	6.48 a. m.	61	Shl., gran., fne. G.
H. 5447	Heceta Lt., S. 74° E., 29.2 miles.	6000	...do.....	6.58 a. m.	61	.....do
H. 5448	Heceta Lt., S. 73½° E., 28.7 miles.	6000	...do.....	7.09 a. m.	61	.....do
H. 5449	Heceta Lt., S. 70½° E., 29.3 miles.	6000	...do.....	10.23 a. m.	62	Shl., hrd. M
H. 5450	Heceta Lt., S. 68½° E., 28.6 miles.	6000	...do.....	10.39 a. m.	65	.....do
H. 5451	Heceta Lt., S. 66½° E., 28.7 miles.	6000	...do.....	11.18 a. m.	54	.....do
H. 5452	Heceta Lt., S. 63½° E., 28.7 miles.	6000	...do.....	12.01 p. m.	65	.....do
H. 5453	Heceta Lt., S. 60° E., 29 miles.	6000	...do.....	12.44 p. m.	72	Shl., gran
H. 5454	Heceta Lt., S. 54° E., 29.7 miles.	6000	...do.....	1.25 p. m.	79	gn. M
H. 5455	Heceta Lt., S. 48½° E., 30.5 miles.	6000	...do.....	2.08 p. m.	82	Shl., rky
H. 5456	Heceta Lt., S. 47½° E., 30.7 miles.	6000	...do.....	2.20 p. m.	78	Shl., hrd. M
H. 5457	Heceta Lt., S. 47½° E., 31.3 miles.	6000	...do.....	2.38 p. m.	79	.....do
H. 5458	Yaquina Lt., N. 70° E., 25.4 miles.	6000	...do.....	3.22 p. m.	162	gn. M
H. 5459	Yaquina Lt., N. 74½° E., 23.4 miles.	6000	...do.....	4.08 p. m.	135	.....do
H. 5460	Yaquina Lt., N. 81° E., 21.7 miles.	6000	...do.....	4.53 p. m.	89	Shl., hrd. M
H. 5461	Yaquina Lt., N. 82° E., 21.4 miles.	6000	...do.....	5.05 p. m.	91	Shl., gran
H. 5462	Yaquina Lt., N. 83° E., 21.2 miles.	6000	...do.....	5.18 p. m.	92	gn. M
H. 5463	Yaquina Lt., N. 84½° E., 20.8 miles.	6000	...do.....	5.31 p. m.	89	.....do
H. 5464	Yaquina Lt., N. 86° E., 20.6 miles.	6000	...do.....	....	85	Shl., hrd. M
H. 5465	Yaquina Lt., N. 87° E., 20.3 miles.	6000	...do.....	5.55 p. m.	89	.....do
H. 5466	Yaquina Lt., N. 88° E., 20 miles.	6000	...do.....	6.07 p. m.	89	
H. 5467	Yaquina Lt., S. 89° E., 19.8 miles.	6000	...do.....	6.23 p. m.	91	gn. M
H. 5468	Yaquina Lt., S. 85½° E., 19.7 miles.	6000	...do.....	6.41 p. m.	90	

INVESTIGATIONS OFF OREGON-WASHINGTON COASTS, 1914 AND 1915—Continued.

Temperature.			Salinity.		Apparatus.	Trial.		Drift.		Remarks.
Air.	Surf.	Botm.	Surf.	Botm.		Depth.	Duration.	Direction.	Distance.	
°F.	°F.	°F.					Min.		Mi.	
55	52.0				Trn.-Blish sdr.; 25-lb. lead.					
55	52.0				do					
55	52.0				do					
55	52.0				do					
59	52.0				do					
60.5	54.0				do					
52.5	51.0				do					
52.5	51.0				do					
53	51.0				do					
53	51.0				do					
53	51.0				do					
55	51.0				do					
57	51.0				do					
56	51.0				do					
55	51.0				do					
55	51.0				Tnr.-Blish sdr.; 25-lb. lead; 2 skates.	botm	60			One dory lowered; 2 fishermen; steamed ahead 5 minutes; then lowered 2d dory. Salt herring bait.
					Tnr.-Blish sdr.; 25-lb. lead.	do	60			
56	52.0				do					
58	52.0				do					
58	52.0				do					
58	52.0				do					
62	54.0				do					
62	54.0				do					
62	54.0				do					
62	54.0				do					
					do					
					do					
62	54.0				do					
61	54.0				do					
60	54.0				do					
					do					
					do					
					do					
60	52.0				do					
59	52.0				do					
58	52.0				do					
56	51.0				do					

DREDGING AND HYDROGRAPHIC RECORDS SECURED DURING HALIBUT

Station number.	Position.	Chart.	Date.	Time of day.	Depth.	Character of bottom.
		C. S.	1914.		Fms.	
H. 5469	Yaquina Lt., S. 83½° E., 19.6 miles.	6000	May 5	6.58 p. m.	89	Shl., hrd. M.......
H. 5470	Yaquina Lt., S. 81° E., 19.2 miles.	6000	...do.....	7.16 p. m.	90	gn. M............
H. 5471	Yaquina Lt., N. 47° E., 10.5 miles.	6000	May 6	6.36 a. m.	47	crs. gy. S..........
H. 5472	Yaquina Lt., N. 50½° E., 10.2 miles.	6000	...do.....	6.55 a. m.	45	crs. gy. S., fne. G...
H. 5473	Yaquina Lt., N. 53½° E., 10.1 miles.	6000	...do.....	7.03 a. m.	45	crs. gy. S., For.....
H. 5474	Yaquina Lt., N. 56½° E., 10 miles.	6000	...do.....	7.12 a. m.	44	crs. gy. S..........
H. 5475	Yaquina Lt., N. 60½° E., 10 miles.	6000	...do.....	7.19 a. m.	41	.....do............
H. 5476	Yaquina Lt., N. 62° E., 10.3 miles.	6000	...do.....	7.27 a. m.	40	.....do............
H. 5477	Yaquina Lt., N. 63° E., 10.6 miles.	6000	...do.....	7.35 a. m.	38	crs. gy. S., fne. G...
H. 5478	Yaquina Lt., N. 64° E., 10.9 miles.	6000	...do.....	7.41 a. m.	39	Shl., hrd. M.......
H. 5479	Yaquina Lt., N. 64½° E., 11.3 miles.	6000	...do.....	7.48 a. m.	35	.....do............
H. 5480	Yaquina Lt., N. 65° E., 11.6 miles.	6000	...do.....	7.55 a. m.	30	Shl., rky., Co......
H. 5481	Yaquina Lt., N. 66° E., 11.9 miles.	6000	...do.....	8.02 a. m.	33	.....do............
H. 5482	Yaquina Lt., N. 67° E., 12.2 miles.	6000	...do.....	8.10 a. m.	38	brk. Sh...........
H. 5483	Yaquina Lt., N. 68° E., 12.6 miles.	6000	...do.....	8.16 a. m.	40	Shl., rky..........
H. 5484	Yaquina Lt., N. 69° E., 13 miles.	6000	...do.....	8.27 a. m.	44	Shl., hrd. M.......
H. 5485	Yaquina Lt., N. 70° E., 13.2 miles.	6000	...do.....	8.36 a. m.	48	fne. bk. S., brk. Sh.
H. 5486	Yaquina Lt., N. 71° E., 13.7 miles.	6000	...do.....	8.47 a. m.	54	.....do............
H. 5487	Yaquina Lt., N. 72° E., 14.5 miles.	6000	...do.....	8.55 a. m.	57	crs. gy. S., brk. Sh.
H. 5488	Yaquina Lt., N. 75½° E., 14.4 miles.	6000	...do.....	11.30 a. m.	64	.....do............
H. 5489	Yaquina Lt., N. 78½° E., 14.4 miles.	6000	...do.....	11.44 a. m.	61	Shl., gran.........
H. 5490	Yaquina Lt., N. 81° E., 14.4 miles.	6000	...do.....	11.54 a. m.	61	.....do............
H. 5491	Yaquina Lt., N. 83° E., 14.5 miles.	6000	...do.....	12.07 p. m.	61	Shl., hrd. M.......
H. 5492	Yaquina Lt., N. 81° E., 14.4 miles.	6000	...do.....	12.26 p. m.	62	Shl., gran., fne. G..
H. 5493	Yaquina Lt., N. 87½° E., 14.8 miles.	6000	...do.....	5.27 p. m.	76	....
H. 5494	Yaquina Lt., S. 88½° E., 13.9 miles.	6000	...do.....	5.33 p. m.	72	fne. bk. S.........
H. 5495	Yaquina Lt., S. 85½° E., 12.4 miles.	6000	May 7	4.40 a. m.	52	fne. gy. S.........
H. 5496	Yaquina Lt., S. 81° E., 12.6 miles.	6000	...do.....	4.52 a. m.	55	.....do............
H. 5497	Yaquina Lt., S. 76½° E., 12.2 miles.	6000	...do.....	5.09 a. m.	60	.....do............
H. 5498	Yaquina Lt., S. 72° E., 11.8 miles.	6000	...do.....	5.30 a. m.	63	.....do............

INVESTIGATIONS OFF OREGON-WASHINGTON COASTS, 1914 AND 1915—Continued.

Temperature.			Salinity.		Apparatus.	Trial.		Drift.		Remarks.
Air.	Surf.	Botm.	Surf.	Botm.		Depth.	Duration.	Direction.	Distance.	
°F.	°F.	°F.					Min.		Mi.	
55.5	51.0				Tnr. Blish sdr.; 25-lb. lead.					
55	51.0				do					
60	52.0				do					
60	52.0				do					
60	52.0				do					
60	52.0				do					
60	52.0				do					
60	52.0				do					
61	52.0				do					
61	52.0				do					
61	52.0				do					
61	52.0				do					
61	52.0				do					
61	52.0				do					
61	52.0				do					
61	52.0				do					
61	52.0				do					
61	52.0				Tnr.-Blish sdr.; 25-lb. lead; 1 skate.	botm	60			At 8.49 lowered a dory; same returned; hoisted 10.57 a. m.
61	52.0				Tnr.-Blish sdr.; 25-lb. lead; Alb. smp.; 1 skate.	do	60			At 8.55 lowered a dory; had fishing lines over side; dory ret., hoisted 11.18 a. m. Alb. smp. used at 11.15 a. m. Salt herring bait.
53	54.0				Tnr.-Blish sdr.; 25-lb. lead.					
53	54.0				do					
52.5					do					
54	54.0				do					
54	*53.9	17.3 (?)	29.76	33.71	Tnr.-Blish sdr.; 25-lb. lead; P. N. bot.; Alb. smp.; 2 skates.					Lowered 2 dories at 12.26, 2 fishermen each made double bank set; 1st dory ret. 1.54; 2d at 3.01. Line broken about 3 ft. from anchor, dory No. 1. Salt herring bait.
53	52.0				Tnr.-Blish sdr.; 25-lb. lead.					
53	52.0				do					
54	50.0				do					
54	50.0				do					
54	50.0				do					
54	50.0				do					

DREDGING AND HYDROGRAPHIC RECORDS SECURED DURING HALIBUT

Station number.	Position.	Chart.	Date.	Time of day.	Depth.	Character of bottom.
		C. S.	1914.		Fms	
H. 5499	Yaquina Lt., S. 66° E., 11.8 miles.	6000	May 7	5.41 a. m.	65	fne. gy. S.
H. 5500	Yaquina Lt., S. 61½° E., 11.8 miles.	6000	...do.....	5.55 a. m.	67	.....do.
H. 5501	Yaquina Lt., S. 57° E., 12 miles.	6000	...do.....	6.10 a. m.	69	.....do.
H. 5502	Yaquina Lt., S. 52° E., 12.2 miles.	6000	...do.....	6.25 a. m.	71	.....do.
H. 5503	Yaquina Lt., S. 48° E., 12.4 miles.	6000	...do.....	6.41 a. m.	71	.....do.
H. 5504	Yaquina Lt., S. 43½° E., 12.7 miles.	6000	...do.....	6.55 a. m.	71	.....do.
H. 5505	Yaquina Lt., S. 40° E., 13.1 miles.	6000	...do.....	7.09 a. m.	71	.....do.
H. 5506	Yaquina Lt., S. 35½° E., 13.2 miles.	6000	...do.....	7.25 a. m.	68	.....do.
H. 5507	Yaquina Lt., S. 31½° E., 13.5 miles.	6000	...do.....	7.40 a. m.	65	.....do.
H. 5508	Yaquina Lt., S. 27½° E., 13.8 miles.	6000	...do.....	7.54 a. m.	60	.....do.
H. 5509	Yaquina Lt., S. 22½° E., 14.1 miles.	6000	...do.....	8.09 a. m.	55	.....do.
H. 5510	Yaquina Lt., S. 19° E., 14.8 miles.	6000	...do.....	8.24 a. m.	55	.....do.
H. 5511	Yaquina Lt., S. 15° E., 15.3 miles.	6000	...do.....	8.37 a. m.	60	.....do.
H. 5512	Yaquina Lt., S. 11½° E., 16.4 miles.	6000	...do.....	8.53 a. m.	53	.....do.
H. 5513	Yaquina Lt., S. 10½° E., 17.2 miles.	6000	...do.....	9.03 a. m.	51	.....do.
H. 5514	Yaquina Lt., S. 8½° E., 18.1 miles.	6000	...do.....	9.20 a. m.	49	.....do.
H. 5515	Yaquina Lt., S. 7° E., 19 miles.	6000	...do.....	9.33 a. m.	45	.....do.
H. 5516	Yaquina Lt., S. 5½° E., 19.8 miles.	6000	...do.....	9.50 a. m.	46	.....do.
H. 5517	Cape Kiwanda, N. 26½° E., 13.3 miles.	6000	...do.....	10.05 a. m.	48	.....do.
H. 5518	Cape Kiwanda, N. 29° E., 12.7 miles.	6000	...do.....	10.17 a. m.	48	.....do.
H. 5519	Cape Kiwanda, N. 31½° E., 11.8 miles.	6000	...do.....	12.23 p. m.	51	.....do.
H. 5520	Cape Kiwanda, N. 33½° E., 11 miles.	6000	...do.....	12.40 p. m.	51	.....do.
H. 5521	Cape Kiwanda, N. 36½° E., 10.2 miles.	6000	...do.....	12.57 p. m.	49	crs. S., fne. G.
H. 5522	Cape Kiwanda, N. 39½° E., 9.5 miles.	6000	...do.....	1.13 p. m.	48	fne. gy. S.
H. 5523	Cape Kiwanda, N. 43½° E., 8.8 miles.	6000	...do.....	1.29 p. m.	47	.....do.
H. 5524	Cape Kiwanda, N. 44½° E., 7.4 miles.	6000	...do.....	1.44 p. m.	44	.....do.
H. 5525	Cape Kiwanda, N. 47° E., 6.5 miles.	6000	...do.....	2.00 p. m.	42	.....do.
H. 5526	Cape Kiwanda, N. 51° E., 5.5 miles.	6000	...do.....	2.07 p. m.	40	.....do.
H. 5527	Cape Kiwanda, N. 55½° E., 4.4 miles.	6000	...do.....	2.18 p. m.	34	.....do.
H. 5528	Cape Kiwanda, N. 80½° E., 5.5 miles.	6000	...do.....	3.01 p. m.	50	.....do.
H. 5529	Cape Kiwanda, S. 87½° E., 5.4 miles.	6000	...do.....	3.17 p. m.	52	.....do.
H. 5530	Cape Kiwanda, S. 77° E., 5.5 miles.	6000	...do.....	3.32 p. m.	50	.....do.

INVESTIGATIONS OFF OREGON-WASHINGTON COASTS, 1914 AND 1915—Continued.

Temperature.			Salinity.		Apparatus.	Trial.		Drift.		Remarks.
Air.	Surf.	Botm.	Surf.	Botm.		Depth.	Duration.	Direction.	Distance.	
°F.	°F.	°F.					Min.		Mi.	
54	50.0				Tur.-Blish.sdr.; 25-lb. lead.					
54	50.0				do.					
54	50.0				do.					
54	50.0				do.					
54	50.0				do.					
54	50.0				do.					
54	50.0				do.					
54	50.0				do.					
....	....				do.					
54	52.0				do.					
54	52.0				do.					
54	52.0				do.					
54	52.0				do.					
55	54.0				do.					
55	54.0				do.					
55	54.0				do.					
55	54.0				do.					
55	54.0				do.					
55	54.0				do.					
....	*53.1		30.17	33.87	Tnr.-Blish.sdr.; 25-lb. lead; P. N. bot.; Alb. smp.; 2 skates.	botm.	60			At 10.17 lowered both dories. At 10.50 sounded in 50 fms. and put over P. N. bot. with 82 m. cable; down 5 min., sent messenger and hove up. Bot. therm. failed to register. At 11.54 used Alb. smp. 1st dory ret. 12.07; 2d at 12.10. Salt herring bait.
53	54.0				Tnr.-Blish.sdr.; 25-lb. lead.					
53	54.0				do.					
54.5	54.0				do.					
54	54.0				do.					
54	54.0				do.					
54	54.0				do.					
54	54.0				do.					
54	54.0				do.					
....	....				do.					
54	54.0				do.					
54	54.0				do.					
54	54.0				do.					

DREDGING AND HYDROGRAPHIC RECORDS SECURED DURING HALIBUT

Station number.	Position.	Chart.	Date.	Time of day.	Depth.	Character of bottom.
		C. S.	1914.		Fms.	
H. 5531	Cape Kiwanda, S. 66° E., 5.5 miles.	6000	May 7	3.50 p. m.	48	fne. gy. S.
H. 5532	Cape Kiwanda, S. 59½° E., 6.2 miles.	6000	...do.....	4.04 p. m.	49	.....do.
H. 5533	Cape Kiwanda, S. 51° E., 6.8 miles.	6000	...do.....	4.27 p. m.	47	.....do.
H. 5534	Cape Meares Lt., N. 29½° E., 10.5 miles.	6100	...do.....	4.52 p. m.	48	.....do.
H. 5535	Cape Meares Lt., N. 40° E., 8.8 miles.	6100	...do.....	5.22 p. m.	51	.....do.
H. 5536	Cape Meares Lt., N. 59½° E., 7.8 miles.	6100	...do.....	6.02 p. m.	56	.....do.
H. 5537	Cape Meares Lt., N. 80° E., 7.1 miles.	6100	...do.....	6.39 p. m.	59	.....do.
H. 5538	Cape Meares Lt., N. 87° E., 7.8 miles.	6100	...do.....	6.56 p. m.	62	
H. 5539	Cape Meares Lt., S. 86½° E., 8 miles.	6100	...do.....	7.07 p. m.	62	
H. 5540	Cape Meares Lt., S. 65½° E., 8.1 miles.	6100	...do.....	7.37 p. m.	57	fne. gy. S.
H. 5541	Cape Meares Lt., S. 48° E., 9.3 miles.	6100	...do.....	8.06 p. m.	55	.....do.
H. 5542	Cape Meares Lt., S. 36° E., 11 miles.	6100	May 8	6.30 a. m.	51	.....do.
H. 5543	Cape Meares Lt., S. 26° E., 13.2 miles.	6100	...do.....	6.57 a. m.	48	.....do.
H. 5544	Tillamook Lt., N. 17½° E., 13.2 miles.	6100	...do.....	7.30 a. m.	47	.....do.
H. 5545	Tillamook Lt., N. 26½° E., 11 miles.	6100	...do.....	7.57 a. m.	50	.....do.
H. 5546	Tillamook Lt., N. 38° E., 8.8 miles.	6100	...do.....	8.22 a. m.	52	Shl., hrd. M.
H. 5547	Tillamook Lt., N. 57½° E., 7.3 miles.	6100	...do.....	8.50 a. m.	52	fne. gy. S.
H. 5548	Tillamook Lt., N. 71° E., 9.7 miles.	6100	...do.....	9.24 a. m.	62	
H. 5549	Tillamook Lt., N. 73½° E., 10.5 miles.	6100	...do.....	9.37 a. m.	66	gn. M.
H. 5550	Tillamook Lt., N. 75° E., 11.4 miles.	6100	...do.....	9.51 a. m.	68	.....do.
H. 5551	Tillamook Lt., N. 77½° E., 12.4 miles.	6100	...do.....	10.06 a. m.	72	.....do.
H. 5552	Tillamook Lt., N. 78° E., 13.4 miles.	6100	...do.....	10.19 a. m.	75	.....do.
H. 5553	Tillamook Lt., N. 82° E., 16.3 miles.	6100	...do.....	10.52 a. m.	79	.....do.
H. 5554	Tillamook Lt., N. 84° E., 19.2 miles.	6100	...do.....	11.28 a. m.	83	.....do.
H. 5555	Tillamook Lt., N. 86° E., 22.2 miles.	6100	...do.....	12.00 noon.	86	Shl., rky.
H. 5556	Tillamook Lt., N. 87° E., 25.1 miles.	6100	...do.....	12.34 p. m.	78	.....do.
H. 5557	Tillamook Lt., N. 87½° E., 25.6 miles.	6100	...do.....	12.43 p. m.	94	gn. M.
H. 5558	Tillamook Lt., N. 87° E., 25.1 miles.	6100	...do.....	1.08 p. m.	79	Shl., gran.
H. 5559	Tillamook Lt., S. 86½° E., 25.3 miles.	6100	...do.....	3.43 p. m.	83	gn. M.
H. 5560	Tillamook Lt., S. 79½° E., 25.9 miles.	6100	...do.....	4.16 p. m.	85	.....do.
H. 5561	Tillamook Lt., S. 73½° E., 26.9 miles.	6100	...do.....	4.51 p. m.	81	.....do.
H. 5562	Tillamook Lt., S. 68° E., 28.2 miles.	6100	...do.....	5.23 p. m.	88	.....do.
H. 5563	Tillamook Lt., S. 66° E., 28.8 miles.	6100	...do.....	5.34 p. m.	89	.....do.
H. 5564	Tillamook Lt., S. 64° E., 29.3 miles.	6100	...do.....	5.54 p. m.	95	.....do.

INVESTIGATIONS OFF OREGON-WASHINGTON COASTS, 1914 AND 1915—Continued.

Temperature.			Salinity.		Apparatus.	Trial.		Drift.		Remarks.
Air.	Surf.	Botm.	Surf.	Botm.		Depth.	Duration.	Direction.	Distance.	
°F.	°F.	°F.					Min.		Mi.	
54	54.0				Tnr.-Blish sdr.; 25-lb lead.					
55	54.0				do.					
55	54.0				do.					
54	53.0				do.					
54	53.0				do.					
53	52.0				do.					
55	52.0				do.					
55	52.0				do.					
55	52.0				do.					
55	52.0				do.					
55	52.0				do.					
53	53.0				do.					
....	....				do.					
54	53.0				do.					
54	55.0				do.					
56.5	55.0				do.					
56	55.0				do.					
56.5	53.5				do.					
56	53.5				do.					
56	53.5				do.					
56	53.5				do.					
56	53.5				do.					
57	53.5				do.					
56	54.0				do.					
57	54.0				do.					
55	52.0				do.					
55	52.0				do.					
55	52.0		30.52	32.79	Tnr.-Blish sdr.; 25-lb. lead; Ek. bot.; Alb. smp.; 2 skates.	botm	60			Location approximately same as H. 5556. At 1.11 lowered f'wd dory, which ret. 3.05 p.m. Lowered aft dory at 1.14; ret. 3.02 p.m. Salt herring bait.
54	54.0				Tnr.-Blish sdr.; 25-lb. lead.					
54	54.0				do.					
54	54.0				do.					
54	52.0				do.					
54	54.0				do.					
54	54.0				do.					

DREDGING AND HYDROGRAPHIC RECORDS SECURED DURING HALIBUT

Station number.	Position.	Chart.	Date.	Time of day.	Depth.	Character of bottom.
		C. S.	1914.		Fms.	
H. 5565	Yaquina Lt., N. 23½° E., 7.7 miles.	6000	May 27	3.06 p. m.	24	fne. gy. S
H. 5566	Yaquina Lt., N. 25½° E., 8.9 miles.	6000	...do	3.16 p. m.	29	...do
H. 5567	Yaquina Lt., N. 25½° E., 9.9 miles.	6000	...do	3.26 p. m.	30	...do
H. 5568	Yaquina Lt., N. 26° E., 10.8 miles.	6000	...do	3.35 p. m.	31	...do
H. 5569	Yaquina Lt., N. 27° E., 11.5 miles.	6000	...do	3.46 p. m.	34	...do
H. 5570	Yaquina Lt., N. 27° E., 13.2 miles.	6000	...do	5.38 p. m.	34	...do
H. 5571	Yaquina Lt., N. 28½° E., 16.1 miles.	6000	...do	6.06 p. m.	38	...do
H. 5572	Yaquina Lt., N. 31° E., 19.2 miles.	6000	...do	6.31 p. m.	39	...do
H. 5573	Yaquina Lt., N. 30° E., 22.4 miles.	6000	...do	6.53 p. m.	40	...do
H. 5574	Heceta Lt., S. 45° E., 14.9 miles.	6000	...do	7.17 p. m.	44	...do
H. 5575	Heceta Lt., S. 56½° E., 14.6 miles.	6000	...do	7.40 p. m.	50	...do
H. 5576	Heceta Lt., S. 68½° E., 15.1 miles.	6000	...do	8.03 p. m.	55	...do
H. 5577	Heceta Lt., S. 79½° E., 15.8 miles.	6000	May 28	7.40 a. m.	56	...do
H. 5578	Heceta Lt., S. 88° E., 17.1 miles.	6000	...do	8.07 a. m.	61	gn. M
H. 5579	Heceta Lt., N. 84½° E., 19 miles.	6000	...do	8.32 a. m.	66	...do
H. 5580	Heceta Lt., N. 78° E., 21 miles.	6000	...do	8.57 a. m.	60	
H. 5581	Heceta Lt., N. 76° E., 21.8 miles.	6000	...do	9.10 a. m.	65	Shl., gran
H. 5582	Heceta Lt., N. 74½° E., 22.3 miles.	6000	...do	9.20 a. m.	61	Shl., rky
H. 5583	Heceta Lt., N. 73° E., 23.1 miles.	6000	...do	9.27 a. m.	64	crs. bk. S
H. 5584	Heceta Lt., N. 71½° E., 24 miles.	6000	...do	9.37 a. m.	55	...do
H. 5585	Heceta Lt., N. 70° E., 24.8 miles.	6000	...do	9.50 a. m.	58	...do
H. 5586	Heceta Lt., N. 69° E., 25.5 miles.	6000	...do	10.02 a. m.	56	Shl., rky
H. 5587	Heceta Lt., N. 68° E., 26.1 miles.	6000	...do	10.17 a. m.	59	Shl., gran
H. 5588	Heceta Lt., N. 67° E., 27 miles.	6000	...do	10.29 a. m.	61	
H. 5589	Heceta Lt., N. 65½° E., 27.8 miles.	6000	...do	10.40 a. m.	66	Shl., gran
H. 5590	Heceta Lt., N. 65° E., 28.3 miles.	6000	...do	10.49 a. m.	68	...do
H. 5591	Heceta Lt., N. 64° E., 29.3 miles.	6000	...do	1.20 p. m.	79	Shl., hrd. M
H. 5592	Heceta Lt., N. 62½° E., 30.2 miles.	6000	...do	1.35 p. m.	133	Shl., gran.; bk. S
H. 5593	Heceta Lt., N. 64° E., 30.5 miles.	6000	...do	1.48 p. m.	128	fne. bk. S., fne. G

INVESTIGATIONS OFF OREGON-WASHINGTON COASTS, 1914 AND 1915—Continued.

Temperature.			Salinity.		Apparatus.	Trial.		Drift.		Remarks.
Air.	Surf.	Botm.	Surf.	Botm.		Depth.	Duration.	Direction.	Distance.	
°F.	°F.	°F.					Min.		Mi.	
57	54.0	......	......	......	Tnr.-Blish sdr.; 25-lb lead.	....	......	....	....	
56.5	54.0	......	......	......	.....do.........	....	......	....	....	
56	54.0	......	......	......	.....do.........	....	......	....	....	
56	54.0	......	......	......	Tnr.-Blish sdr.; 25-lb. lead; 1 skate.	botm...	60	....	....	Lowered f'wd dory with 2 fishermen at 3.40 p. m.; hoisted at 5.27 p. m. Salt herring bait.
....	55.0	......	30.25	33.64	Tnr.-Blish sdr.; 25-lb. lead; Ek. bot.; Alb. smp.; 1 skate.	...do....	60	....	....	Lowered aft dory with 2 fishermen at 3.49; hoisted dory at 5.32. Ek. bot. lowered to 27 fms. Alb. smp.; no sample at 34 fms. Salt herring bait.
56	53.0	......	......	......	Tnr.-Blish sdr.; 25-lb. lead.	....	......	....	....	
56	53.0	......	......	......	.....do.........	....	......	....	....	
55	54.0	......	......	......	.....do.........	....	......	....	....	
55	54.0	......	......	......	.....do.........	....	......	....	....	
55	54.0	......	......	......	.....do.........	....	......	....	....	
53	54.0	......	......	......	.....do.........	....	......	....	....	
53	54.0	......	......	......	.....do.........	....	......	....	....	
57	51.0	......	......	......	.....do.........	....	......	....	....	
57	51.0	......	......	......	.....do.........	....	......	....	....	
58	51.0	......	......	......	.....do.........	....	......	....	....	
58	51.0	......	......	......	.....do.........	....	......	....	....	
58	51.0	......	......	......	.....do.........	....	......	....	....	
58	51.0	......	......	......	.....do.........	....	......	....	....	
58	51.0	......	......	......	.....do.........	....	......	....	....	
58	51.0	......	......	......	.....do.........	....	......	....	....	
56	53.0	......	......	......	.....do.........	....	......	....	....	
56	54.0	......	......	......	.....do.........	....	......	....	....	
56	54.0	......	......	......	.....do.........	....	......	....	....	
56	54.0	......	......	......	.....do.........	....	......	....	....	
55.5	*53.9			......	Tnr.-Blish sdr.; 25-lb. lead; 1 skate.	botm...	60	....	....	Lowered f'wd dory at 10.54; hoisted at 1.07 p. m. Lowered aft dory at 11.05; hoisted at 1 p. m. Salt herring bait.
55.1	54.0	......	31.64	33.82	Tnr.-Blish sdr.; 25-lb. lead; Ek. bot.; Alb. smp.	...do....	60	....	....	
58	54.0	......	......	......	Tnr.-Blish sdr.; 25-lb. lead.	....	......	....	....	
58	54.0	......	......	......	.....do.........	....	......	....	....	
56	54.0	......	......	......	.....do.........	....	......	....	....	

DREDGING AND HYDROGRAPHIC RECORDS SECURED DURING HALIBUT

Station number.	Position.	Chart.	Date.	Time of day.	Depth.	Character of bottom.
		C. S.	1914.		*Fms.*	
H. 5594	Heceta Lt., N. 63° E., 30 miles.	6000	May 28	2.10 p. m.	109	fne. bk. S., fne. G.
H. 5595	Heceta Lt., N. 63° E., 28.8 miles.	6000	...do.....	4.43 p. m.	115	Shl., rky.; bk. S...
H. 5596	Heceta Lt., N. 63° E., 27.9 miles.	6000	...do.....	5.00 p. m.	115	gn. M., bk. S.......
H. 5597	Heceta Lt., N. 63° E., 24.9 miles.	6000	...do.....	5.40 p. m.	79	Shl., hrd. M.......
H. 5598	Heceta Lt., N. 63° E., 21.8 miles.	6000	...do.....	6.18 p. m.	84	gn. M............
H. 5599	Heceta Lt., N. 63° E., 18.7 miles.	6000	...do.....	6.55 p. m.	94	.....do............
H. 5600	Heceta Lt., N. 63° E., 15.6 miles.	6000	...do.....	7.32 p. m.	95	.....do............
H. 5601	Heceta Lt., N. 63° E., 12.6 miles.	6000	...do.....	8.08 p. m.	82	....
H. 5602	Heceta Lt., S. 74½° E., 7.8 miles.	6000	May 29	4.23 a. m.	46	fne. gy. S..........
H. 5603	Heceta Lt., S. 85° E., 10.4 miles.	6000	...do.....	4.59 a. m.	55	.....do............
H. 5604	Heceta Lt., E., 13 miles.....	6000	...do.....	5.36 a. m.	63	....
H. 5605	Heceta Lt., N. 86½° E., 15.7 miles.	6000	...do.....	6.14 a. m.	70	gn. M............
H. 5606	Heceta Lt., N. 84° E., 18.7 miles.	6000	...do.....	6.51 a. m.	75	.....do............
H. 5607	Heceta Lt., N. 82½° E., 21.4 miles.	6000	...do.....	7.28 a. m.	68	fne. G., bk. S......
H. 5608	Heceta Lt., N. 81½° E., 22.5 miles.	6000	...do.....	7.43 a. m.	62	.....do............
H. 5609	Heceta Lt., N. 81° E., 23.9 miles.	6000	...do.....	7.57 a. m.	65	Shl., rky.; fne. G...
H. 5610	Heceta Lt., N. 80½° E., 24.8 miles.	6000	...do.....	8.13 a. m.	75	Shl. gran., fne. G.
H. 5611	Heceta Lt., N. 80° E., 27.6 miles.	6000	...do.....	8.50 a. m.	67	.....do............
H. 5612	Heceta Lt., N. 79½° E., 28.1 miles.	6000	...do.....	9.00 a. m.	67	Shl., hrd. M.......
H. 5613	Heceta Lt., N. 79° E., 29.2 miles.	6000	...do.....	9.16 a. m.	70	.....do............
H. 5614	Heceta Lt., N. 78½° E., 30.2 miles.	6000	...do.....	9.32 a. m.	71	.....do............
H. 5615	Heceta Lt., N. 80° E., 31.4 miles.	6000	...do.....	9.47 a. m.	79	.....do............
H. 5616	Heceta Lt., N. 78° E., 32.7 miles.	6000	...do.....	10.01 a. m.	100	bk. S., fne. G......
H. 5617	Heceta Lt., N. 77° E., 33 miles.	6000	...do.....	10.17 a. m.	170	....
H. 5618	Heceta Lt., N. 76° E., 32.3 miles.	6000	...do.....	10.49 a. m.	124	fne. Gr............
H. 5619	Heceta Lt., N. 77½° E., 31.6 miles.	6000	...do.....	11.10 a. m.	100	fne. bk. S.........
H. 5620	Umpqua River Lt., N. 66½° E., 9.8 miles.	6000	Aug. 29	9.24 a. m.	74	....
H. 5621	Umpqua River Lt., N. 56° E., 9 miles.	6000	...do.....	11.55 a. m.	65	Shl., gran., fne. G.
H. 5622	Umpqua River Lt., N. 43° E., 8.3 miles.	6000	...do.....	1.00 p. m.	55	fne. gy. S.........
H. 5623	Umpqua River Lt., N. 36° E., 8.2 miles.	6000	...do.....	1.15 p. m.	45	.....do............

INVESTIGATIONS OFF OREGON-WASHINGTON COASTS, 1914 AND 1915—Continued.

Temperature.			Salinity.		Apparatus.	Trial.		Drift.		Remarks.
Air.	Surf.	Botm.	Surf.	Botm.		Depth.	Duration.	Direction.	Distance.	
°F.	°F.	°F.					Min.		Mi.	
56	*54.1	......	31.71	......	Tnr.-Blish sdr.; 25-lb. lead; Ek. bot.; Alb. smp.; 2 skates.	botm...	60	......	......	Lowered aft dory at 2.19 with 2 fishermen; hoisted at 4.22. Lowered f'wd dory at 2.20; hoisted at 4.15 p. m. Ek. bot. lowered to 190 m.; did not trip until hauled up to 90 m. Salt herring bait.
57	54.0	......	......	......	Tnr.-Blish sdr.; 25-lb. lead.	......	......	......	......	
57	54.0	......	......	......	....do....	......	......	......	......	
57	54.0	......	......	......	....do....	......	......	......	......	
57	54.0	......	......	......	....do....	......	......	......	......	
56	53.0	......	......	......	....do....	......	......	......	......	
53	52.0	......	......	......	....do....	......	......	......	......	
53	52.0	......	......	......	....do....	......	......	......	......	
53	50.0	......	......	......	....do....	......	......	......	......	
53	50.0	......	......	......	....do....	......	......	......	......	
53.5	50.0	......	......	......	....do....	......	......	......	......	
54	50.0	......	......	......	....do....	......	......	......	......	
55	50.0	......	......	......	....do....	......	......	......	......	
55	50.0	......	......	......	....do....	......	......	......	......	
55	50.0	......	......	......	....do....	......	......	......	......	
56	52.0	......	......	......	....do....	......	......	......	......	
56	52.0	......	......	......	....do....	......	......	......	......	
56	52.0	......	......	......	....do....	......	......	......	......	
56	52.0	......	......	......	....do....	......	......	......	......	
58	52.0	......	......	......	....do....	......	......	......	......	
58	52.0	......	......	......	....do....	......	......	......	......	
58	52.0	......	......	......	....do....	......	......	......	......	
59	52.0	......	......	......	....do....	......	......	......	......	
58	52.0	......	......	......	....do....	......	......	......	......	
56	52.0	......	......	......	....do....	......	......	......	......	
......	......	......	32.08	......	Tnr.-Blish sdr.; 25-lb. lead; Alb. smp.; 2 skates.	botm...	60	......	......	Lowered f'wd dory at 11.15; hoisted at 1.22 p. m.; lowered aft dory at 11.16; hoisted at 1.23 p. m.; 2 fishermen in each. Salt herring bait.
53	47.0	......	......	......	Tnr.-Blish sdr.; 25-lb. lead.	......	......	......	......	
52	47.0	......	......	......	....do....	......	......	......	......	
53.5	......	......	......	......	....do....	......	......	......	......	
53	......	......	......	......	....do....	......	......	......	......	

DREDGING AND HYDROGRAPHIC RECORDS SECURED DURING HALIBUT

Station number.	Position.	Chart.	Date.	Time of day.	Depth.	Character of bottom.
		C. S.	1914.		*Fms.*	
H.5624	Umpqua River Lt., N. 28½° E., 8.2 miles.	6000	Aug. 29	1.50 p.m.	36	fne. gy. S
H.5625	Cape Arago Lt., S. 71° E., 2.5 miles.	6000	Aug. 30	7.28 a.m.	39	...do
H.5626	Cape Arago Lt., S. 85° E., 3.3 miles.	6000	...do	7.38 a.m.	45	...do
H.5627	Cape Arago Lt., N. 87° E., 4.1 miles.	6000	...do	7.50 a.m.	44	...do
H.5628	Cape Arago Lt., N. 82° E., 5 miles.	6000	...do	8.01 a.m.	47	...do
H.5629	Cape Arago Lt., N. 78° E., 6 miles.	6000	...do	8.12 a.m.	56	...do
H.5630	Cape Arago Lt., N. 75° E., 6.9 miles.	6000	...do	8.23 a.m.	57	
H.5631	Cape Arago Lt., N. 73½° E., 8 miles.	6000	...do	8.35 a.m.	59	Shl., hrd. M
H.5632	Cape Arago Lt., N. 72° E., 9 miles.	6000	...do	9.12 a.m.	65	Shl., gran
H.5633	Cape Arago Lt., S. 20½° E., 2.7 miles.	6000	...do	1.56 p.m.	30	fne. gy. S
H.5634	Cape Arago Lt., S. 28° E., 3.6 miles.	6000	...do	2.10 p.m.	45	...do
H.5635	Cape Arago Lt., S. 34° E., 4.6 miles.	6000	...do	2.22 p.m.	48	...do
H.5636	Cape Arago Lt., S. 37½° E., 5.6 miles.	6000	...do	2.34 p.m.	56	...do
H.5637	Cape Arago Lt., S. 40° E., 6.4 miles.	6000	...do	2.46 p.m.	60	
H.5638	Cape Arago Lt., S. 41° E., 7.5 miles.	6000	...do	2.58 p.m.	62	fne. gy. S
H.5639	Cape Arago Lt., S. 43° E., 8.5 miles.	6000	...do	3.08 p.m.	66	...do
H.5640	Cape Arago Lt., S. 44° E., 9.6 miles.	6000	...do	3.21 p.m.	63	
H.5641	Cape Arago Lt., S. 45° E., 10.5 miles.	6000	...do	3.33 p.m.	78	
H.5642	Cape Arago Lt., N. 58° E., 9.1 miles.	6000	...do	5.52 p.m.	52	Shl., gran
H.5643	Cape Arago Lt., N. 51° E., 9.3 miles.	6000	...do	6.04 p.m.	46	fne. G
H.5644	Cape Arago Lt., N. 45½° E., 9.5 miles.	6000	...do	6.16 p.m.	38	Shl., hrd. M
H.5645	Cape Arago Lt., N. 40° E., 9.9 miles.	6000	...do	6.26 p.m.	42	fne. G
H.5646	Cape Arago Lt., N. 34° E., 10.3 miles.	6000	...do	6.36 p.m.	38	Shl., rky., Co
H.5647	Cape Arago Lt., N. 29° E., 10.8 miles.	6000	...do	6.47 p.m.	34	Shl., gran
H.5648	Cape Arago Lt., S. 1° E., 3.3 miles.	6000	Aug. 31	5.21 a.m.	28	fne. gy. S
H.5649	Cape Arago Lt., S. 1° E., 4.4 miles.	6000	...do	5.37 a.m.	38	...do
H.5650	Cape Arago Lt., S. 2½° E., 5.5 miles.	6000	...do	5.56 a.m.	47	...do
H.5651	Cape Arago Lt., S. 5° W., 8.2 miles.	6000	...do	9.20 a.m.	58	...do
H.5652	Cape Arago Lt., S. 9° W., 11.2 miles.	6000	...do	9.46 a.m.	71	...do
H.5653	Umpqua River Lt., N. 43° E., 7.6 miles.	6000	...do	10.13 a.m.	55	fne. gy. S., gn. M

INVESTIGATIONS OFF OREGON-WASHINGTON COASTS, 1914 AND 1915—Continued.

Temperature.			Salinity.		Apparatus.	Trial.		Drift.		Remarks.
Air.	Surf.	Botm.	Surf.	Botm.		Depth.	Duration.	Direction.	Distance.	
°F.	°F.	°F.					Min.		Mi.	
53	*48.2		33.78	33.68	Tnr.-Blish sdr.; 25-lb. lead; Ek. bot.; 2 skates.	botm.	120			Lowered f'wd dory at 1.24; hoisted at 4.05 p. m. Lowered aft dory at 1.24; hoisted at 4.10 p. m. Ek. bot. lowered at 1.40; up at 1.45. Fresh salmon bait.
54	44.0				Tnr.-Blish sdr.; 25-lb. lead.					
54	44.0				do.					
55	44.0				do.					
55	45.0				do.					
55	45.0				do.					
56	45.0				do.					
57	45.0				do.					
57	*52.5		33.78	32.90	Tnr.-Blish sdr.; 25-lb. lead; Ek. bot.; 2 skates.	botm.	120			Both dories out 8.51 a. m.; f'wd dory in 11.59, aft dory in 12.11 p. m. Fresh salmon bait.
58	46.0				Tnr.-Blish sdr.; 25-lb. lead; 2 skates.	do.	120			Both dories out 1.50; f'wd dory in 4.41, aft dory in 4.43. Temp. taken at 4.30. Fresh salmon bait.
					do.					
					do.					
					Tnr.-Blish sdr.; 25-lb. lead.					
					do.					
					do.					
					do.					
					do.					
					do.					
53	47.0				do.					
52	47.0				do.					Temp. taken at 6.09 p. m.
53	47.0				do.					
53	47.0				do.					
53	47.0				do.					
53	47.0				do.					
47	45.0				do.					
47	45.0				do.					
47	45.0		33.57		Tnr.-Blish sdr.; 25-lb. lead; 2 skates.	botm.	120			F'wd dory out, 5.50; in, 8.39. Aft dory out, 5.51; in, 8.46. Fresh salmon bait.
55	46.0				Tnr.-Blish sdr.; 25-lb. lead.					
55	46.0				do.					
56	46.0				do.					

DREDGING AND HYDROGRAPHIC RECORDS SECURED DURING HALIBUT

Station number.	Position.	Chart.	Date.	Time of day.	Depth.	Character of bottom.
		C. S.	1914.		Fms.	
H. 5654	Umpqua River Lt., N. 57° E., 5 miles.	6000	Aug. 31	10.38 a. m.	55	gn. M.
H. 5655	Umpqua River Lt., S. 87° E., 3.2 miles.	6000	...do.....	11.05 a. m.	51	.....do.
H. 5656	Umpqua River Lt., S. 45° E., 4.6 miles.	6000	...do.....	11.30 a. m.	51	.....do.
H. 5657	Umpqua River Lt., S. 26½° E., 7.1 miles.	6000	...do.....	12.00 noon.	53	.....do.
H. 5658	Umpqua River Lt., S. 19° E., 9.8 miles.	6000	...do.....	12.26 p. m.	54	.....do.
H. 5659	Umpqua River Lt., S. 14° E., 12.7 miles.	6000	...do.....	12.47 p. m.	55	.....do.
H. 5660	Umpqua River Lt., S. 11° E., 15.6 miles.	6000	...do.....	1.15 p. m.	55	
H. 5661	Umpqua River Lt., S. 9½° E., 18.6 miles.	6000	...do.....	1.41 p. m.	48	fne. gy. S.
H. 5662	Heceta Lt., N. 29½° E., 11.25 miles.	6000	...do.....	1.50 p. m.	47	.....do.
H. 5663	Heceta Lt., N. 28½° E., 10.8 miles.	6000	...do.....	2.00 p. m.	42	.....do.
H. 5664	Heceta Lt., N. 30½° E., 9.8 miles.	6000	...do	5.12 p. m.	41	Shl., gran., crs. G., fne. G., fne. gy. S.
H. 5665	Heceta Lt., N. 37½° E., 6.9 miles.	6000	...do.....	5.40 p. m.	35	fne. gy. S.
H. 5666	Heceta Lt., N. 53° E., 4.3 miles.	6000	...do.....	6.10 p. m.	33	.....do.
H. 5667	Heceta Lt., N. 87½° E., 2.8 miles.	6000	...do.....	6.38 p. m.	31	.....do.
H. 5668	Heceta Lt., N. 82° E., 26.9 miles.	6000	Sept. 1	5.20 a. m.	56	Shl., hrd. M.
H. 5669	Heceta Lt., N. 82° E., 27.9 miles.	6000	...do.....	5.31 a. m.	52	.....do.
H. 5670	Heceta Lt., N. 82° E., 29 miles.	6000	...do.....	5.41 a. m.	55	.....do.
H. 5671	Heceta Lt., N. 82° E., 30.1 miles.	6000	...do.....	5.53 a. m.	65	.....do.
H. 5672	Heceta Lt., N. 82° E., 31.3 miles.	6000	...do.....	6.04 a. m.	83	Shl., rky.
H. 5673	Heceta Lt., N. 82° E., 31.8 miles.	6000	...do.....	6.12 a. m.	114	fne. bk. S.
H. 5674	Heceta Lt., N. 80½° E., 31.5 miles.	6000	...do.....	6.31 a. m.	84	Shl., hrd. M.
H. 5675	Heceta Lt., N. 78½° E., 31.2 miles.	6000	...do.....	6.46 a. m.	80	Shl., rky., gran.
H. 5676	Heceta Lt., N. 78½° E., 31.7 miles.	6000	...do.....	6.57 a. m.	93	crs. bk. S., fne. G.
H. 5677	Heceta Lt., N. 78½° E., 32.2 miles.	6000	...do.....	7.10 a. m.	131	fne. bk. S.
H. 5678	Heceta Lt., N. 79½° E., 32.1 miles.	6000	...do.....	7.22 a. m.	139	.....do.
H. 5679	Heceta Lt., N. 79½° E., 31.7 miles.	6000	...do.....	7.35 a. m.	88	Shl., gran., fne. G.
H. 5680	Heceta Lt., N. 79° E., 31.2 miles.	6000	...do.....	7.47 a. m.	71	crs. S., For.
H. 5681	Heceta Lt., N. 79° E., 31.4 miles.	6000	...do.....	8.00 a. m.	82	Shl., gran., fne. bk. S.
H. 5682	Heceta Lt., N. 84½° E., 31.2 miles.	6000	...do.....	11.28 a. m.	83	Shl., hrd. M.
H. 5683	Heceta Lt., N. 89° E., 31.1 miles.	6000	...do.....	11.56 a. m.	80	.....do.
H. 5684	Heceta Lt., S. 86° E., 31.3 miles.	6000	...do.....	12.20 p. m.	68	.....do.
H. 5685	Heceta Lt., S. 81½° E., 31.8 miles.	6000	...do.....	12.56 p. m.	71	Shl., rky., bk. S.
H. 5686	Heceta Lt., S. 79½° E., 32 miles.	6000	...do.....	1.08 p. m.	77	fne. bk. S.
H. 5687	Heceta Lt., S. 77½° E., 32.2 miles.	6000	...do.....	1.23 p. m.	80	Shl., gran., fne. bk. S.

INVESTIGATIONS OFF OREGON-WASHINGTON COASTS, 1914 AND 1915—Continued.

Temperature.			Salinity.		Apparatus.	Trial.		Drift.		Remarks.
Air.	Surf.	Botm.	Surf.	Botm.		Depth.	Duration.	Direction.	Distance.	
°F.	°F.	°F.					Min.		Mi.	
56	46.0				Tnr.-Blish sdr.; 25-lb. lead.					
59	47.0				do.					
59	47.0				do.					
					do.					
					do.					
					do.					
					do.					
					do.					
					do.					
62	*48.8	46.4	33.62	33.53	Tnr.-Blish sdr.; 25-lb. lead; Ek. bot.; 2 skates.	botm...	120			Temp. taken at 4.55. F'wd dory out 2.06; in, 4.53. Aft dory out, 2.06; in, 4.50.
56	47.0				Tnr.-Blish sdr.; 25-lb. lead.					
62	47.0				do.					
62	47.0				do.					
62	47.0				do.					
50	42.0				do.					
50	42.0				do.					
50	42.0				do.					
50	42.0				do.					
51	42.0				do.					
51	42.0				do.					
51	42.0				do.					
51	42.0				do.					
51	42.0				do.					
51	42.0				do.					
51	42.0				do.					
51	42.0				do.					
51	42.0				do.					
58	*57.2	46.65	33.98	31.78	Tnr.-Blish sdr.; 32-lb. lead; Ek. bot.; 2 skates.	botm...	120			F'wd dory out, 8.05; in, 11.01. Aft dory out, 8.05; in, 11.03. Fresh salmon bait. Temp. taken at 8.30.
					Tnr.-Blish sdr.; 32-lb. lead.					
59	54.0				do.					Temp. taken at 12.01.
59	54.0				do.					
59.5	54.0				do.					
59	54.0				do.					
59	54.0				do.					

DREDGING AND HYDROGRAPHIC RECORDS SECURED DURING HALIBUT

Station number.	Position.	Chart.	Date.	Time of day.	Depth.	Character of bottom.
		C. S.	1914.		*Fms.*	
H. 5688	Heceta Lt., S. 76° E., 32.6 miles.	6000	Sept. 1	1.33 p. m.	92	bk. S
H. 5689	Heceta Lt., S. 76° E., 32.1 miles.	6000	...do.....	1.39 p. m.	87	Shl., rky., hrd. M., fne. bk. S.
H. 5690	Heceta Lt., S. 73° E., 29.6 miles.	6000	...do.....	5.05 p. m.	82	fne. bk. S
H. 5691	Heceta Lt., S. 69° E., 27.8 miles.	6000	...do.....	5.30 p. m.	62	Shl., hrd. M
H. 5692	Heceta Lt., S. 64° E., 25.8 miles.	6000	...do.....	5.57 p. m.	55	Shl., rky.; Co
H. 5693	Heceta Lt., S. 58° E., 24.2 miles.	6000	...do.....	6.21 p. m.	51	Shl., rky
H. 5694	Heceta Lt., S. 51° E., 22.9 miles.	6000	...do.....	6.47 p. m.	54	Shl., hrd. M
H. 5695	Yaquina Lt., N. 50° E., 23.8 miles.	6000	...do.....	7.14 p. m.	47	crs. G., fne. G
H. 5696	Yaquina Lt., N. 53° E., 20.9 miles.	6000	...do.....	7.40 p. m.	44	Shl., rky., Co
H. 5697	Yaquina Lt., N. 57° E., 18.2 miles.	6000	...do.....	8.05 p. m.	43	fne. gy. S., crs. G., P.
H. 5698	Yaquina Lt., N. 62½° E., 15.5 miles.	6000	...do.....	8.31 p. m.	36	Shl., rky., Co., fne. G.
H. 5699	Yaquina Lt., N. 69½° E., 13.1 miles.	6000	...do.....	8.52 p. m.	47	crs. gy. S., For
H. 5700	Yaquina Lt., N. 53° E., 8.8 miles.	6000	Sept. 2	5.24 a. m.	39	.....do
H. 5701	Yaquina Lt., N. 57½° E., 11.6 miles.	6000	...do.....	5.49 a. m.	40	.....do
H. 5702	Yaquina Lt., N. 60° E., 14.5 miles.	6000	...do.....	6.14 a. m.	33	Shl., hrd. M
H. 5703	Yaquina Lt., N. 62° E., 17.4 miles.	6000	...do.....	6.39 a. m.	43	crs. gy. S
H. 5704	Yaquina Lt., N. 63° E., 20.2 miles.	6000	...do.....	7.04 a. m.	61	crs. G
H. 5705	Yaquina Lt., N. 63° E., 21.2 miles.	6000	...do.....	7.16 a. m.	67	Shl., rky., bk. S
H. 5706	Yaquina Lt., N. 63° E., 20.7 miles.	6000	...do.....	7.30 a. m.	63	crs. gy. S., fne. G., brk. Sh.
H. 5707	Yaquina Lt., N. 54° E., 19.7 miles.	6000	...do....	10.57 a. m.	44	Shl., gran., crs. gy. S., fne. G.
H. 5708	Yaquina Lt., N. 51° E., 19.7 miles.	6000	...do.....	11.08 a. m.	40	Shl., gran., fne. gy. S., fne. G., crs. G.
H. 5709	Yaquina Lt., N. 48° E., 19.7 miles.	6000	...do.....	11.21 a. m.	42	fne. gy. S., fne. G
H. 5710	Yaquina Lt., N. 45° E., 19.8 miles.	6000	...do.....	11.33 a. m.	42	Shl., gran
H. 5711	Yaquina Lt., N. 42° E., 19.9 miles.	6000	...do.....	11.45 a. m.	42	fne. gy. S
H. 5712	Yaquina Lt., N. 39° E., 20 miles.	6000	...do.....	11.56 a. m.	42	.....do
H. 5713	Yaquina Lt., N. 53° E., 5.8 miles.	6000	...do.....	1.43 p. m.	29	crs. gy. S
H. 5714	Yaquina Lt., N. 62° E., 6.4 miles.	6000	...do.....	1.57 p. m.	33	.....do
H. 5715	Yaquina Lt., N. 77½° E., 8 miles.	6000	...do.....	3.00 p. m.	42	crs. gy. S., fne. G
H. 5716	Yaquina Lt., S. 84° E., 5.1 miles.	6000	...do.....	4.07 p. m.	34	crs. gy. S
H. 5717	Yaquina Lt., S. 80° E., 2.8 miles.	6000	...do.....	5.05 p. m.	28	.....do

INVESTIGATIONS OFF OREGON-WASHINGTON COASTS, 1914 AND 1915—Continued.

Temperature.			Salinity.		Apparatus.	Trial.		Drift.		Remarks.
Air.	Surf.	Botm.	Surf.	Botm.		Depth.	Duration.	Direction.	Distance.	
°F.	°F.	°F.					Min.		Mi.	
60	54.0	......	......	......	Tnr.-Blish sdr.; 32-lb. lead.	......	......	......	....	
...	.....	46.05	33.55	32.34	Tnr.-Blish sdr.; 32-lb. lead; Ek. bot.; 2 skates.	botm...	120	......	....	F'wd dory out, 1.40; in, 4.31. Aft dory out, 1.39; in, 4.40. Fresh salmon bait.
...	.....	......	......	......	Tnr.-Blish sdr.; 32-lb. lead.	......	......	......	....	
...	.....	......	......	......	..do......	......	......	......	....	
58	53.0	......	......	......	Tnr.-Blish sdr.; 32-lb. lead.	......	......	......	....	
58	53.0	......	......	......	....do......	......	......	......	....	
57	53.0	......	......	......	....do......	......	......	......	....	
57	53.0	......	......	......	....do......	......	......	......	....	
57	53.0	......	......	......	....do......	......	......	......	....	
...	.....	......	......	......	....do......	......	......	......	....	
...	.....	......	......	......	....do......	......	......	......	....	
...	.....	......	......	......	....do......	......	......	......	....	
51	48.0	......	......	......	....do......	......	......	......	....	
52	48.0	......	......	......	....do......	......	......	......	....	
53	48.0	......	......	......	....do......	......	......	......	....	
53	48.0	......	......	......	....do......	......	......	......	....	
52	48.0	......	......	......	....do......	......	......	......	....	
52	49.0	......	......	......	....do......	......	......	......	....	
52	*50.8	45.95	33.95	32.54	Tnr.-Blish sdr.; 32-lb. lead; Ek. bot.; 2 skates.	botm...	120	......	....	F'wd dory out, 7.33; in, 10.22. Aft dory out, 7.33; in, 10.26. Temp. taken at 7.50 a. m.
57	49.0	......	......	......	Tnr.-Blish sdr.; 32-lb. lead.	......	......	......	....	
57	49.0	......	......	......	....do......	......	......	......	....	
57	49.0	......	......	......	....do......	......	......	......	....	
56	49.0	......	......	......	....do......	......	......	......	....	
56	49.0	......	......	......	....do......	......	......	......	....	
...	.....	......	......	......	....do......	......	......	......	....	
...	.....	......	......	......	....do......	......	......	......	....	
...	.....	......	......	......	Tnr.-Blish sdr.; 32-lb. lead; oys. dr.; 150-lb. sinker.	botm...	17½	S. 12° E...	1	Cable out 100 fms.
...	.....	......	......	......	Tnr.-Blish sdr.; 32-lb. lead; 9' Ag.	...do....	19	S.........	1	Cable out 120 fms.
57	54.0	......	......	......	Tnr.-Blish sdr.; 32-lb. lead; 9' Ag.; 2 trimming wts.	...do....	17	S. 13° W ..	1	Cable out 170 fms.
58	54.0	......	......	......	....do......	...do....	15	S.........	.7	Sheave at lower end of boom failed to turn at times. Cable out 100 fms.

DREDGING AND HYDROGRAPHIC RECORDS SECURED DURING HALIBUT

Station number.	Position.	Chart.	Date.	Time of day	Depth.	Character of bottom.
		C. S.	1914.		*Fms.*	
H. 5718	Yaquina Lt., N. 75° E., 4 miles.	6000	Sept. 2	5.53 p. m.	33	crs. gy. S
H. 5719	Yaquina Lt., N. 84° E., 5.5 miles.	6000	Sept. 3	5.44 a. m.	....	med. gy. S
H. 5720	Yaquina Lt., N. 85° E., 6.5 miles.	6000	...do.....	6.06 a. m.	40	.....do
H. 5721	Yaquina Lt., N. 85½° E., 7.5 miles.	6000	...do.....	6.24 a. m.	38	.....do
H. 5722	Yaquina Lt., N. 86° E., 8.5 miles.	6000	...do.....	6.41 a. m.	42	.....do
H. 5723	Yaquina Lt., N. 86½° E., 9.5 miles.	6000	...do.....	6.59 a. m.	43	.....do
H. 5724	Yaquina Lt., N. 87° E., 10.5 miles.	6000	...do.....	7.18 a. m.	45	Shl., gran., fne. gy. S., For.
H. 5725	Yaquina Lt., S. 77° E., 8.7 miles.	6000	...do.....	7.59 a. m.	48	fne. gy. S
H. 5726	Yaquina Lt., S. 60½° E., 8 miles.	6000	...do.....	8.50 a. m.	....	.....do
H. 5727	Yaquina Lt., S. 43½° E., 10.8 miles.	6000	...do.....	9.25 a. m.	65	.....do
H. 5728	Yaquina Lt., S. 20½° E., 12.7 miles.	6000	...do.....	10.06 a. m.	53	.....do
H. 5729	Yaquina Lt., S. 8° E., 15 miles.	6000	...do.....	10.43 a. m.	35	.....do
H. 5730	Cape Kiwanda, N. 23½° E., 14.8 miles.	6000	...do.....	11.20 a. m.	43	.....do
H. 5731	Cape Kiwanda, N. 25½° E., 13.8 miles.	6000	...do.....	11.32 a. m.	45	.....do
H. 5732	Cape Kiwanda, N. 31° E., 12.2 miles.	6000	...do.....	11.51 a. m.	50	.....do
H. 5733	Cape Kiwanda, N. 22° E., 10.5 miles.	6000	...do.....	12.50 p. m.	32	.....do
H. 5734	Cape Kiwanda, N. 20½° E., 13.5 miles.	6000	...do.....	2.28 p. m.	30	crs. gy. S., crs. G., fne. G.
H. 5735	Cape Kiwanda, N. 34° E., 10.1 miles.	6000	...do.....	3.40 p. m.	42	crs. gy. S
H. 5736	Cape Kiwanda, N. 77° E., 8.7 miles.	6000	...do.....	5.03 p. m.	70	fne. gy. S
H. 5737	Cape Kiwanda, S. 70° E., 10 miles.	6000	...do.....	5.47 p. m.	77	.....do
H. 5738	Cape Meares Lt., N. 66° E., 4.8 miles.	6100	Sept. 4	5.12 a. m.	47	.....do
H. 5739	Cape Meares Lt., S. 86° E., 4 miles.	6100	...do.....	5.34 a. m.	43	.....do
H. 5740	Cape Meares Lt., S. 49½° E., 5.5 miles.	6100	...do.....	6.05 a. m.	44	.....do
H. 5741	Cape Meares Lt., S. 33° E., 7.8 miles.	6100	...do.....	6.24 a. m.	44	.....do
H. 5742	Cape Meares Lt., S. 28° E., 8.5 miles.	6100	...do.....	6.36 a. m.	43	.....do
H. 5743	Cape Meares Lt., S. 25° E., 9.4 miles.	6100	...do.....	6.47 a. m.	43	.....do
H. 5744	Cape Meares Lt., S. 15° E., 12 miles.	6100	...do.....	9.56 a. m.	38	.....do
H. 5745	Cape Meares Lt., S. 9° E., 14 miles.	6100	...do.....	10.15 a. m.	32	crs. gy. S
H. 5746	Cape Meares Lt., S. 12° E., 16.8 miles.	6100	...do.....	10.41 a. m.	40	fne. gy. S
H. 5747	Tillamook Lt., N. 17½° E., 8.1 miles.	6100	...do.....	11.08 a. m.	43	.....do

INVESTIGATIONS OFF OREGON-WASHINGTON COASTS, 1914 AND 1915—Continued.

Temperature.			Salinity.		Apparatus.	Trial.		Drift.		Remarks.
Air.	Surf.	Botm.	Surf.	Botm.		Depth.	Duration.	Direction.	Distance.	
° *F.*	° *F.*	° *F.*					*Min.*		*Mi.*	
52	54.0				Tnr.-Blish sdr.; 32-lb. lead; oys. dr.; 2 trimming wts.; 150-lb. sinker.	botm...	15½	S. 67° E...	1	Cable out 120 fms.
52	51.0				Tnr.-Blish sdr.; 32-lb. lead.					
52	51.0				do					
52	51.0				do					
52	52.0				do					
52	52.0				do					
52	52.0				do					
					do					
					do					
					do					
					do					
					do					
					do					
58	53.0	45.9	32.57	31.33	Tnr.-Blish sdr.; 32-lb. lead; Ek. bot.; 2 skates.	botm...	120			F'wd dory out, 11.32; in, 2.12. Aft dory out, 11.32; in, 2.08. Fresh salmon bait. Ek. bot. lowered at 1.40 to 75 fms.
58.5	53.0				Tnr.-Blish sdr.; 32-lb. lead; oys. dr.; 150-lb. sinker; 3 trimming wts.	...do...	20½	S. 26° E...	1	Cable out 200 fms. A small hole was torn in wire netting.
59	53.0				do	...do...	15	...do...	1	
57	53.0				do	...do...		...do...	1	
57	53.0				do	...do...		...do...	1	
59	53.0				Tnr.-Blish sdr.; 32-lb. lead.					
59	53.0				do					
					do					
					do					
					do					
					do					
					do					
58	*56.5	45.75	33.66	30.75	Tnr.-Blish sdr.; 32-lb. lead; Ek. bot.; 2 skates.	botm...	120			F'wd dory out, 6.49; in, 9.30. Aft dory out, 6.49; in, 9.26. Temp. taken, 7.10 a. m. Fresh salmon bait.
58	54.0				Tnr.-Blish sdr.; 32-lb. lead.					
57	54.0				do					
57	54.0				do					
57	54.0				do					

DREDGING AND HYDROGRAPHIC RECORDS SECURED DURING HALIBUT

Station number.	Position.	Chart.	Date.	Time of day.	Depth.	Character of bottom.
		C. S.	1914.		*Fms.*	
H. 5748	Tillamook Lt., N. 23° E., 7.5 miles.	6100	Sept. 4	11.21 a. m.	48	fne. gy. S........
H. 5749	Tillamook Lt., N. 30° E., 7 miles.	6100	...do.....	11.38 a. m.	45	.....do............
H. 5750	Tillamook Lt., N. 36° E., 8.7 miles.	6100	...do.....	12.10 p. m.	54	.....do............
H. 5751	Tillamook Lt., N. 43½° E., 8.2 miles.	6100	...do.....	12.27 p. m.	56	.....do............
H. 5752	Tillamook Lt., N. 55½° E., 4.3 miles.	6100	...do.....	3.53 p. m.	44	.....do............
H. 5753	Tillamook Lt., S. 53° E., 2.9 miles.	6100	...do.....	4.31 p. m.	40	.....do............
H. 5754	Tillamook Lt., S. 35° E., 6.6 miles.	6100	...do.....	5.07 p. m.	42	.....do............
H. 5755	Tillamook Lt., S. 28° E., 10.5 miles.	6100	...do.....	5.43 p. m.	41	....
H. 5756	North Head Lt., N. 21° E., 9.4 miles.	6100	...do.....	6.10 p. m.	36	fne. gy. S..........
H. 5757	Cape Shoalwater Lt., S. 83° E., 7.9 miles.	6100	Sept. 5	7.11 a. m.	27	fne. gy. S., gn. M...
H. 5758	Cape Shoalwater Lt., S. 83° E., 10.8 miles.	6100	...do.....	7.35 a. m.	36	fne. gy. S..........
H. 5759	Cape Shoalwater Lt., S. 83° E., 13.8 miles.	6100	...do.....	8.00 a. m.	44	.....do............
H. 5760	Cape Shoalwater Lt., S. 82° E., 16.7 miles.	6100	...do.....	8.25 a. m.	46	....
H. 5761	Cape Shoalwater Lt., S. 82° E., 19 miles.	6100	...do.....	8.42 a. m.	57	gn. M............
H. 5762	Cape Shoalwater Lt., S. 81° E., 21.1 miles.	6100	...do.....	9.00 a. m.	63	.....do............
H. 5763	Cape Shoalwater Lt., S. 81° E., 22.2 miles.	6100	...do.....	9.11 a. m.	67	.....do............
H. 5764	Cape Shoalwater Lt., S. 80° E., 23.2 miles.	6100	...do.....	9.24 a. m.	71	.....do............
H. 5765	Cape Shoalwater Lt., S. 75° E., 23 miles.	6100	...do.....	9.45 a. m.	65	.....do............
H. 5766	Cape Shoalwater Lt., S. 70° E., 22.9 miles.	6100	...do.....	10.02 a. m.	60	.....do............
H. 5767	Cape Shoalwater Lt., S. 65½° E., 21.9 miles.	6100	...do.....	10.20 a. m.	55	.....do............
H. 5768	Cape Shoalwater Lt., S. 60½° E., 21 miles.	6100	...do.....	10.37 a. m.	50	.....do............
H. 5769	Cape Shoalwater Lt., S. 55½° E., 20.5 miles.	6100	...do.....	10.54 a. m.	44	....
H. 5770	Cape Shoalwater Lt., S. 50° E., 20.8 miles.	6100	...do.....	11.13 a. m.	40	crs. G., fne. G., gy., S.
H. 5771	Cape Shoalwater Lt., S. 49° E., 20.9 miles.	6100	...do.....	11.20 a. m.	38	fne. G., crs. S......
H. 5772	Cape Shoalwater Lt., S. 57½° E., 34 miles.	6100	...do.....	1.03 p. m.	69	gn. M............
H. 5773	Cape Shoalwater Lt., S. 57° E., 35 miles.	6100	...do.....	1.15 p. m.	73	Shl., gran.........
H. 5774	Cape Shoalwater Lt., S. 56½° E., 36 miles.	6100	...do.....	1.26 p. m.	74	gn. M............
			1915.			
H. 5775	North Head, N. 56° E., 12.6 miles.	6100	July 9	7.35 a. m.	60	....
H. 5776	North Head, N. 67° E., 13.1 miles.	6100	...do.....	7.57 a. m.	68	fne. gn. S.........
H. 5777	North Head, N. 78° E., 14.2 miles.	6100	...do.....	8.18 a. m.	140	....
H. 5778	North Head, N. 86½° E., 15.5 miles.	6100	...do.....	8.43 a. m.	96	fne. gn. S.........
H. 5779	North Head, N. 89½° E., 16.2 miles.	6100	...do.....	8.53 a. m.	77	fne. bk. S.........
H. 5780	North Head, S. 88° E., 16.8 miles.	6100	...do.....	9.02 a. m.	74	fne. gy. S.........
H. 5781	North Head, S. 85° E., 17.8 miles.	6100	...do.....	9.12 a. m.	74	.....do............

INVESTIGATIONS OFF OREGON-WASHINGTON COASTS, 1914 AND 1915—Continued.

Temperature.			Salinity.		Apparatus.	Trial.		Drift.		Remarks.
Air.	Surf.	Botm.	Surf.	Botm.		Depth.	Duration.	Direction.	Distance.	
°F.	°F.	°F.					Min.		Mi.	
57	54.0				Tnr.-Blish sdr.: 32-lb. lead.					
57	54.0				do.					
56	54.0				do.					
57	54.0				Tnr.-Blish sdr.; 32-lb. lead; 2 skates.	botm.	120			F'wd dory out, 12.30; in, 3.12. Aft dory out, 12.30; in, 3.09.
57	55.0				Tnr.-Blish sdr.; 32-lb. lead.					
					do.					
					do.					
					do.					Lead was lost by wire breaking while heaving in.
					do.					
56	51.0				do.					
56	51.0				do.					
56	51.0				do.					
56	51.0				do.					
56	51.0				do.					
60	53.0				do.					
60	53.0				do.					
60	53.0				do.					
60	53.0				do.					
60	53.0				do.					
60	53.0				do.					
60	53.0				do.					
62	53.0				do.					
62	53.0				do.					
62 62	53.0 *56.1	45.35	33.24	32.47	Tnr.-Blish sdr.; 32-lb. lead; Ek. bot.; 4 skates.	botm.				F'wd dory out, 11.28; in, 3.10. Aft dory out, 11.24; in, 3.12. Temp. taken at 11.10 a. m. and 3.18 p. m. Fresh salmon bait.
					Tnr.-Blish sdr.; 32-lb. lead.					
					do.					
					do.					
60	54				El. sdr.; 30-lb. lead.					Lead lost.
62	54				do.					
61	54				do.					Clean lead.
64	54				do.					Do.
65	54				do.					
66	55				do.					
66	55				do.					

DREDGING AND HYDROGRAPHIC RECORDS SECURED DURING HALIBUT

Station number.	Position.	Chart.	Date.	Time of day.	Depth.	Character of bottom.
		C. S.	1915.		*Fms.*	
H. 5782	North Head, S. 82° E., 18.7 miles.	6100	July 9	9.22 a. m.	76	fne. gy. S........
H. 5783	North Head, S. 80° E., 19.4 miles.	6100	...do.....	9.33 a. m.	77	....
H. 5784	North Head, S. 78° E., 20.2 miles.	6100	...do.....	9.43 a. m.	81	fne. gy. S........
H. 5785	North Head, S. 76½° E., 21 miles.	6100	...do.....	9.52 a. m.	85	.....do...........
H. 5886	North Head, S. 75° E., 21.7 miles.	6100	...do.....	10.03 a. m.	135	.....do...........
H. 5787	North Head, S. 72° E., 20.5 miles.	6100	...do.....	10.20 a. m.	88	.....do...........
H. 5788	North Head, S. 71¾° E., 18.8 miles.	6100	...do.....	10.29 a. m.	87	.....do...........
H. 5789	North Head, S. 71½° E., 17.4 miles.	6100	...do.....	10.38 a. m.	85	.....do...........
H. 5790	North Head, S. 71° E., 14.2 miles.	6100	...do.....	11.03 a. m.	69	gn. M., fne. gy. S..
H. 5791	North Head, S. 70° E., 11.5 miles.	6100	...do.....	11.32 a. m.	50	.....do...........
H. 5792	North Head, N. 84° E., 13.6 miles.	6100	...do.....	12.30 p. m.	217	fne. gy. S........
H. 5793	North Head, N. 82° E., 14.3 miles.	6100	...do.....	12.42 p. m.	218	fne. bk. S........
H. 5794	North Head, N. 79° E., 15.3 miles.	6100	...do.....	12.53 p. m.	241	hrd..............
H. 5795	North Head, N. 80° E., 16.2 miles.	6100	...do.....	1.16 p. m.	248	fne. gy. s., gn. M..
H. 5796	North Head, N. 85° E., 17.6 miles.	6100	...do.....	1.39 p. m.	111	fne. gy. S........
H. 5797	North Head, N. 88° E., 18.2 miles.	6100	...do.....	1.50 p. m.	78	fne. gy. S., gn. M., bk. Sp.
H. 5798	North Head, N. 87½° E., 19.2 miles.	6100	...do.....	2.01 p. m.	81	fne. gy. S., bk. Sp.
H. 5799	North Head, N. 87° E., 20.2 miles.	6100	...do.....	2.18 p. m.	77	fne. gy. S........
H. 5800	North Head, N. 86½° E., 21 miles.	6100	...do.....	2.28 p. m.	79	bk. S............
H. 5801	North Head, N. 86° E., 22 miles.	6100	...do.....	2.38 p. m.	83	.....do...........
H. 5802	North Head, N. 86° E., 23 miles.	6100	...do.....	2.44 p. m.	204	bl. M............
H. 5803	North Head, S. 88° E., 22.1 miles.	6100	...do.....	3.18 p. m.	84	fne. bk. S........
H. 5804	North Head, S. 80° E., 21.5 miles.	6100	...do.....	3.39 p. m.	82	fne. bk. S., Sh. (1).
H. 5805	North Head, S. 66½° E., 22.6 miles.	6100	...do.....	4.27 p. m.	0 / 295	....
H. 5806	North Head, S. 53½° E., 25 miles.	6100	...do.....	5.12 p. m.	0 / 295	....
H. 5807	Grays Harbor Lt., S. 67° E., 17 miles.	6400	July 20	8.23 a. m.	46	crs. G...........
H. 5808	Grays Harbor Lt., S. 67½° E., 19 miles.	6400	...do.....	8.41 a. m.	49	G................
H. 5809	Grays Harbor Lt., S. 67½° E., 21 miles.	6400	...do.....	8.58 a. m.	53	fne. gy. S........
H. 5810	Grays Harbor Lt., S. 67½° E., 23 miles.	6400	...do.....	9.16 a. m.	65	fne. bk. S., Ml....
H. 5811	Grays Harbor Lt., S. 68° E., 25 miles.	6400	...do.....	9.34 a. m.	64	fne. gy S., Ml., M..
H. 5812	Grays Harbor Lt., S. 68° E., 27 miles.	6400	...do.....	9.52 a. m.	68	.....do...........
H. 5813	Grays Harbor Lt., S. 68° E., 29 miles.	6400	...do.....	10.10 a. m.	73	fne. gy. S., Ml......
H. 5814	Grays Harbor Lt., S. 68° E., 31 miles.	6400	...do.....	10.28 a. m.	80	fne. gy. S., Ml., M..
H. 5815	Grays Harbor Lt., S. 68° E., 33 miles.	6400	...do.....	10.46 a. m.	84	....
H. 5816	Grays Harbor Lt., S. 68½° E., 35 miles.	6400	...do.....	11.07 a. m.	87	fne. gy. S........
H. 5817	Grays Harbor Lt., S. 68½° E., 36.2 miles.	6400	...do.....	11.18 a. m.	92	.....do...........
H. 5818	Grays Harbor Lt., S. 68½° E., 37.2 miles.	6400	...do.....	11.30 a. m.	104	crs. & fne. bk. S....

INVESTIGATIONS OFF OREGON-WASHINGTON COASTS, 1914 AND 1915—Continued.

Temperature.			Salinity.		Apparatus.	Trial.		Drift.		Remarks.
Air.	Surf.	Botm.	Surf.	Botm.		Depth.	Duration.	Direction.	Distance.	
°F.	°F.	°F.					Min.		Mi.	
65	55				El. sdr.; 30-lb. lead.					
65	55				do.					Arming lost.
65	55				do.					
64	55				do.					
64	55				do.					
65	55				do.					
65	56				do.					
65	56				do.					
65	56				do.					
66	56				do.					
66	56				do.					
65	56				do.					
66	56				do.					
65	56				do.					
64	56				do.					
65	56				do.					
....	56				do.					
66	56				do.					
65	56				do.					
65	56				do.					
66	56				do.					
69	56				do.					
68	56				do.					
69	56				do.					Sounding wire was only 295 fms. long; wire all let out, but no botm.
68	56				do.					Do.
62	52				El. sdr.; 35-lb. lead.					
62	52				do.					
62	52				do.					
61	52				do.					
61	52				do.					
61	52				do.					
61	52				do.					
61	52				do.					
61	52				do.					Lead lost.
61	52				do.					
61	52				do.					
61	52				do.					

DREDGING AND HYDROGRAPHIC RECORDS SECURED DURING HALIBUT

Station number.	Position.	Chart.	Date.	Time of day.	Depth.	Character of bottom.
		C. S.	1915.		*Fms.*	
H. 5819	Grays Harbor Lt., S. 68½° E., 38.2 miles.	6400	July 20	11.42 a. m.	194	fne. gy. S., Ml......
H. 5820	Grays Harbor Lt., S. 67½° E., 35 miles.	6400	...do.....	12.14 p. m.	90	fne. gy. S..........
H. 5821	Grays Harbor Lt., S. 67° E., 33 miles.	6400	...do.....	12.33 p. m.	82	....
H. 5822	Grays Harbor Lt., S. 66° E., 31 miles.	6400	...do.....	12.53 p. m.	76	gn. M..............
H. 5823	Grays Harbor Lt., S. 65½° E., 29.2 miles.	6400	...do.....	1.12 p. m.	68	gn. M., fne. gy. S...
H. 5824	Grays Harbor Lt., S. 64° E., 27.2 miles.	6400	...do.....	1.32 p. m.	65	.....do.............
H. 5825	Grays Harbor Lt., S. 64½° E., 30.2 miles.	6400	...do.....	2.04 p. m.	75	gn. M..............
H. 5826	Grays Harbor Lt., S. 65° E., 32.2 miles.	6400	...do.....	2.24 p. m.	81	.....do.............
H. 5827	Grays Harbor Lt., S. 65° E., 34.2 miles.	6400	...do.....	2.42 p. m.	83	.....do.............
H. 5828	Grays Harbor Lt., S. 65° E., 36.2 miles.	6400	...do.....	3.02 p. m.	88	fne. gy. S., gn. M...
H. 5829	Grays Harbor Lt., S. 65½° E., 37.4 miles.	6400	...do.....	3.10 p. m.	92	crs. & fne. gy. S....
H. 5830	Grays Harbor Lt., S. 65½° E., 38.4 miles.	6400	...do.....	2.54 p. m.	95	....
H. 5831	Grays Harbor Lt., S. 65½° E., 39.5 miles.	6400	...do.....	3.05 p. m.	110	....
H. 5832	Grays Harbor Lt., S. 65½° E., 40.5 miles.	6400	...do.....	3.16 p. m.	0 295	....
H. 5833	Grays Harbor Lt., S. 64½° E., 38.5 miles.	6400	...do.....	3.45 p. m.	93	fne. gy. S., gn. M., Sh.
H. 5834	Grays Harbor Lt., S. 63½° E., 36.5 miles.	6400	...do.....	4.06 p. m.	84	fne. gy. S., gn. M...
H. 5835	Grays Harbor Lt., S. 62½° E., 34.5 miles.	6400	...do.....	4.25 p. m.	80	.....do.............
H. 5836	Grays Harbor Lt., S. 61° E., 32.7 miles.	6400	...do.....	4.43 p. m.	74	....
H. 5837	Grays Harbor Lt., S. 59½° E., 30 miles.	6400	...do.....	5.00 p. m.	69	fne. gy. S., gn. M...
H. 5838	Grays Harbor Lt., S. 57½° E., 29.2 miles.	6400	...do.....	5.18 p. m.	64	fne. gy. S..........
H. 5839	Grays Harbor Lt., S. 55½° E., 27.2 miles.	6400	...do.....	5.38 p. m.	56	.....do.............
H. 5840	Grays Harbor Lt., S. 53½° E., 25.5 miles.	6400	...do.....	5.56 p. m.	49	.....do.............
H. 5841	Grays Harbor Lt., S. 50½° E., 23.8 miles.	6400	...do.....	6.16 p. m.	48	.....do.............
H. 5842	Grays Harbor Lt., S. 48° E., 22.2 miles.	6400	...do.....	6.35 p. m.	38	crs. bk. S..........
H. 5843	Grays Harbor Lt., S. 44° E., 20.5 miles.	6400	...do.....	6.55 p. m.	37	fne. gy. S..........
H. 5844	Grays Harbor Lt., S. 40° E., 19 miles.	6400	...do.....	7.07 p. m.	29	fne. rd. & gy. S....
H. 5845	Destruction Id. Lt., N. 28° E., 20.2 miles.	6400	July 21	7.06 a. m.	63	gn. M., fne. gy. S..
H. 5846	Destruction Id. Lt., N. 31½° E., 21 miles.	6400	...do.....	7.24 a. m.	75	gn. M..............
H. 5847	Destruction Id. Lt., N. 36° E., 22.3 miles.	6400	...do.....	7.43 a. m.	249	....
H. 5848	Destruction Id. Lt., N. 37° E., 21.5 miles.	6400	...do.....	8.00 a. m.	290	gn. M..............
H. 5849	Destruction Id. Lt., N. 40° E., 19.8 miles.	6400	...do.....	8.22 a. m.	80	gn. M., fne. gy. S..
H. 5850	Destruction Id. Lt., N. 41½° E., 19 miles.	6400	...do.....	8.32 a. m.	70	.....do.............
H. 5851	Destruction Id. Lt., N. 43½° E., 18.2 miles.	6400	...do.....	8.47 a. m.	74	gn. M..............
H. 5852	Destruction Id. Lt., N. 45½° E., 17.6 miles.	6400	...do.....	8.59 a. m.	70	gn. M., fne. gy. S..
H. 5853	Destruction Id. Lt., N. 47½° E., 18.3 miles.	6400	...do.....	9.14 a. m.	76	.....do.............
H. 5854	Destruction Id. Lt., N. 49½° E., 19.1 miles.	6400	...do.....	9.24 a. m.	95	.....do.............

INVESTIGATIONS OFF OREGON-WASHINGTON COASTS, 1914 AND 1915—Continued.

Temperature.			Salinity.		Apparatus.	Trial.		Drift.		Remarks.
Air.	Surf.	Botm.	Surf.	Botm.		Depth.	Duration.	Direction.	Distance.	
°F.	°F.	°F.					Min.		Mi.	
61	52				El. sdr.; 35-lb. lead.					
62	53				do.					
62.5	53				do.					
62	53				do.					
62.5	54				El. sdr.; 30-lb. lead.					
64	54				do.					
64	54				do.					
64	54				do.					
64	54				do.					At 2.30 p. m. set clock back 26 min., which is not shown on records of H. 5827 and H. 5829 incl. H. 5830 shows correct time.
64	54				do.					
65	54				do.					
65	54				do.					Arming lost.
64	54				do.					Do.
63	54				do.					
62	54				do.					
62	54				do.					
62	54				do.					
62	54				do.					
63	54				do.					
63	54				do.					
62	54				do.					
63	54				do.					
63	54				do.					
63	54				do.					
62	54				do.					
61	53				do.					
60	52				do.					
60	52				do.					
60	52				do.					Clean lead
60	52				do.					
60	52				do.					
60	52				do.					
60	52				do.					
60	53				do.					
60	53				do.					
60	53				do.					

DREDGING AND HYDROGRAPHIC RECORDS SECURED DURING HALIBUT

Station number.	Position.	Chart.	Date.	Time of day.	Depth.	Character of bottom.
		C. S.	1915.		*Fms.*	
H. 5855	Destruction Id. Lt., N. 51½° E., 19.8 miles.	6400	July 21	9.35 a. m.	241	gn. M., fne. gy. S..
H. 5856	Destruction Id. Lt., N. 53° E., 20.8 miles.	6400	...do.....	9.51 a. m.	0 287	....
H. 5857	Destruction Id. Lt., N. 55½° E., 20.1 miles.	6400	...do.....	10.09 a. m.	0 298	....
H. 5858	Destruction Id. Lt., N. 58° E., 19.6 miles.	6400	...do.....	10.25 a. m.	246	....
H. 5859	Destruction Id. Lt., N. 60° E., 19.1 miles.	6400	...do.....	10.40 a. m. to 12.00 m.	88	G., crs. bk. S......
H. 5860	Destruction Id. Lt., N. 63° E., 18.7 miles.	6400	...do.....	1.25 p. m.	92	gn. M., fne. gy. S..
H. 5861	Destruction Id. Lt., N. 66° E., 18.2 miles.	6400	...do.....	1.37 p. m.	87	.....do............
H. 5862	Destruction Id. Lt., N. 68° E., 18 miles.	6400	...do.....	1.49 p. m.	78	gn. M.............
H. 5863	Destruction Id. Lt., N. 69° E., 18.9 miles.	6400	...do.....	2.02 p. m.	84	gn. M., fne. gy. S..
H. 5864	Destruction Id. Lt., N. 70° E., 19.8 miles.	6400	...do.....	2.12 p. m.	95	gn. M., bk. S......
H. 5865	Destruction Id. Lt., N. 70½° E., 20.9 miles.	6400	...do.....	2.23 p. m.	100	.....do............
H. 5866	Destruction Id. Lt., N. 71° E., 21.8 miles.	6400	...do.....	2.34 p. m.	103	G., fne. gy. S., crs. bk. S.
H. 5867	Destruction Id. Lt., N. 71½° E., 22.8 miles.	6400	...do.....	2.45 p. m.	189	fne. gy. S..........
H. 5868	Destruction Id. Lt., N. 73½° E., 22 miles.	6400	...do.....	3.03 p. m.	105	fne. G., gy. S......
H. 5869	Destruction Id. Lt., N. 75° E., 21.3 miles.	6400	...do.....	3.15 p. m.	101	gn. M., fne. G., Sh., fne. gy. S.
H. 5870	Destruction Id. Lt., N. 76½° E., 20.5 miles.	6400	...do.....	3.26 p. m.	93	fne. G., gn. M., fne. bk. S.
H. 5871	Destruction Id. Lt., N. 70½° E., 18.2 miles.	6400	July 22	4.47 a. m.	76	gn. M.............
H. 5872	Destruction Id. Lt., N. 71° E., 20.3 miles.	6400	...do.....	5.04 a. m.	93	....
H. 5873	Destruction Id. Lt., N. 71° E., 21.2 miles.	6400	...do.....	5.16 a. m.	103	gn. M.............
H. 5874	Destruction Id. Lt., N. 71° E., 21.8 miles.	6400	...do.....	5.25 a. m.	105	fne. gy. S., gn. M..
H. 5875	Destruction Id. Lt., N. 72½° E., 22 miles.	6400	...do.....	5.36 a. m.	105	G., gn. M., fne. gy. S.
H. 5876	Destruction Id. Lt., N. 74° E., 22 miles.	6400	...do.....	5.48 a. m.	103	crs. G.............
H. 5877	Destruction Id. Lt., N. 75° E., 21.8 miles.	6400	...do.....	6.02 a. m.	101	G., gn. M., fne. gy. S.
H. 5878	Destruction Id. Lt., N. 79° E., 19.9 miles.	6400	...do.....	9.38 a. m.	99	gn. M., crs. G., fne. bk. S.
H. 5879	Destruction Id. Lt., N. 81° E., 20.6 miles.	6400	...do.....	9.51 a. m.	97	gn. M., fne. gy. S..
H. 5880	Destruction Id. Lt., N. 82½° E., 20.2 miles.	6400	...do.....	10.01 a. m.	93	....
H. 5881	Destruction Id. Lt., N. 87° E., 19.8 miles.	6400	...do.....	10.20 a. m.	84	gn. M.............
H. 5882	Destruction Id. Lt., N. 87° E., 20.8 miles.	6400	...do.....	10.34 a. m.	97	.....do............
H. 5883	Destruction Id. Lt., N. 87° E., 21.8 miles.	6400	...do.....	10.45 a. m.	97	gn. M., fne. gy. S..
H. 5884	Destruction Id Lt., N. 87° E., 22.8 miles.	6400	...do.....	10.58 a. m.	101	fne. bk. S.........
H. 5885	Destruction Id. Lt., N. 87° E., 23.9 miles.	6400	...do.....	11.09 a. m.	104	.....do............
H. 5886	Destruction Id. Lt., N. 87° E., 24.9 miles.	6400	...do.....	11.20 a. m.	235	.....do............
H. 5887	Destruction Id. Lt., N. 88½° E., 24.1 miles.	6400	...do.....	11.40 a. m.	160	.....do............

INVESTIGATIONS OFF OREGON-WASHINGTON COASTS, 1914 AND 1915—Continued.

Temperature.			Salinity.		Apparatus.	Trial.		Drift.		Remarks.
Air.	Surf.	Botm.	Surf.	Botm.		Depth.	Duration.	Direction.	Distance.	
°F.	°F.	°F.					Min.		Mi.	
60	53				El. sdr.; 30-lb. lead.					
60	53				do.					
61	53				do.					
61	53				do.					
62	*57.5	44.95	32.23	32.66	El. sdr.; 30-lb. lead; Ek. bot.; NZ; 2 skates.	botm.	60			1st dory left 10.46; 1st dory ret. 12.52; 2d dory left 10.48; 2d dory ret. 1.06. Frozen herring bait.
61	53				El. sdr.; 30-lb. lead.					
61	53				do.					
61	54				do.					
61	54				do.					
61	54				do.					
61	54				do.					
61	54				do.					
61	54				do.					
64	54				do.					
64	54				do.					
64	54				do.					
62	57				do.					
59	52				do.					Clean lead.
59	52				do.					
59	52				do.					This station is the same as H. 5866.
59	52				do.					
					do.					
59	*56	44.35	32.45	34.05	El. sdr.; 30-lb. lead; Ek. bot.; 4' inter.; #12, #20; NZ.	botm.	60			1st dory left 6.10; 1st dory ret. 9.00. 2d dory left 6.15; 2d dory ret. 9.17. Frozen herring bait. Vertical townet haul.
64	54				El. sdr.; 30-lb. lead.					
64	54				do.					
65	54				do.					
65	54				do.					
65	54				do.					
65	54				do.					
64	54				do.					
64	54				do.					
64	54				do.					
64	54				do.					

DREDGING AND HYDROGRAPHIC RECORDS SECURED DURING HALIBUT

Station number.	Position.	Chart.	Date.	Time of day.	Depth.	Character of bottom.
		C. S.	1915.		Fms.	
H. 5888	Destruction Id. Lt., S. 89½° E., 23.1 miles.	6400	July 22	11.52 a. m.	116	fne. bk. S., G......
H. 5889	Destruction Id. Lt., S. 89° E., 22.3 miles.	6400	...do.....	12.03 p. m.	94	fne. bk. S., gn. M..
H. 5890	Destruction Id. Lt., S. 87½° E., 21.3 miles.	6400	...do.....	12.15 p. m.	90	fne. gy. S., gn. M..
H. 5891	Destruction Id. Lt., S. 86° E., 20.5 miles.	6400	...do.....	12.27 p. m.	92	.....do............
H. 5892	Destruction Id. Lt., S. 85° E., 19.6 miles.	6400	...do.....	12.39 p. m.	80	gn. M., fne. gy. S., bk. Sp.
H. 5893	Destruction Id. Lt., S. 83° E., 20.2 miles.	6400	...do.....	12.53 p. m.	78	gn. M............
H. 5894	Destruction Id. Lt., S. 80° E., 20.3 miles.	6400	...do.....	1.05 p. m.	85	.....do............
H. 5895	Destruction Id. Lt., S. 78½° E., 21 miles.	6400	...do.....	1.16 p. m.	86	.....do............
H. 5896	Destruction Id. Lt., S. 77° E., 21.9 miles.	6400	...do.....	1.27 p. m.	80	gn. M., bk. S......
H. 5897	Destruction Id. Lt., S. 76° E., 22.7 miles.	6400	...do.....	3.05 p. m.	88	fne. gy. S., gn. M..
H. 5898	Destruction Id. Lt., S. 74° E., 23.3 miles.	6400	...do.....	3.24 p. m.	111	gn. M............
H. 5899	Destruction Id. Lt., S. 72½° E., 24.3 miles.	6400	...do.....	3.37 p. m.	96	gn. M., fne. gy. S..
H. 5900	Destruction Id. Lt., S. 71½° E., 25.1 miles.	6400	...do.....	3.48 p. m.	100	gn. M............
H. 5901	Destruction Id. Lt., S. 70° E., 25.9 miles.	6400	...do.....	4.00 p. m.	92	.....do............
H. 5902	Destruction Id. Lt., S. 69½° E., 26.7 miles.	6400	...do.....	4.11 p. m.	97	.....do............
H. 5903	Destruction Id. Lt., S. 68½° E., 27.6 miles.	6400	...do.....	4.24 p. m.	93	gn. M., fne. gy. S..
H. 5904	Destruction Id. Lt., S. 67½° E., 28.4 miles.	6400	...do.....	4.35 p. m.	93	.....do............
H. 5905	Destruction Id. Lt., S. 66½° E., 29.3 miles.	6400	...do.....	4.48 p. m.	93	gn. M............
H. 5906	Destruction Id. Lt., S. 65½° E., 30.1 miles.	6400	...do.....	5.00 p. m.	94	gn. M., fne. gy. S..
H. 5907	Destruction Id. Lt., S. 65° E., 31 miles.	6400	...do.....	5.14 p. m.	94	....
H. 5908	Destruction Id. Lt., S. 64° E., 31.8 miles.	6400	...do.....	5.25 p. m.	94	gn. M............
H. 5909	Destruction Id. Lt., S. 63½° E., 32.8 miles.	6400	...do.....	5.36 p. m.	95	gn. M., fne. gy. S., bk. Sp.
H. 5910	Destruction Id. Lt., S. 63° E., 33.7 miles.	6400	...do.....	5.49 p. m.	94	gn. M., bk. S......
H. 5911	Destruction Id. Lt., S. 62½° E., 34.6 miles.	6400	...do.....	6.01 p. m.	93	G., crs. bk. S., fne. gn. S., gn. M.
H. 5912	Destruction Id. Lt., S. 62° E., 35.5 miles.	6400	...do.....	6.15 p. m.	92	G., crs. and fne. bk. S.
H. 5913	Destruction Id. Lt., S. 61° E., 36.5 miles.	6400	...do.....	6.27 p. m.	90	fne. G., gy. S......
H. 5914	Destruction Id. Lt., S. 60½° E., 37.3 miles.	6400	...do.....	6.40 p. m.	92	bk. Sp., gn. M., fne. G., fne. gy. S.
H. 5915	Destruction Id. Lt., S. 60° E., 38.2 miles.	6400	...do.....	6.53 p. m.	88	G., crs. and fne. gy. S., gn. M.
H. 5916	Grays Harbor Lt., N. 76° E., 26.8 miles.	6400	July 23	4.36 p. m.	78	gn. M., fne. gy. S...
H. 5917	Grays Harbor Lt., N. 76½° E., 27.8 miles.	6400	...do.....	4.47 p. m.	82	gn. M., fne. gy. S., Mi.
H. 5918	Grays Harbor Lt., N. 76¾° E., 28.8 miles.	6400	...do.....	4.58 p. m.	87	bl. C., fne. gy. S....
H. 5919	Grays Harbor Lt., N. 77° E., 29.8 miles.	6400	...do.....	5.10 p. m.	93	....
H. 5920	Grays Harbor Lt., N. 77¼° E., 30.8 miles.	6400	...do.....	5.18 p. m.	99	crs. G., crs. bk. S., fne. gn. S., gran. Shl.
H. 5921	Grays Harbor Lt., N. 77¾° E., 31.8 miles.	6400	...do.....	5.30 p. m.	111	fne. gn. S., fne. G..
H. 5922	Grays Harbor Lt., N. 78° E., 32.8 miles.	6400	...do.....	5.42 p. m.	203	fne. S............
H. 5923	Grays Harbor Lt., N. 80° E., 31.8 miles.	6400	...do.....	5.58 p. m.	124	fne. gn. S., crs. bk. S., Mi.
H. 5924	Grays Harbor Lt., N. 82½° E., 30.7 miles.	6400	...do.....	6.10 p. m.	99	G., gran. Shl., crs. bk. S., fne. gy. S.

INVESTIGATIONS OFF OREGON-WASHINGTON COASTS, 1914 AND 1915—Continued.

Temperature.			Salinity.		Apparatus.	Trial.		Drift.		Remarks.
Air.	Surf.	Botm.	Surf.	Botm.		Depth.	Duration.	Direction.	Distance.	
°F.	°F.	°F.					Min.		Mi.	
64	54				El. sdr; 30-lb. lead.					
65	55				do					
65	55				do					
65	55				do					
65	55				do					
60	55				do					
60	55				do					
60	55				do					
60	55				do					
61	55				do					
61	55				do					
61	55				do					
61	55				do					
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62	55				do					
62	55				do					
62	55				do					
62	55				do					
61	55				do					
61	51				do					
60	51				do					
60	51				do					
61	51				do					

DREDGING AND HYDROGRAPHIC RECORDS SECURED DURING HALIBUT

Station number.	Position.	Chart.	Date.	Time of day.	Depth.	Character of bottom.
		C. S.	1915.		*Fms.*	
H. 5925	Grays Harbor Lt., N. 84° E., 30.2 miles.	6400	July 23	6.22 p. m.	95	fne. gy. S., gn. M., gran. Shl.
H. 5926	Grays Harbor Lt., N. 85° E., 29.7 miles.	6400	...do.....	6.36 p. m.	91	fne. gy. S., gn. M..
H. 5927	Grays Harbor Lt., N. 86° E., 29.2 miles.	6400	...do.....	6.50 p. m.	88	gn. M............
H. 5928	Grays Harbor Lt., N. 87° E., 30 miles.	6400	...do.....	7.03 p. m.	90	fne. gy. S., gn. M., Ml.
H. 5929	Grays Harbor Lt., N. 88° E., 30.9 miles.	6400	...do.....	7.15 p. m.	90	bl. Shl............
H. 5930	Grays Harbor Lt., N. 89° E., 31.9 miles.	6400	...do.....	7.28 p. m.	94	bl. Shl., fne. bk. S..
H. 5931	Grays Harbor Lt., E., 32.9 miles.	6400	...do.....	7.40 p. m.	111	fne. gy. S..........
H. 5932	Grays Harbor Lt., S. 89° E., 33.7 miles.	6400	...do.....	7.52 p. m.	279	bl. Shl., rky.......
H. 5933	Grays Harbor Lt., N. 84° E., 28.7 miles.	6400	July 24	8.31 a. m.	88	fne. gy. S., gn. M...
H. 5934	Grays Harbor Lt., N. 83° E., 29.8 miles.	6400	...do.....	8.48 a. m.	93	fne. gy. S..........
H. 5935	Grays Harbor Lt., N. 82¾° E., 30.2 miles.	6400	...do.....	8.51 a. m.	98	....do...........
H. 5936	Grays Harbor Lt., N. 82½° E., 30.6 miles.	6400	...do.....	8.59 a. m.	99	bl. M............
H. 5937	Grays Harbor Lt., N. 82° E., 31.1 miles.	6400	...do.....	9.07 a. m.	111	crs. & fne. gn. S....
H. 5938	Grays Harbor Lt., N. 82¾° E., 31 miles.	6400	...do.....	9.20 a. m.	107	fne. gn. S..........
H. 5939	Grays Harbor Lt., N. 83¼° E., 31 miles.	6400	...do.....	9.29 a. m.	100	fne. gn. S., gran. Shl.
H. 5940	Grays Harbor Lt., N. 84° E., 31 miles.	6400	...do.....	9.34 a. m.	98	fne. gn. S..........
H. 5941	Grays Harbor Lt., S. 87° E., 31.3 miles.	6400	...do.....	1.54 p. m.	0/230	....
H. 5942	Grays Harbor Lt., S. 85° E., 31.5 miles.	6400	...do.....	2.07 p. m.	93	gn. M., fne. gn. S...
H. 5943	Grays Harbor Lt., S. 83° E., 31.9 miles.	6400	...do.....	2.20 p. m.	93	....
H. 5944	Grays Harbor Lt., S. 81½° E., 32.5 miles.	6400	...do.....	2.31 p. m.	93	gn. M., fne. gy. S...
H. 5945	Grays Harbor Lt., S. 80° E., 33 miles.	6400	...do.....	2.43 p. m.	93	fne. G., fne. gy. S...
H. 5946	Grays Harbor Lt., S. 78½° E., 33.8 miles.	6400	...do.....	2.58 p. m.	91	bl. Shl., crs. bk. S., fne. gn. S.
H. 5947	Grays Harbor Lt., S. 77° E., 34.3 miles.	6400	...do.....	3.08 p. m.	86	G., bl. M., crs. bk. S., fne. gy. S.
H. 5948	Grays Harbor Lt., S. 76° E., 35.2 miles.	6400	...do.....	3.21 p. m.	88	Co., gn. M., fne. gy. S.
H. 5949	Grays Harbor Lt., S. 75½° E., 36.2 miles.	6400	...do.....	3.34 p. m.	96	Co., hrd. bl. M....
H. 5950	Grays Harbor Lt., S. 74½° E., 37 miles.	6400	...do.....	3.46 p. m.	147	G., fne. gy. S., crs. bk. S., gran. Shl.
H. 5951	Grays Harbor Lt., S. 73° E., 36.9 miles.	6400	...do.....	4.04 p. m.	0/246	....
H. 5952	Grays Harbor Lt., S. 71½° E., 36.9 miles.	6400	...do.....	4.21 p. m.	0/242	....
H. 5953	Grays Harbor Lt., S. 70½° E., 36 miles.	6400	...do.....	4.38 p. m.	126	fne. gy. S.........
H. 5954	Grays Harbor Lt., S. 69½° E., 35.3 miles.	6400	...do.....	4.52 p. m.	90	O., Sh., fne. gy. S., gn. M.
H. 5955	Grays Harbor Lt., S. 68° E., 36 miles.	6400	...do.....	5.07 p. m.	88	fne. gy. S.........
H. 5956	Grays Harbor Lt., S. 67° E., 36.5 miles.	6400	...do.....	5.20 p. m.	87	....do..........
H. 5957	Grays Harbor Lt., S. 66½° E., 37.4 miles.	6400	...do.....	5.35 p. m.	91	fne. and crs. gy. S..
H. 5958	Grays Harbor Lt., S. 65½° E., 38.2 miles.	6400	...do.....	5.48 p. m.	98	fne. gy. S.........
H. 5959	Grays Harbor Lt., S. 64¾° E., 39.1 miles.	6400	...do.....	6.00 p. m.	105	G., crs. and fne. gy. S.

INVESTIGATIONS OFF OREGON-WASHINGTON COASTS, 1914 AND 1915—Continued.

Temperature.			Salinity.		Apparatus.	Trial.		Drift.		Remarks.
Air.	Surf.	Botm.	Surf.	Botm.		Depth.	Duration.	Direction.	Distance.	
°F.	°F.	°F.					Min.		Mi.	
61	51				El. sdr.; 30-lb. lead.					
57	53				do.					
61	53				do.					
60	53				do.					
60	53				do.					
60	53				do.					
60	53				do.					
60	53				do.					
61	52				do.					
61	52				do.					
61	52				do.					
60	52				do.					
60	52				do.					
60	52				do.					
60	52				do.					
60	*57.7	44.0	32.75	32.72	El. sdr.; 30-lb. lead; Ek. bot.; 4' inter.; #12, #20; NZ; 2 skates.	botm.	60			Vertical townet haul: 1st dory left, 9.45; 1st dory ret., 12.58; 2d dory left, 9.50; 2d dory ret., 12.47. Vertical haul to 93 fms. Frozen herring bait.
63	53				El. sdr.; 30-lb. lead.					
63	52				do.					
63	53				do.					
63	53				do.					
63	53				do.					
62	53				do.					
62	53				do.					
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62	53				do.					
62	53				do.					
63	52				do.					
63	52				do.					
63	52				do.					
62	52				do.					

DREDGING AND HYDROGRAPHIC RECORDS SECURED DURING HALIBUT

Station number.	Position.	Chart.	Date.	Time of day.	Depth.	Character of bottom.
			1915.		*Fms.*	
H. 5960	Grays Harbor Lt., S. 64° E., 40 miles.	C. S. 6400	July 24	6.17 p.m.	217	fne. gy. S., gn. M..
H. 5961	Grays Harbor Lt., S. 62° E., 35.6 miles.	C. S. 6400	July 26	1.07 p.m.	96	fne. wh. S., bk. Sp.
H. 5962	Grays Harbor Lt., S. 62° E., 36.7 miles.	C. S. 6400	...do.....	1.21 p.m.	162	bl. M............
H. 5963	Grays Harbor Lt., S. 60½° E., 36.8 miles.	C. S. 6400	...do.....	1.38 p.m.	0/200	....
H. 5964	Grays Harbor Lt., S. 59° E., 37 miles.	C. S. 6400	...do.....	1.53 p.m.	0/200	....
H. 5965	Grays Harbor Lt., S. 57½° E., 37.2 miles.	C. S. 6400	...do.....	2.10 p.m.	0/200	....
H. 5966	Grays Harbor Lt., S. 56° E., 37.5 miles.	C. S. 6400	...do.....	2.24 p.m.	0/200	....
H. 5967	Grays Harbor Lt., S. 54½° E., 37.2 miles.	C. S. 6400	...do.....	2.39 p.m.	115	crs. bk. S., gn. M..
H. 5968	Grays Harbor Lt., S. 53° E., 37.1 miles.	C. S. 6400	...do.....	2.53 p.m.	110	....
H. 5969	Grays Harbor Lt., S. 51½° E., 36.9 miles.	C. S. 6400	...do.....	3.06 p.m.	0/200	....
H. 5970	Destruction Id. Lt., N. 29° E., 26.1 miles.	C. S. 6400	...do.....	3.21 p.m.	0/200	....
H. 5971	Destruction Id. Lt., N. 28½° E., 25.2 miles.	C. S. 6400	...do.....	3.35 p.m.	77	fne. wh. S., gn. M.
H. 5972	Destruction Id. Lt., N. 29° E., 24.2 miles.	C. S. 6400	...do.....	3.50 p.m.	68	gn. M............
H. 5973	Destruction Id. Lt., N. 30° E., 23.2 miles.	C. S. 6400	...do.....	4.03 p.m.	64	.....do..........
H. 5974	Destruction Id. Lt., N. 31° E., 21.6 miles.	C. S. 6400	...do.....	4.20 p.m.	59	fne. bk. S., gn. M..
H. 5975	Destruction Id. Lt., N. 33° E., 23.5 miles.	C. S. 6400	...do.....	4.44 p.m.	75	gn. M............
H. 5976	Destruction Id. Lt., N. 34½° E., 25.5 miles.	C. S. 6400	...do.....	5.03 p.m.	0/200	....
H. 5977	Destruction Id. Lt., N. 36° E., 26.4 miles.	C. S. 6400	...do.....	5.25 p.m.	0/200	....
H. 5978	Destruction Id. Lt., N. 37° E., 27.4 miles.	C. S. 6400	...do.....	5.44 p.m.	0/200	....
H. 5979	Grays Harbor Lt., N. 57½° E., 39.3 miles.	C. S. 6400	...do.....	6.06 p.m.	0/200	....
H. 5980	Grays Harbor Lt., N. 60° E., 38.5 miles.	C. S. 6400	...do.....	6.25 p.m.	0/200	....
H. 5981	Destruction Id. Lt., S. 73½° E., 22.8 miles.	C. S. 6400	July 27	8.29 a.m.	82	gy. S............
H. 5982	Destruction Id. Lt., S. 74° E., 23.8 miles.	C. S. 6400	...do.....	8.49 a.m.	128	fne. bk. G., gn. M. gran. Shl.
H. 5983	Destruction Id. Lt., S. 72° E., 25.8 miles.	C. S. 6400	...do.....	9.14 a.m.	0/200	....
H. 5984	Destruction Id. Lt., S. 70° E., 27.7 miles.	C. S. 6400	...do.....	9.35 a.m.	137	fne. gy. S., gran. Shl.
H. 5985	Destruction Id. Lt., S. 68° E., 29.5 miles.	C. S. 6400	...do.....	9.57 a.m.	120	fne. gn. S.........
H. 5986	Umatilla Lightship, N. 41° E., 22.1 miles.	C. S. 6400	...do.....	10.17 a.m.	105	crs. bk. S., fne. gn. S.
H. 5987	Umatilla Lightship, N. 46° E., 21.9 miles.	C. S. 6400	...do.....	10.37 a.m.	128	fne. gn. S. ....
H. 5988	Umatilla Lightship, N. 51° E., 21.8 miles.	C. S. 6400	...do.....	10.58 a.m.	176	gn. M............
H. 5989	Umatilla Lightship, N. 53½° E., 21.3 miles.	C. S. 6400	...do.....	11.13 a.m.	91	R., G., crs. and fne. gy. S.
H. 5990	Umatilla Lightship, N. 56° E., 20.7 miles.	C. S. 6400	...do.....	11.25 a.m.	95	G., crs. and fne. gy. S.
H. 5991	Destruction Id. Lt., S. 70½° E., 41.5 miles.	P. S. #9	Aug. 10	5.44 a.m.	549	rky..............
H. 5992	Destruction Id. Lt., S. 74½° E., 45 miles.	P. S. #9	...do.....	6.32 a.m.	0/500	....
H. 5993	Destruction Id. Lt., S. 78° E., 48.9 miles.	P. S. #9	...do.....	7.24 a.m.	0/500	....
H. 5994	Destruction Id. Lt., S. 80½° E., 53 miles.	P. S. #9	...do.....	8.12 a.m.	0/500	....

INVESTIGATIONS OFF OREGON-WASHINGTON COASTS, 1914 AND 1915—Continued.

Temperature.			Salinity.		Apparatus.	Trial.		Drift.		Remarks.
Air.	Surf.	Botm.	Surf.	Botm.		Depth.	Duration.	Direction.	Distance.	
°F.	°F.	°F.					Min.		Mi.	
62	52				El. sdr.; 30-lb. lead.					
60	52				do					
60	52				do					
60	52				do					
60	52				do					
61	52				do					
61	52				do					
61	52				do					
61	52				do					Lost the lead and a few feet of wire.
61	52				do					
61	52				do					
61	52				do					
61	52				do					
61	52				do					
61	52				do					
61	52				do					
60	52				do					
60	52				do					
60	52				do					
60	52				do					
60	52				do					
58	50				do					
58	50				do					
59	51				do					
59	51				do					
59	51				do					
57	51				do					
57	51				do					
59	51				do					
59	51				do					
59	*54.5	44.05	32.56	34.40	El. sdr.; 30-lb. lead; Ek. bot.; 4' inter.; #12, #20; NZ; 2 skates.	botm.	60			1st dory left, 11.26; 1st dory ret., 12.52. 2d dory left, 11.27; 2d dory ret., 1.33. Frozen herring bait. Vertical townet haul.
58	53				Luc. sdr.; Sigs. rod.					Weight failed to trip.
58	53				Luc. sdr.; 30-lb. lead.					
62	54				do					
64	54				do					

DREDGING AND HYDROGRAPHIC RECORDS SECURED DURING HALIBUT

Station number.	Position.	Chart.	Date.	Time of day.	Depth.	Character of bottom.
			1915.		*Fms.*	
H. 5995	Destruction Id. Lt., S. 83° E., 57.2 miles.	P. S. #9	Aug. 10	8.59 a. m.	0/500	....
H. 5996	Destruction Id. Lt., S. 85½° E., 61.2 miles.	P. S. #9	...do.....	9.49 a. m.	750	gy. M............
H. 5997	Destruction Id. Lt., S. 87° E., 65.6 miles.	P. S. #9	...do.....	10.44 a. m.	0/500	....
H. 5998	Destruction Id. Lt., S. 89° E., 70.2 miles.	P. S. #9	...do.....	11.27 a. m.	0/500	....
H. 5999	Destruction Id. Lt., N. 89½° E., 74.5 miles.	P. S. #9	...do.....	12.16 p. m.	0/500	....
H. 6000	Destruction Id. Lt., N. 88½° E., 79.2 miles.	P. S. #9	...do.....	1.05 p. m.	0/500	....
H. 6001	Destruction Id. Lt., N. 87½° E., 83.8 miles.	P. S. #9	...do.....	1.54 p. m.	1,300	....
H. 6002	Destruction Id. Lt., N. 86° E., 87.9 miles.	P. S. #9	...do.....	3.07 p. m.	0/500	....
H. 6003	Destruction Id. Lt., N. 85¼° E., 92.6 miles.	P. S. #9	...do.....	3.57 p. m.	0/500	....
H. 6004	Destruction Id. Lt., N. 84½° E., 97.2 miles.	P. S. #9	...do.....	4.46 p. m.	0/500	....
H. 6005	Destruction Id. Lt., N. 84¾° E., 101.6 miles.	P. S. #9	...do.....	5.30 p. m.	0/500	....
H. 6006	Destruction Id. Lt., N. 83° E., 106.4 miles.	P. S. #9	...do.....	6.14 p. m.	1,400	....
H. 6007	Destruction Id. Lt., N. 82½° E., 110.8 miles.	P. S. #9	...do.....	7.19 p. m.	0/500	....
H. 6008	Destruction Id. Lt., N. 82° E., 115.5 miles.	P. S. #9	...do.....	8.06 p. m.	0/500	....
H. 6009	Destruction Id. Lt., N. 81½° E., 120.3 miles.	P. S. #9	...do.....	8.53 p. m.	0/500	....
H. 6010	Destruction Id. Lt., N. 81° E., 124.9 miles.	P. S. #9	...do.....	9.40 p. m.	0/500	....
H. 6011	Destruction Id. Lt., N. 80½° E., 129.4 miles.	P. S. #9	...do.....	10.29 p. m.	1,480	gn. M............
H. 6012	Destruction Id., Lt., N. 80° E., 134 miles.	P. S. #9	...do.....	11.35 p. m.	0/500	....
H. 6013	Destruction Id. Lt., N. 79½° E., 138.9 miles.	P. S. #9	Aug. 11	12.22 a. m.	0/500	....
H. 6014	Destruction Id. Lt., N. 79° E., 143.5 miles.	P. S. #9	...do.....	1.09 a. m.	0/500	....
H. 6015	Destruction Id. Lt., N. 78½° E., 148.3 miles.	P. S. #9	...do.....	1.55 a. m.	0/500	....
H. 6016	Destruction Id. Lt., N. 78¼° E., 153 miles.	P. S. #9	...do.....	2.41 a. m.	1,490	gn. M............
H. 6017	Destruction Id. Lt., N. 78° E., 157.8 miles.	P. S. #9	...do.....	3.51 a. m.	0/500	....
H. 6018	Destruction Id. Lt., N. 77¾° E., 162.3 miles.	P. S. #9	...do.....	4.44 a. m.	0/500	....
H. 6019	Destruction Id. Lt., N. 77½° E., 167.1 miles.	P. S. #9	...do.....	5.30 a. m.	0/500	....
H. 6020	Destruction Id. Lt., N. 77¼° E., 172 miles.	P. S. #9	...do.....	6.16 a. m.	0/500	....
H. 6021	Destruction Id. Lt., N. 77° E., 176.6 miles.	P. S. #9	...do.....	7.04 a. m.	1,470	gy. M............
H. 6022	Destruction Id. Lt., N. 76¾° E., 181.2 miles.	P. S. #9	...do.....	8.10 a. m.	0/500	....
H. 6023	Destruction Id. Lt., N. 76½° E., 185.9 miles.	P. S. #9	...do.....	9.00 a. m.	0/500	....
H. 6024	Destruction Id. Lt., N. 76¼° E., 190.8 miles.	P. S. #9	...do.....	9.53 a. m.	0/500	....
H. 6025	Destruction Id. Lt., N. 76° E., 196 miles.	P. S. #9	...do.....	10.44 a. m.	0/500	....
H. 6026	Destruction Id. Lt., N. 75¾° E., 201.5 miles.	P. S. #9	...do.....	11.20 a. m.	1,300	....

INVESTIGATIONS OFF OREGON-WASHINGTON COASTS, 1914 AND 1915—Continued.

Temperature.			Salinity.		Apparatus.	Trial.		Drift.		Remarks.
Air.	Surf.	Botm.	Surf.	Botm.		Depth.	Duration.	Direction.	Distance.	
°F.	°F.	°F.					Min.		Mi.	
70	54				Luc. sdr.; 30-lb lead.					
68	54				Luc. sdr.; Sigs. rod.					
68	54				Luc. sdr.; 30-lb. lead.					
69	56				do.					
69	56				do.					
67	56				do.					
67	56				Luc. sdr.; Sigs. rod.					Stray line and sampler lost. Wire broke when register read 20 fms., probably due to kink. One kink found in wire about 2 fms. above break.
67	56				Luc. sdr.; 30-lb. lead.					
67	56				do.					
65	56				do.					
65	56				do.					
66	56				Luc. sdr.; Sigs. rod.					Sounding cup wrecked when hove against fairleader; botm. sample lost.
63	55				Luc. sdr.; 30-lb. lead.					
62	55				do.					
64	56				do.					
64	56				do.					
62	56				Luc. sdr.; Sigs. rod.					Shot did not trip but came up with sounding cup.
62	56				Luc. sdr.; 30-lb. lead.					
62	56				do.					
60	55				do.					
60	54				do.					
59	53				Luc. sdr.; Sigs. rod.					Shot did not detach.
59	53				Luc. sdr.; 30-lb. lead.					
59	53				do.					
59	53				do.					
60	54				do.					
62	54				Luc. sdr.; Sigs. rod.					Weight did not detach.
63	55				Luc. sdr.; 30-lb. lead.					
65	56				do.					
67	56				do.					
69	57				do.					
71	57				Luc. sdr.; Sigs. rod.					

DREDGING AND HYDROGRAPHIC RECORDS SECURED DURING HALIBUT

Station number.	Position.	Chart.	Date.	Time of day.	Depth.	Character of bottom.
			1915.		*Fms.*	
H. 6027	Destruction Id. Lt., N. 75° 43′ E., 206.4 miles.	P. S. #9	Aug. 11	12.31 p. m.	0/500	
H. 6028	Destruction Id. Lt., N. 75° 41′ E., 211.2 miles.	P. S. #9	...do.....	1.21 p. m.	0/500	
H. 6029	Destruction Id. Lt., N. 75° 39′ E., 215.9 miles.	P. S. #9	...do.....	2.11 p. m.	0/500	
H. 6030	Destruction Id. Lt., N. 75° 37′ E., 220.3 miles.	P. S. #9	...do.....	3.01 p. m.	0/500	
H. 6031	Destruction Id. Lt., N. 75° 35′ E., 224.9 miles.	P. S. #9	...do.....	3.50 p. m.	1,480	fne. bk. S., bn. M.
H. 6032	Destruction Id. Lt., N. 75° 33′ E., 229.3 miles.	P. S. #9	...do.....	5.03 p. m.	0/500	
H. 6033	Destruction Id. Lt., N. 75° 31′ E., 233.9 miles.	P. S. #9	...do.....	5.54 p. m.	0/500	
H. 6034	Destruction Id. Lt., N. 75° 29′ E., 238.8 miles.	P. S. #9	...do.....	6.43 p. m.	0/500	
H. 6035	Destruction Id. Lt., N. 75° 27′ E., 243.4 miles.	P. S. #9	...do.....	7.31 p. m.	0/500	
H. 6036	Destruction Id. Lt., N. 75° 25′ E., 248 miles.	P. S. #9	...do.....	8.24 p. m.	1,518	bn. M.
H. 6037	Destruction Id. Lt., N. 75° 23′ E., 252.8 miles.	P. S. #9	...do.....	9.33 p. m.	0/500	
H. 6038	Destruction Id. Lt., N. 75° 21′ E., 257.4 miles.	P. S. #9	...do.....	10.23 p. m.	0/500	
H. 6039	Destruction Id. Lt., N. 75° 19′ E., 262 miles.	P. S. #9	...do.....	11.13 p. m.	0/500	
H. 6040	Destruction Id. Lt., N. 75° 17′ E., 266.8 miles.	P. S. #9	Aug. 12	12.01 a. m.	0/500	
H. 6041	Destruction Id. Lt., N. 75° 15′ E., 271.5 miles.	P. S. #9	...do.....	12.53 a. m.	635	bn. M., For.
H. 6042	Destruction Id. Lt., N. 75° 14′ E., 273.8 miles.	P. S. #9	...do.....	1.26 a. m.	525	
H. 6043	Destruction Id. Lt., N. 75° 13′ E., 276.5 miles.	P. S. #9	...do.....	1.54 a. m.	830	bn. M.
H. 6044	Destruction Id. Lt., N. 75° 45′ E., 275.5 miles.	P. S. #9	...do.....	2.47 a. m.	0/500	
H. 6045	Destruction Id. Lt., N. 75° 30′ E., 272.5 miles.	P. S. #9	...do.....	3.46 a. m.	0/700	
H. 6046	Destruction Id. Lt., N. 75° 30′ E., 274.7 miles.	P. S. #9	...do.....	4.25 a. m.	0/700	
H. 6047	Destruction Id. Lt., N. 75° 11′ E., 280.9 miles.	P. S. #9	...do.....	5.36 a. m.	0/500	
H. 6048	Destruction Id. Lt., N. 75° 09′ E., 285.8 miles.	P. S. #9	...do.....	6.29 a. m.	0/500	
H. 6049	Destruction Id. Lt., N. 75° 07′ E., 290.8 miles.	P. S. #9	...do.....	7.17 a. m.	0/500	
H. 6050	Destruction Id. Lt., N. 75° 05′ E., 294.9 miles.	P. S. #9	...do.....	8.07 a. m.	0/500	
H. 6051	Destruction Id. Lt., N. 75° 03′ E., 299.2 miles.	P. S. #9	...do.....	8.55 a. m.	1,600	bn. M.
H. 6052	Destruction Id. Lt., N. 75° 02′ E., 303.5 miles.	P. S. #9	...do.....	10.18 a. m.	0/500	
H. 6053	Destruction Id. Lt., N. 75° 01′ E., 308 miles.	P. S. #9	...do.....	11.06 a. m.	0/500	
H. 6054	Destruction Id. Lt., N. 75° E., 312.8 miles.	P. S. #9	...do.....	11.45 a. m.	0/500	
H. 6055	Tatoosh Id. Lt., N. 68° E., 317.3 miles.	P. S. #9	...do.....	12.41 p. m.	0/500	
H. 6056	Tatoosh Id. Lt., N. 68° 50′ E., 317.3 miles.	P. S. #9	...do.....	1.31 p. m.	0/500	
H. 6057	Tatoosh Id. Lt., N. 69° 40′ E., 317.3 miles.	P. S. #9	...do.....	2.21 p. m.	0/500	
H. 6058	Tatoosh Id. Lt., N. 70½° E., 317.3 miles.	P. S. #9	...do.....	3.10 p. m.	1,774	bk. M.
H. 6059	Tatoosh Id. Lt., N. 70° 31′ 27″ E., 311.6 miles.	P. S. #9	...do.....	4.33 p. m.	0/500	
H. 6060	Tatoosh Id. Lt., N. 70° 32′ 53″ E., 306 miles.	P. S. #9	...do.....	5.25 p. m.	0/500	
H. 6061	Tatoosh Id. Lt., N. 70° 34′ 20″ E., 300.6 miles.	P. S. #9	...do.....	6.12 p. m.	0/500	
H. 6062	Tatoosh Id. Lt., N. 70° 35′ 46″ E., 295.2 miles.	P. S. #9	...do.....	7.00 p. m.	0/500	
H. 6063	Tatoosh Id. Lt., N. 70° 37′ 13″ E., 289.8 miles.	P. S. #9	...do.....	7.51 p. m.	1,445	bn. M., For.
H. 6064	Tatoosh Id. Lt., N. 70° 38′ 39″ E., 284.3 miles.	P. S. #9	...do.....	9.04 p. m.	0/500	

INVESTIGATIONS OFF OREGON-WASHINGTON COASTS, 1914 AND 1915—Continued.

Temperature.			Salinity.		Apparatus.	Trial.		Drift.		Remarks.
Air.	Surf.	Botm.	Surf.	Botm.		Depth.	Duration.	Direction.	Distance.	
°F.	°F.	°F.					Min.		Mi.	
71	57				Luc. sdr.; 30-lb. lead.					
67	58				do.					
67	58				do.					
66	57				do.					
66	57				Luc. sdr.; Sigs. rod.					
66	57				Luc. sdr.; 30-lb. lead.					
64	55				do.					
64	55				do.					
64	55				do.					
59	54				Luc. sdr.; Sigs. rod.					Weight returned.
57.5	54				Luc. sdr.; 30-lb. lead.					
57	54				do.					
56	53				do.					
56	53				do.					
61	54				Luc. sdr.; Sigs. rod.					
64	54				do.					Lost sounder.
63	54				Luc. sdr.; 30-lb. lead.					
62	54				do.					
62	55				do.					
62	55				do.					
63	55				do.					
64	55				do.					
66	55				do.					
68	55				do.					
71	56				Luc. sdr.; Sigs. rod.					Weight returned.
72	56				Luc. sdr.; 30-lb. lead.					
72	56				do.					
72	56				do.					
72	57				do.					
73	57				do.					
73	57				do.					
71	57				Luc. sdr.; Sigs. rod.					Do.
68	57				Luc. sdr.; 30-lb. lead.					
68	57				do.					
69	56				do.					
66	55				do.					
64	55				Luc. sdr.; Sigs. rod.					
60	55				Luc. sdr.; 30-lb. lead.					

DREDGING AND HYDROGRAPHIC RECORDS SECURED DURING HALIBUT

Station number.	Position.	Chart.		Date.	Time of day.	Depth.	Character of bottom.
				1915.		*Fms.*	
H. 6065	Tatoosh Id. Lt., N. 70° 40′ 06″ E., 278.8 miles.	P. S.	#9	Aug. 12	9.54 p. m.	$\frac{0}{800}$	....
H. 6066	Tatoosh Id. Lt., N. 70° 41′ 32″ E., 273.3 miles.	P. S.	#9	...do.....	10.52 p.m.	$\frac{0}{800}$	....
H. 6067	Tatoosh Id. Lt., N. 70° 42′ 59″ E., 267.7 miles.	P. S.	#9	...do.....	11.48 p. m.	$\frac{0}{800}$	....
H. 6068	Tatoosh Id. Lt., N. 70° 44′ 25″ E., 262 miles.	P. S.	#9	Aug. 13	12.46 a. m.	1,644	bn. M., For.......
H. 6069	Tatoosh Id. Lt., N. 70° 45′ 52″ E., 256.6 miles.	P. S.	#9	...do.....	2.03 a. m.	$\frac{0}{500}$	....
H. 6070	Tatoosh Id. Lt., N. 70° 47′ 18″ E., 251.2 miles.	P. S.	#9	...do.....	2.51 a. m.	$\frac{0}{500}$	....
H. 6071	Tatoosh Id. Lt., N. 70° 48′ 45″ E., 245.5 miles.	P. S.	#9	...do.....	3.42 a. m.	$\frac{0}{500}$	....
H. 6072	Tatoosh Id. Lt., N. 70° 50′ 12″ E., 240.3 miles.	P. S.	#9	...do.....	4.32 a. m.	$\frac{0}{500}$	....
H. 6073	Tatoosh Id. Lt., N. 70° 51′ 38″ E., 234.5 miles.	P. S.	#9	...do.....	5.20 a. m.	1,433	bn. M.............
H. 6074	Tatoosh Id. Lt., N. 70° 53′ 05″ E., 228.8 miles.	P. S.	#9	...do.....	6.29 a. m.	$\frac{0}{500}$	....
H. 6075	Tatoosh Id. Lt., N. 70° 54′ 31″ E., 223.5 miles.	P. S.	#9	...do.....	7.16 a. m.	$\frac{0}{500}$	....
H. 6076	Tatoosh Id. Lt., N. 70° 55′ 58″ E., 217.7 miles.	P. S.	#9	...do.....	8.05 a. m.	$\frac{0}{500}$	....
H. 6077	Tatoosh Id. Lt., N. 70° 57′ 24″ E., 212.7 miles.	P. S.	#9	...do.....	8.53 a. m.	$\frac{0}{500}$	....
H. 6078	Tatoosh Id. Lt., N. 70° 58′ 51″ E., 207.8 miles.	P. S.	#9	...do.....	9.41 a. m.	1,530	bn. M., For.......
H. 6079	Tatoosh Id. Lt., N. 71° 00′ 17″ E., 202.5 miles.	P. S.	#9	...do.....	10.50 a. m.	$\frac{0}{500}$	....
H. 6080	Tatoosh Id. Lt., N. 71° 01′ 44″ E., 197.5 miles.	P. S.	#9	...do.....	11.44 a. m.	$\frac{0}{500}$	....
H. 6081	Tatoosh Id. Lt., N. 71° 03′ 10″ E., 192.2 miles.	P. S.	#9	...do.....	12.36 p. m.	$\frac{0}{500}$	....
H. 6082	Tatoosh Id. Lt., N. 71° 04′ 37″ E., 187.2 miles.	P. S.	#9	...do.....	1.25 p. m.	$\frac{0}{500}$	....
H. 6083	Tatoosh Id. Lt., N. 71° 06′ 03″ E., 182.4 miles.	P. S.	#9	...do.....	2.13 p. m.	1,330	....
H. 6084	Tatoosh Id. Lt., N. 71° 07′ 30″ E., 177.4 miles.	P. S.	#9	...do.....	3.31 p. m.	$\frac{0}{500}$	....
H. 6085	Tatoosh Id. Lt., N. 71° 08′ 57″ E., 172.3 miles.	P. S.	#9	...do.....	4.18 p. m.	$\frac{0}{500}$	....
H. 6086	Tatoosh Id. Lt., N. 71° 10′ 23″ E., 167.5 miles.	P. S.	#9	...do.....	5.04 p.m.	$\frac{0}{500}$	....
H. 6087	Tatoosh Id. Lt., N. 71° 11′ 50″ E., 162.3 miles.	P. S.	#9	...do.....	5.49 p. m.	$\frac{0}{500}$	....
H. 6088	Tatoosh Id. Lt., N. 71° 13′ 16″ E., 157.3 miles.	P. S.	#9	...do.....	6.39 p. m.	1,457	bn. M., For.......
H. 6089	Tatoosh Id. Lt., N. 71° 14′ 43″ E., 152.4 miles.	P. S.	#9	...do.....	7.51 p. m.	$\frac{0}{500}$	....
H. 6090	Tatoosh Id. Lt., N. 71° 16′ 09″ E., 147.3 miles.	P. S.	#9	...do.....	8.41 p. m.	$\frac{0}{500}$	....
H. 6091	Tatoosh Id. Lt., N. 71° 17′ 36″ E., 142 miles.	P. S.	#9	...do.....	9.29 p. m.	$\frac{0}{500}$	....
H. 6092	Tatoosh Id. Lt., N. 71° 19′ 02″ E., 137.5 miles.	P. S.	#9	...do.....	10.16 p. m.	$\frac{0}{500}$	....
H. 6093	Tatoosh Id. Lt., N. 71° 20′ 29″ E., 132.2 miles.	P. S.	#9	...do.....	11.05 p. m.	1,450	bn. M., For.......
H. 6094	Tatoosh Id. Lt., N. 71° 21′ 55″ E., 127.1 miles.	P. S.	#9	Aug. 14	12.21 a. m.	$\frac{0}{500}$	....
H. 6095	Tatoosh Id. Lt., N. 71° 23′ 22″ E., 122.1 miles.	P. S.	#9	...do.....	1.09 a. m.	$\frac{0}{500}$	....
H. 6096	Tatoosh Id. Lt., N. 71° 24′ 48″ E., 117.1 miles.	P. S.	#9	...do.....	1.54 a. m.	$\frac{0}{500}$	....
H. 6097	Tatoosh Id. Lt., N. 71° 26′ 15″ E., 112.1 miles.	P. S.	#9	...do.....	2.40 a. m.	$\frac{0}{500}$	....
H. 6098	Tatoosh Id. Lt., N. 71° 27′ 42″ E., 107.2 miles.	P. S.	#9	...do.....	3.26 a. m.	1,430	bn. M., For.......
H. 6099	Tatoosh Id. Lt., N. 71° 29′ 08″ E., 102.2 miles.	P. S.	#9	...do.....	4.32 a. m.	$\frac{0}{500}$	....
H. 6100	Tatoosh Id. Lt., N. 71° 30′ 35″ E., 97.4 miles.	P. S.	#9	...do.....	5.22 a. m.	$\frac{0}{500}$	....
H. 6101	Tatoosh Id. Lt., N. 71° 32′ 01″ E., 92.2 miles.	P. S.	#9	...do.....	6.14 a. m.	$\frac{0}{500}$	....

INVESTIGATIONS OFF OREGON-WASHINGTON COASTS, 1914 AND 1915—Continued.

Temperature.			Salinity.		Apparatus.	Trial.		Drift.		Remarks.
Air.	Surf.	Botm.	Surf.	Botm.		Depth.	Duration.	Direction.	Distance.	
°F.	°F.	°F.					Min.		Mi.	
60	55	......	......	......	Luc. sdr.; 30-lb. lead.	......	......	......	....	
60	55	......	......	......	....do......	......	......	......	....	
60	55	......	......	......	....do......	......	......	......	....	
58	54	......	......	......	Luc. sdr.; Sigs. rod.	......	......	......	....	Weight returned.
58	54	......	......	......	Luc. sdr.; 30-lb. lead.	......	......	......	....	
59	54	......	......	......	....do......	......	......	......	....	
59	54	......	......	......	....do......	......	......	......	....	
60	54	......	......	......	....do......	......	......	......	....	
62	54	......	......	......	Luc. sdr.; Sigs. rod.	......	......	......	....	Do.
66	54	......	......	......	Luc. sdr.; 30-lb. lead.	......	......	......	....	
67	55	......	......	......	....do......	......	......	......	....	
68	56	......	......	......	....do......	......	......	......	....	
64	56	......	......	......	....do......	......	......	......	....	
66	56	......	......	......	Luc. sdr.; Sigs. rod.	......	......	......	....	
66	56	......	......	......	Luc. sdr.; 30-lb. lead.	......	......	......	....	
66	56	......	......	......	....do......	......	......	......	....	
68	56	......	......	......	....do......	......	......	......	....	
70	56	......	......	......	....do......	......	......	......	....	
71	56	......	......	......	Luc. sdr.; Sigs. rod.	......	......	......	....	Register read 175 fms. when sdr. reached surface.
71	56	......	......	......	Luc. sdr.; 30-lb. lead.	......	......	......	....	
70	56	......	......	......	....do......	......	......	......	....	
68	56	......	......	......	....do......	......	......	......	....	
66	56	......	......	......	....do......	......	......	......	....	
66	56	......	......	......	Luc. sdr.; Sigs. rod.	......	......	......	....	
63	55	......	......	......	Luc. sdr.; 30-lb. lead.	......	......	......	....	
66	54	......	......	......	....do......	......	......	......	....	
66	54	......	......	......	....do......	......	......	......	....	
57	53	......	......	......	....do......	......	......	......	....	
57	53	......	......	......	Luc. sdr.; Sigs. rod.	......	......	......	....	
57	53	......	......	......	Luc. sdr.; 30-lb. lead.	......	......	......	....	
57	53	......	......	......	....do......	......	......	......	....	
57	53	......	......	......	....do......	......	......	......	....	
56	53	......	......	......	....do......	......	......	......	....	
56	53	......	......	......	Luc. sdr.; Sigs. rod.	......	......	......	....	Weight returned.
58	53	......	......	......	Luc. sdr.; 30-lb. lead.	......	......	......	....	
58	53	......	......	......	....do......	......	......	......	....	
62	54	......	......	......	....do......	......	......	......	....	

DREDGING AND HYDROGRAPHIC RECORDS SECURED DURING HALIBUT

Station number.	Position.	Chart.	Date.	Time of day.	Depth.	Character of bottom.
			1915.		*Fms.*	
H. 6102	Tatoosh Id. Lt., N. 71° 33′ 28″ E., 87.3 miles.	P. S. #9	Aug. 14	7.04 a. m.	0 500	....
H. 6103	Tatoosh Id. Lt., N. 71° 34′ 54″ E., 82.1 miles.	P. S. #9	...do.....	7.50 a. m.	1,268	gn. M........
H. 6104	Tatoosh Id. Lt., N. 71° 36′ 21″ E., 77.3 miles.	P. S. #9	...do.....	8.57 a. m.	0 500	....
H. 6105	Tatoosh Id. Lt., N. 71° 37′ 47″ E., 72.3 miles.	P. S. #9	...do.....	9 45 a. m.	0 500	....
H. 6106	Tatoosh Id. Lt., N. 71° 39′ 14″ E., 67.3 miles.	P. S. #9	...do.....	10.33 a. m.	0 500	....
H. 6107	Tatoosh Id. Lt., N. 71° 40′ 40″ E., 62.4 miles.	P. S. #9	...do.....	11.33 a. m.	0 500	....
H. 6108	Tatoosh Id. Lt., N. 71° 42′ 07″ E., 57.5 miles.	P. S. #9	...do.....	12.20 p. m.	650	gn. M........
H. 6109	Tatoosh Id. Lt., N. 71° 43′ 33″ E., 52.5 miles.	P. S. #9	...do.....	1.10 p. m.	490	....
H. 6110	Tatoosh Id. Lt., N. 71° 45′ E., 47.7 miles.	P. S. #9	...do.....	1.57 p. m.	240	gran. Shl........
H. 6111	Pachena Pt. Lt., N. 66° 40′ E., 41.7 miles.	P. S. #9	...do.....	4.56 p m.	210	gy. S........
H. 6112	Pachena Pt. Lt., N. 66° 45′ E., 46.7 miles.	P. S. #9	...do.....	5.40 p. m.	300	fne. gy. S........
H. 6113	Pachena Pt. Lt., N. 67° E., 51.5 miles.	P. S. #9	...do.....	6.25 p. m.	390	crs. and fne. gy. S.
H. 6114	Pachena Pt. Lt., N. 67° 5′ E., 56.3 miles.	P. S. #9	...do.....	7.12 p. m.	724	gy. S., G........
H. 6115	Pachena Pt. Lt., N. 67° 30′ E., 61 miles.	P. S. #9	...do.....	8.45 p. m.	0 500	....
H. 6116	Pachena Pt. Lt., N. 67° 45′ E., 65.9 miles.	P. S. #9	...do.....	9.34 p. m.	0 500	....
H. 6117	Pachena Pt. Lt., N. 68° E., 70.8 miles.	P. S. #9	...do.....	10.24 p. m.	0 500	....
H. 6118	Pachena Pt. Lt., N. 68° 5′ E., 75.1 miles.	P. S. #9	...do.....	11.12 p. m.	0 500	....
H. 6119	Pachena Pt. Lt., N. 68° 25′ E., 79.7 miles.	P. S. #9	Aug. 15	12.01 a. m.	1,400	gn. M........
H. 6120	Pachena Pt. Lt., N. 68° 45′ E., 83.9 miles.	P. S. #9	...do.....	1.10 a. m.	0 500	....
H. 6121	Pachena Pt. Lt., N. 68° 48′ E., 88.8 miles.	P. S. #9	...do.....	2.02 a. m.	0 500	....
H. 6122	Pachena Pt. Lt., N. 68° 51′ E., 94 miles.	P. S. #9	...do.....	2.53 a. m.	0 500	....
H. 6123	Pachena Pt. Lt., N. 68° 54′ E., 98.5 miles.	P. S. #9	...do.....	3.41 a. m.	0 500	....
H. 6124	Pachena Pt. Lt., N. 68° 57′ E., 103 miles.	P. S. #9	...do.....	5.15 a. m.	1,455	bn. M., For........
H. 6125	Pachena Pt. Lt., N. 69° E., 108 miles.	P. S. #9	...do.....	6.24 a. m.	0 500	....
H. 6126	Pachena Pt. Lt., N. 69° E., 112.5 miles.	P. S. #9	...do.....	7.11 a. m.	0 500	....
H. 6127	Pachena Pt. Lt., N. 69° E., 117.6 miles.	P. S. #9	...do.....	7.56 a. m.	0 500	....
H. 6128	Pachena Pt. Lt., N. 69° 1′ 40″ E., 122.1 miles.	P. S. #9	...do.....	8.45 a. m.	0 500	....
H. 6129	Pachena Pt. Lt., N. 69° 2′ 26″ E., 127.1 miles.	P. S. #9	...do.....	9.33 a. m.	1,450	bn. M., For........
H. 6130	Pachena Pt. Lt., N. 69° 5′ E., 131.7 miles.	P. S. #9	...do.....	10.41 a. m.	0 500	....
H. 6131	Pachena Pt. Lt., N. 69° 10′ E., 136.7 miles.	P. S. #9	...do.....	11.29 a. m.	0 500	....
H. 6132	Pachena Pt. Lt., N. 69° 15′ E., 141.1 miles.	P. S. #9	...do.....	12.09 p. m.	0 500	....
H. 6133	Pachena Pt. Lt., N. 69° 20′ E., 146 miles.	P. S. #9	...do.....	1.02 p. m.	0 500	....
H. 6134	Pachena Pt. Lt., N. 69° 25′ E., 150.7 miles.	P. S. #9	...do.....	1.50 p. m.	1,445	bn. M., For........
H. 6135	Pachena Pt. Lt., N. 69° 30′ E., 155.7 miles.	P. S. #9	...do.....	2.54 p. m.	0 500	....
H. 6136	Pachena Pt. Lt., N. 69° 32′ E., 160.5 miles.	P. S. #9	...do.....	3.46 p. m.	0 500	....

INVESTIGATIONS OFF OREGON-WASHINGTON COASTS, 1914 AND 1915—Continued.

Temperature.			Salinity.		Apparatus.	Trial.		Drift.		Remarks.
Air.	Surf.	Botm.	Surf.	Botm.		Depth.	Duration.	Direction.	Distance.	
°F.	°F.	°F.					Min.		Mi.	
62	54				Luc.sdr.; 30-lb. lead.					
67	55				Luc. sdr.; Sigs. rod.					
63	56				Luc. sdr.; 30-lb. lead.					
63	56				do.					
63	56				do.					
64	56				do.					
64	56				Luc. sdr.; Sigs. rod.					
64	56				Luc. sdr.; 30-lb. lead.					Register read 20 fms. when lead was in. No botm. sample.
62	56				do.					
67	56				do.					
67	56				do.					
67	56				do.					
67	56				do.					G. sample lost.
64	55				do.					
63	54				do.					
62	54				do.					
61	54				do.					
61	54				Luc. sdr.; Sigs. rod.					Register read 15 fms. when all wire was hove in.
60	53				Luc. sdr.; 30-lb. lead.					
60	53				do.					
60	54				do.					
60	54				do.					
61	54				Luc. sdr.; Sigs. rod.					Sounding rod and 5 fms. wire carried away because of kink in wire; repairs made and operations continued.
61	55				Luc. sdr.; 30-lb. lead.					
68	55				do.					
69	56				do.					
70	56				do.					
69	56				Luc. sdr.; Sigs. rod.					Weight returned.
69	56				Luc. sdr.; 30-lb. lead.					
71	56				do.					
72	57				do.					
67	56				do.					
64	56				Luc. sdr.; Sigs. rod.					
63	58				Luc. sdr.; 30-lb. lead.					
63	58				do.					

DREDGING AND HYDROGRAPHIC RECORDS SECURED DURING HALIBUT

Station number.	Position.	Chart.	Date.	Time of day.	Depth.	Character of bottom.
			1915.		*Fms.*	
H. 6137	Pachena Pt. Lt., N. 69° 34′ E., 165.2 miles.	P. S. #9	Aug. 15	4.34 p. m.	0 500	....
H. 6138	Pachena Pt. Lt., N. 69° 36′ E., 169.6 miles.	P. S. #9	...do.....	5.21 p. m.	0 500	....
H. 6139	Pachena Pt. Lt., N. 69° 38′ E., 174.5 miles.	P. S. #9	...do.....	6.17 p. m.	1,430	bn. M........
H. 6140	Pachena Pt. Lt., N. 69° 40′ E., 179.2 miles.	P. S. #9	...do.....	7.15 p. m.	0 500	....
H. 6141	Pachena Pt. Lt., N. 69° 42′ E., 184 miles.	P. S. #9	...do.....	8.02 p. m.	0 500	....
H. 6142	Pachena Pt. Lt., N. 69° 44′ E., 189 miles.	P. S. #9	...do.....	8.49 p. m.	0 500	....
H. 6143	Pachena Pt. Lt., N. 69° 46′ E., 193.8 miles.	P. S. #9	...do.....	9.37 p. m.	0 500	....
H. 6144	Pachena Pt. Lt., N. 69° 48′ E., 198.6 miles.	P. S. #9	...do.....	10.26 p. m.	1,438	bn. M., For.......
H. 6145	Pachena Pt. Lt., N. 69° 50′ E., 203.5 miles.	P. S. #9	...do.....	11.35 p. m.	0 500	....
H. 6146	Pachena Pt. Lt., N. 69° 52′ E., 208.3 miles.	P. S. #9	Aug. 16..	12.28 a. m.	0 500	....
H. 6147	Pachena Pt. Lt., N. 69° 54′ E., 213.8 miles.	P. S. #9	...do.....	1.16 a. m.	0 500	....
H. 6148	Pachena Pt. Lt., N. 69° 56′ E., 218.7 miles.	P. S. #9	...do.....	2.03 a. m.	0 500	....
H. 6149	Pachena Pt. Lt., N. 69° 58′ E., 223.7 miles.	P. S. #9	...do.....	2.53 a. m.	1,236	bn. M., For.......
H. 6150	Pachena Pt. Lt., N. 70° E., 228.5 miles.	P. S. #9	...do.....	3.54 a. m.	0 500	....
H. 6151	Pachena Pt. Lt., N. 70° E., 233.2 miles.	P. S. #9	...do.....	4.42 a. m.	1,532	bn. M., For.......
H. 6152	Cape Beale Lt., N. 70° E., 230.3 miles.	P. S. #9	...do.....	5.52 a. m.	0 500	....
H. 6153	Cape Beale Lt., N. 71° 15′ E., 230.3 miles.	P. S. #9	...do.....	6.37 a. m.	0 500	....
H. 6154	Cape Beale Lt., N. 72½° E., 230.5 miles.	P. S. #9	...do.....	7.23 a. m.	0 500	....
H. 6155	Cape Beale Lt., N. 73° 45′ E., 230.7 miles.	P. S. #9	...do.....	8.10 a. m.	0 500	....
H. 6156	Cape Beale Lt., N. 73° 47′ 18″ E., 226 miles.	P. S. #9	...do.....	9.04 a. m.	1,600	bn. M., For.......
H. 6157	Cape Beale Lt., N. 73° 49′ 37″ E., 221.3 miles.	P. S. #9	...do.....	10.20 a. m.	0 500	....
H. 6158	Cape Beale Lt., N. 73° 51′ 55″ E., 216.8 miles.	P. S. #9	...do.....	11.08 a. m.	0 500	....
H. 6159	Cape Beale Lt., N. 73° 54′ 14″ E., 211.9 miles.	P. S. #9	...do.....	11.46 a. m.	0 500	....
H. 6160	Cape Beale Lt., N. 73° 56′ 32″ E., 207.2 miles.	P. S. #9	...do.....	12.34 p. m.	0 500	....
H. 6161	Cape Beale Lt., N. 73° 58′ 51″ E., 202.5 miles.	P. S. #9	...do.....	1.21 p. m.	1,565	bn. M., For.......
H. 6162	Cape Beale Lt., N. 74° 01′ 09″ E., 197.7 miles.	P. S. #9	...do.....	2.32 p. m.	0 500	....
H. 6163	Cape Beale Lt., N. 74° E., 192.8 miles.	P. S. #9	...do.....	3.18 p. m.	0 500	....
H. 6164	Cape Beale Lt., N. 74° E., 187.8 miles.	P. S. #9	...do.....	4.05 p. m.	0 500	....
H. 6165	Cape Beale Lt., N. 74° E., 182.8 miles.	P. S. #9	...do.....	4.51 p. m.	0 500	....
H. 6166	Pachena Pt. Lt., N. 74° 10′ 23″ E., 178.1 miles.	P. S. #9	...do.....	5.38 p. m.	1,387	yl. M., For.......
H. 6167	Pachena Pt. Lt., N. 74° 12′ 42″ E., 172.8 miles.	P. S. #9	...do.....	6.44 p. m.	0 500	....
H. 6168	Pachena Pt. Lt., N. 74° 15′ E., 167.5 miles.	P. S. #9	...do.....	7.34 p. m.	0 500	....
H. 6169	Pachena Pt. Lt., N. 76° 15′ E., 165.8 miles.	P. S. #9	...do.....	8.28 p. m.	0 500	....
H. 6170	Pachena Pt. Lt., N. 76° 15′ E., 160.8 miles.	P. S. #9	...do.....	9.15 p. m.	0 500	....
H. 6171	Pachena Pt. Lt., N. 76° 15′ E., 156.3 miles.	P. S. #9	...do.....	10.05 p. m.	1,410	bn. M., For.......
H. 6172	Pachena Pt. Lt., N. 76° 15′ E., 151.3 miles.	P. S. #9	...do.....	11.05 p. m.	0 500	....
H. 6173	Pachena Pt. Lt., N. 76° 15′ E., 146.4 miles.	P. S. #9	...do.....	11.54 p. m.	0 500	....

INVESTIGATIONS OFF OREGON-WASHINGTON COASTS, 1914 AND 1915—Continued.

Temperature.			Salinity.		Apparatus.	Trial.		Drift.		Remarks.
Air.	Surf.	Botm.	Surf.	Botm.		Depth.	Duration.	Direction.	Distance.	
°F.	°F.	°F.					Min.		Mi.	
62	57				Luc. sdr.; 30-lb. lead.					
62	56				do.					
61	55				Luc. sdr.; Sigs. rod.					
60	55				Luc. sdr.; 30-lb. lead.					
58	54				do.					
58	54				do.					
57	54				do.					
57	54				Luc. sdr.; Sigs. rod.					
57	53				Luc. sdr.; 30-lb. lead.					
57	53				do.					
60	53				do.					
56	53				do.					
56	52				Luc. sdr.; Sigs. rod.					
56	52				Luc. sdr.; 30-lb. lead.					
58	53				Luc. sdr.; Sigs. rod.					
59	54				Luc. sdr.; 30-lb. lead.					
59	54				do.					
60	55				do.					
64	55				do.					
64	56				Luc. sdr.; Sigs. rod.					
64	56				Luc. sdr.; 30-lb. lead.					
64	56				do.					
64	56				do.					
64	56				do.					
65	57				Luc. sdr.; Sigs. rod.					
65	57				Luc. sdr.; 30-lb. lead.					
64	57				do.					
64	57				do.					
63	56				do.					
64	56				Luc. sdr.; Sigs. rod.					
64	56				Luc. sdr.; 30-lb. lead.					
64	56				do.					
60	54				do.					
59	54				do.					
58	54				Luc. sdr.; Sigs. rod.					
58	54				Luc. sdr.; 30-lb. lead.					
58	54				do.					

DREDGING AND HYDROGRAPHIC RECORDS SECURED DURING HALIBUT

Station number.	Position.	Chart.	Date.	Time of day.	Depth.	Character of bottom.
			1915.		*Fms.*	
H.6174	Pachena Pt. Lt., N. 76° 15′ E., 141.5 miles.	P. S. #9	Aug. 17	12.44 a. m.	0 500	....
H.6175	Pachena Pt. Lt., N. 76° 15′ E., 136.8 miles.	P. S. #9	...do.....	1.34 a. m.	0 500	....
H.6176	Pachena Pt. Lt., N. 76° 15′ E., 131.7 miles.	P. S. #9	...do.....	2.22 a. m.	1,430	bn. M., For.......
H.6177	Pachena Pt. Lt., N. 76° 15′ E., 126.9 miles.	P. S. #9	...do.....	3.33 a. m.	0 500	....
H.6178	Pachena Pt. Lt., N. 76° 15′ E., 122.1 miles.	P. S. #9	...do.....	4.29 a. m.	0 500	....
H.6179	Pachena Pt. Lt., N. 76° 15′ E., 117.3 miles.	P. S. #9	...do.....	5.16 a. m.	0 500	....
H.6180	Pachena Pt. Lt., N. 76° E., 112.5 miles.	P. S. #9	...do.....	6.03 a. m.	0 500	....
H.6181	Pachena Pt. Lt., N. 76° E., 107.8 miles.	P. S. #9	...do.....	6.50 a. m.	1,439	bn. M., For.......
H.6182	Pachena Pt. Lt., N. 76° E., 102.8 miles.	P. S. #9	...do.....	7.59 a. m.	0 500	....
H.6183	Pachena Pt. Lt., N. 76° E., 98 miles.	P. S. #9	...do.....	8.51 a. m.	0 500	....
H.6184	Pachena Pt. Lt., N. 76° E., 93.2 miles.	P. S. #9	...do.....	9.40 a. m.	0 500	....
H.6185	Pachena Pt. Lt., N. 76° E., 88.2 miles.	P. S. #9	...do.....	10.27 a. m.	0 500	....
H.6186	Pachena Pt. Lt., N. 75° 50′ E., 83.3 miles.	P. S. #9	...do.....	11.13 a. m.	1,432	bn. M., For.......
H.6187	Pachena Pt. Lt., N. 75° 50′ E., 78.4 miles.	P. S. #9	...do.....	12.21 p. m.	0 500	....
H.6188	Pachena Pt. Lt., N. 78° E., 74 miles.	P. S. #9	...do.....	1.22 p. m.	0 500	....
H.6189	Pachena Pt. Lt., N. 80° E., 69.8 miles.	P. S. #9	...do.....	2.11 p. m.	0 500	....
H.6190	Pachena Pt. Lt., N. 82° 45′ E., 65.6 miles.	P. S. #9	...do.....	2.59 p. m.	0 500	....
H.6191	Pachena Pt. Lt., N. 85° E., 61.7 miles.	P. S. #9	...do.....	3.48 p. m.	705	gn. M.............
H.6192	Pachena Pt. Lt., N. 88° 15′ E., 58 miles.	P. S. #9	...do.....	4.38 p. m.	300	.....do...........
H.6193	Pachena Pt. Lt., N. 88° 30′ E., 54.2 miles.	P. S. #9	...do.....	5.24 p. m.	180	fne. gy. S.........
H.6194	Cape Shoalwater Lt., N. 66° E., 20.8 miles.	*C. S.* 6100	Sept. 4	10.42 a. m.	169	gn. M.............
H.6195	Cape Shoalwater Lt., N. 68° E., 21.5 miles.	6100	...do.....	11.02 a. m.	207	gn. M., fne. bk. S..
H.6196	Cape Shoalwater Lt., N. 70° E., 22.4 miles.	6100	...do.....	11.19 a. m.	191	gn. M., fne. gy. S...
H.6197	Cape Shoalwater Lt., N. 71° E., 23.4 miles.	6100	...do.....	11.35 a. m.	177	fne. gn. S., gn. M...
H.6198	Cape Shoalwater Lt., N. 72½° E., 24.3 miles.	6100	...do.....	11.53 a. m.	133	gy. M., bk. S.......
H.6199	Cape Shoalwater Lt., N. 74° E., 25 miles.	6100	...do.....	12.08 p. m.	0 300	....
H.6200	Cape Shoalwater Lt., N. 76° E., 24 miles.	6100	...do.....	12.35 p. m.	284	gn. M., fne. gy. S...
H.6201	Cape Shoalwater Lt., N. 78° E., 24.3 miles.	6100	...do.....	12.57 p. m.	268	gn. M.............
H.6202	Cape Shoalwater Lt., N. 80½° E., 24.1 miles.	6100	...do.....	1.19 p. m.	167	bl. Shl............
H.6203	Cape Shoalwater Lt., N. 83° E., 23.9 miles.	6100	...do.....	1.38 p. m.	97	fne. gy. S.........
H.6204	Cape Shoalwater Lt., N. 85° E., 23.8 miles.	6100	...do.....	1.54 p. m.	87	.....do...........
H.6205	Cape Shoalwater Lt., N. 86° E., 24.7 miles.	6100	...do.....	2.11 p. m.	90	.....do...........
H.6206	Cape Shoalwater Lt., N. 86½° E., 25.7 miles.	6100	...do.....	2.26 p. m.	94	.....do...........
H.6207	Cape Shoalwater Lt., N. 87° E., 26.7 miles.	6100	...do.....	2.42 p. m.	136½	bl. M., fne. gy. S ...
H.6208	Cape Shoalwater Lt., N. 88° E., 27.5 miles.	6100	...do.....	2.59 p. m.	109	fne. gy. S.........
H.6209	Cape Shoalwater Lt., N. 88½° E., 28.5 miles.	6100	...do.....	3.16 p. m.	122½	fne. gn. S., gn. M., crs. bk. S.
H.6210	Cape Shoalwater Lt., N. 89° E., 29.5 miles.	6100	...do.....	3.32 p. m.	186½	fne. gn. S., crs. bk. S.
H.6211	Cape Shoalwater Lt., N. 89½° E., 30.4 miles.	6100	...do.....	3.49 p. m.	194	fne. gn. S.........

INVESTIGATIONS OFF OREGON-WASHINGTON COASTS, 1914 AND 1915—Continued.

Temperature.			Salinity.		Apparatus.	Trial.		Drift.		Remarks.
Air.	Surf.	Botm.	Surf.	Botm.		Depth.	Duration.	Direction.	Distance.	
°F.	°F.	°F.					Min.		Mi.	
58	54				Luc. sdr.; 30-lb. lead.					
58	54				do.					
58	54				Luc. sdr.; Sigs. rod.					
57	54				Luc. sdr.; 30-lb. lead.					
57	54				do.					
61	54				do.					
61	55				do.					
61	55				Luc. sdr.; Sigs. rod.					
61	55				Luc. sdr.; 30-lb. lead.					
62	56				do.					
62	56				do.					
62	56				do.					
62	56				Luc. sdr.; Sigs. rod.					
62	56				Luc. sdr.; 30-lb. lead.					
62	56				do.					
63	56				do.					
63	56				do.					
63	56				Luc. sdr.; Sigs. rod.					
63	56				Luc. sdr.; 30-lb. lead.					
64	56				do.					
64	55				El. sdr.; 30-lb. lead.					
63	56				do.					
63	56				do.					
63	56				do.					
63	56				do.					
63	56				do.					
63	56				do.					
66	56				do.					
66	56				do.					
66	56				do.					
66	56				do.					
68	56				do.					
66	56				do.					
65	56				do.					
64	56				do.					
64	56				do.					
64	56				do.					
64	56				do.					

DREDGING AND HYDROGRAPHIC RECORDS SECURED DURING HALIBUT

Station number.	Position.	Chart.	Date.	Time of day.	Depth.	Character of bottom.
		C. S.	1915.		*Fms.*	
H. 6212	Cape Shoalwater Lt., N. 89½° E., 31.3 miles.	6100	Sept. 4	4.07 p. m.	219	fne. gy. S..........
H. 6213	Cape Shoalwater Lt., E., 32.3 miles.	6100	...do.....	4.26 p. m.	247	gn. M., gran. Shl...
H. 6214	Cape Shoalwater Lt., S. 89½° E., 33.2 miles.	6100	...do.....	4.45 p. m.	0/300	....
H. 6215	Cape Shoalwater Lt., S. 89¼° E., 32.2 miles.	6100	...do.....	5.11 p. m.	261	fne. gy. S..........
H. 6216	Cape Shoalwater Lt., S. 88½° E., 31.2 miles.	6100	...do.....	5.31 p. m.	202	gy. S., crs. S......
H. 6217	Cape Shoalwater Lt., S. 87¾° E., 30.3 miles.	6100	...do.....	5.48 p. m.	149	fne. gn. S.........
H. 6218	Cape Shoalwater Lt., S. 87° E., 29.4 miles.	6100	...do.....	6.07 p. m.	111½	fne. bk. S.........
H. 6219	Cape Shoalwater Lt., S. 86¼° E., 28.5 miles.	6100	...do.....	6.23 p. m.	98	fne. gy. S.........
H. 6220	Cape Shoalwater Lt., S. 85° E., 27 miles.	6100	...do.....	6.39 p. m.	92	gn. M., fne. bk. S..
H. 6221	Cape Shoalwater Lt., N. 77° E., 23.7 miles.	6100	...do.....	8.20 p. m.	143	fne. gy. S.........
H. 6222	Cape Shoalwater Lt., N. 73½° E., 23.1 miles.	6100	...do.....	8.42 p. m.	232	....
H. 6223	Tillamook Head Lt., S. 49° E., 15.5 miles.	6100	Sept. 5	6.01 a. m.	68	fne. gy. S., gn. M..
H. 6224	Tillamook Head Lt., S. 56½° E., 15.3 miles.	6100	...do.....	6.28 a. m.	72	.....do...........
H. 6225	Tillamook Head Lt., S. 65° E., 15.5 miles.	6100	...do.....	6.51 a. m.	77	.....do...........
H. 6226	Tillamook Head Lt., S. 72½° E., 15.8 miles.	6100	...do.....	7.10 a. m.	79	.....do...........
H. 6227	Tillamook Head Lt., S. 80° E., 16.5 miles.	6100	...do.....	7.28 a. m.	82	gn. M.............
H. 6228	Tillamook Head Lt., S. 87° E., 17.5 miles.	6100	...do.....	7.53 a. m.	82	.....do...........
H. 6229	Tillamook Head Lt., S. 82½° E., 17.2 miles.	6100	...do.....	8.13 a. m.	82	.....do...........
H. 6230	Tillamook Head Lt., S. 78° E., 16.9 miles.	6100	...do.....	8.28 a. m.	82	gn. M., fne. gy. S..
H. 6231	Tillamook Head Lt., S. 72¾° E., 16.8 miles.	6100	...do.....	8.43 a. m.	81	.....do...........
H. 6232	Tillamook Head Lt., S. 68½° E., 16.8 miles.	6100	...do.....	8.58 a. m.	78	.....do...........
H. 6233	Tillamook Head Lt., S. 64° E., 16.9 miles.	6100	...do.....	9.14 a. m.	77	.....do...........
H. 6234	Tillamook Head Lt., S. 63½° E., 18 miles.	6100	...do.....	1.55 p. m.	72½	.....do...........
H. 6235	Tillamook Head Lt., S. 60¾° E., 18.4 miles.	6100	...do.....	2.16 p. m.	71	.....do...........
H. 6236	Tillamook Head Lt., S. 58¼° E., 18.8 miles.	6100	...do.....	2.30 p. m.	70½	.....do...........
H. 6237	Tillamook Head Lt., S. 55¾° E., 19.4 miles.	6100	...do.....	2.46 p. m.	69	.....do...........
H. 6238	Tillamook Head Lt., S. 53° E., 19.8 miles.	6100	...do.....	3.01 p. m.	68	fne. gy. S.........
H. 6239	Tillamook Head Lt., S. 59° E., 19.5 miles.	6100	...do.....	3.28 p. m.	70½	fne. gy. S., gn. M..
H. 6240	Tillamook Head Lt., S. 61¾° E., 19.5 miles.	6100	...do.....	3.43 p. m.	72	.....do...........
H. 6241	Tillamook Head Lt., S. 64½° E., 19.5 miles.	6100	...do.....	3.57 p. m.	73	.....do...........
H. 6242	Tillamook Head Lt., S. 67¼° E., 19.5 miles.	6100	...do.....	4.10 p. m.	70	.....do...........
H. 6243	Tillamook Head Lt., S. 70° E., 19.6 miles.	6100	...do.....	4.24 p. m.	75	.....do...........
H. 6244	Tillamook Head Lt., S. 73° E., 19.7 miles.	6100	...do.....	4.37 p. m.	78	.....do...........
H. 6245	Tillamook Head Lt., S. 78° E., 20.2 miles.	6100	...do.....	5.01 p. m.	78	.....do...........
H. 6246	Tillamook Head Lt., S. 86° E., 21.2 miles.	6100	...do.....	5.35 p. m.	86	gn. M.............
H. 6247	Tillamook Head Lt., S. 81½° E., 21.9 miles.	6100	...do.....	6.10 p. m.	86	gn. M., fne. gy. S...
H. 6248	Tillamook Head Lt., S. 77° E., 22.6 miles.	6100	...do.....	6.45 p. m.	84	....

INVESTIGATIONS OFF OREGON-WASHINGTON COASTS, 1914 AND 1915—Continued.

Temperature.			Salinity.		Apparatus.	Trial.		Drift.		Remarks.
Air.	Surf.	Botm.	Surf.	Botm.		Depth.	Duration.	Direction.	Distance.	
°F.	°F.	°F.					Min.		Mi.	
67	56				El. sdr.; 30-lb. lead.					
67	56				do					
67	56				do					
63	54				do					
63	54				do					
63	54				do					
63	54				do					
63	54				do					
63	54				do					
55	53				do					
55	53				do					
59	53				do					
59	53				do					
59	53				do					
60	54				do					
60	54				do					
61	54				do					
61	54				do					
61	54				do					
61	54				do					
61	54				do					
62	55				do					
63	55				do					
63	57				do					
63	57				do					
63	57				do					
63	57				do					
63	57				do					
63	57				do					
63	57				do					
63	57				do					
63	57				do					
63	57				do					
63	57				do					
63	57				do					
62	57				do					
62	57				do					Clean lead.

DREDGING AND HYDROGRAPHIC RECORDS SECURED DURING HALIBUT

Station number.	Position.	Chart.	Date.	Time of day.	Depth.	Character of bottom.
		C. S.	1915.		*Fms.*	
H. 6249	Tillamook Head Lt., S. 75° E., 23 miles.	6100	Sept. 5	7.02 p. m.	84	gn. M., fne. gy. S..
H. 6250	Tillamook Head Lt., S. 73° E., 23.5 miles.	6100	...do.....	7.18 p. m.	87	.....do.............
H. 6251	Tillamook Head Lt., S. 71° E., 24.1 miles.	6100	...do.....	7.35 p. m.	81	.....do.............
H. 6252	Tillamook Head Lt., S. 67½° E., 25.2 miles.	6100	...do.....	8.03 p. m.	81	gran. shl..........
H. 6253	Tillamook Head Lt., S. 64° E., 26.3 miles.	6100	...do.....	8.31 p. m.	88	gn. M., fne. gy. S..
H. 6254	Tillamook Head Lt., S. 61½° E., 27.5 miles.	6100	...do.....	9.00 p. m.	93	....
H. 6255	Tillamook Head Lt., S. 60° E., 28.1 miles.	6100	...do.....	9.18 p. m.	95	gn. M., fne. gy. S...
H. 6256	Tillamook Head Lt., S. 59° E., 28.7 miles.	6100	...do.....	9.36 p. m.	101	.....do.............
H. 6257	Tillamook Head Lt., S. 57½° E., 29.4 miles.	6100	...do.....	9.54 p. m.	224	.....do.............
H. 6258	Tillamook Head Lt., S. 55° E., 27.6 miles.	6100	...do.....	10.33 p. m.	0 285	....
H. 6259	Tillamook Head Lt., S. 52° E., 25.9 miles.	6100	...do.....	11.06 p. m.	98	bl. M., Sh..........
H. 6260	Tillamook Head Lt., S. 51° E., 25 miles.	6100	...do.....	11.23 p. m.	81	bl. shl.............
H. 6261	Tillamook Head Lt., S. 69° E., 26.5 miles.	6100	Sept. 6	7.26 a. m.	87	gn. M., fne. gy. S...
H. 6262	Tillamook Head Lt., S. 70° E., 27.4 miles.	6100	...do.....	7.42 a. m.	94	.....do.............
H. 6263	Tillamook Head Lt., S. 71½° E., 28.2 miles.	6100	...do.....	8.04 a. m.	106	bl. M., gran. Shl....
H. 6264	Tillamook Head Lt., S. 72½° E., 29 miles.	6100	...do.....	8.21 a. m.	119	gn. M., fne. gn. S...
H. 6265	Tillamook Head Lt., S. 74° E., 29.9 miles.	6100	...do.....	8.38 a. m.	130	gn. M., fne. gy. S...
H. 6266	Tillamook Head Lt., S. 75° E., 30.8 miles.	6100	...do.....	9.56 a. m.	186	.....do.............
H. 6267	Tillamook Head Lt., S. 77° E., 28.8 miles.	6100	...do.....	9.31 a. m.	118	.....do.............
H. 6268	Tillamook Head Lt., S. 77¾° E., 27.7 miles.	6100	...do.....	9.47 a. m.	110	.....do.............
H. 6269	Tillamook Head Lt., S. 78½° E., 26.8 miles.	6100	...do.....	10.03 a. m.	104	fne. gy. S..........
H. 6270	Tillamook Head Lt., S. 79½° E., 25.8 miles.	6100	...do.....	10.19 a. m.	98	gn. M., fne. bk. S...
H. 6271	Tillamook Head Lt., S. 80½° E., 24.9 miles.	6100	...do.....	10.35 a. m.	85	fne. bk. S., gran. Shl.
H. 6272	Tillamook Head Lt., S. 83° E., 26.4 miles.	6100	...do.....	11.06 a. m.	108	gn. M., fne. gy. S...
H. 6273	Tillamook Head Lt., S. 84½° E., 27.3 miles.	6100	...do.....	11.23 a. m.	114	.....do.............
H. 6274	Tillamook Head Lt., S. 85° E., 28.2 miles.	6100	...do.....	11.40 a. m.	128	....
H. 6275	Tillamook Head Lt., S. 86° E., 29 miles.	6100	...do.....	11.57 a. m.	214	gn. M.............
H. 6276	Tillamook Head Lt., S. 87½° E., 27.3 miles.	6100	...do.....	12.42 p. m.	117	gn. M., fne. bk. S..
H. 6277	Tillamook Head Lt., S. 88° E., 26.3 miles.	6100	...do.....	1.00 p. m.	111	.....do.............
H. 6278	Tillamook Head Lt., S. 88° E., 25.4 miles.	6100	...do.....	1.16 p. m.	86½	gran. Shl..........
H. 6279	Tillamook Head Lt., E., 26 miles.	6100	...do.....	1.39 p. m.	108	fne. gy. S., bl. M..
H. 6280	Tillamook Head Lt., N. 89° E., 26.8 miles.	6100	...do.....	1.57 p. m.	112	.....do.............
H. 6281	Tillamook Head Lt., N. 87½° E., 27.7 miles.	6100	...do.....	2.13 p. m.	119	gn. M., fne. bk. S..
H. 6282	Tillamook Head Lt., N. 86° E., 28.4 miles.	6100	...do.....	2.31 p. m.	134	gn. M., fne. gy. S..
H. 6283	Tillamook Head Lt., N. 85° E., 29.2 miles.	6100	...do.....	2.48 p. m.	173	.....do.............
H. 6284	Tillamook Head Lt., N. 84° E., 27.4 miles.	6100	...do.....	3.23 p. m.	113	fne. gy. S..........
H. 6285	Tillamook Head Lt., N. 83° E., 26.4 miles.	6100	...do.....	3.40 p. m.	104	fne. G.............

INVESTIGATIONS OFF OREGON-WASHINGTON COASTS, 1914 AND 1915—Continued.

Temperature.			Salinity.		Apparatus.	Trial.		Drift.		Remarks.
Air.	Surf.	Botm.	Surf.	Botm.		Depth.	Duration.	Direction.	Distance.	
°F.	°F.	°F.					Min.		Mi.	
60	56				El. sdr.; 30-lb. lead.					
60	56				do.					
60	56				do.					
60	55				do.					
60	55				do.					
59	54				do.					No sample.
59	54				do.					
59	54				do.					
56	53				do.					
56	53				do.					
56	53				do.					
....	....				do.					
59	52				do.					
59	52				do.					
60	53				do.					
60	53				do.					
60	53				do.					
62	54				do.					
62	54				do.					Chronometers were set back after sounding H. 6266 was made.
62	54				do.					
63	54				do.					
63	54				do.					
63	54				do.					
64	54				do.					
64	54				do.					
64	54				do.					Clean lead.
64	55				do.					
64	55				do.					
64	55				do.					
64	55				do.					
64	55				do.					
65	55				do.					
65	55				do.					
65	55				do.					
64	55				do.					
65	56				do.					
65	56				do.					

DREDGING AND HYDROGRAPHIC RECORDS SECURED DURING HALIBUT

Station number.	Position.	Chart.	Date.	Time of day.	Depth.	Character of bottom.
		C. S.	1915.		*Fms.*	
H. 6286	Tillamook Head Lt., N. 82½° E., 25.4 miles.	6100	Sept. 6	3.56 p.m.	97	bl. M., fne. gn. S..
H. 6287	Tillamook Head Lt., N. 82° E., 24.4 miles.	6100	...do.....	4.12 p.m.	94	gran. Shl., fne. gy. S.
H. 6288	Tillamook Head Lt., N. 81° E., 23.4 miles.	6100	...do.....	4.29 p.m.	79	rky., G., S........
H. 6289	Tillamook Head Lt., N. 80° E., 25.8 miles.	6100	...do.....	5.04 p.m.	97	fne. gy. S.........
H. 6290	Tillamook Head Lt., N. 80° E., 25.8 miles.	6100	...do.....	5.20 p.m.	104	....
H. 6291	Tillamook Head Lt., N. 79½° E., 28 miles.	6100	...do.....	5.37 p.m.	116	bl. M., fne. gy. S..
H. 6292	Tillamook Head Lt., N. 79° E., 29.1 miles.	6100	...do.....	5.54 p.m.	132	fne. bk. S., gran. Shl.
H. 6293	Tillamook Head Lt., N. 79° E., 30.3 miles.	6100	...do.....	6.11 p.m.	165	fne. bk. S., gn. M..
H. 6294	Tillamook Head Lt., N. 77° E., 28.5 miles.	6100	...do.....	6.44 p.m.	125	fne. bk. S., gran. Shl.
H. 6295	Tillamook Head Lt., N. 76° E., 27.6 miles.	6100	...do.....	7.02 p.m.	117½	fne. gy. S., gn. M., gran. Shl.
H. 6296	Tillamook Head Lt., N. 75° E., 26.6 miles.	6100	...do.....	7.20 p.m.	104	gn. M., fne. gy. S..
H. 6297	Tillamook Head Lt., N. 73½° E., 25.6 miles.	6100	...do.....	7.38 p.m.	94½	fne. bk. S.........
H. 6298	Tillamook Head Lt., N. 72° E., 24.7 miles.	6100	...do.....	7.56 p.m.	93	gy. M.............
H. 6299	Tillamook Head Lt., N. 71° E., 23.8 miles.	6100	...do.....	8.12 p.m.	94	gn. M., fne. gn. S..
H. 6300	Tillamook Head Lt., N. 69° E., 22.9 miles.	6100	...do.....	8.32 p.m.	90	....
H. 6301	Tillamook Head Lt., N. 67° E., 22 miles.	6100	...do.....	8.49 p.m.	89	gn. M., fne. bk. S..
H. 6302	Tillamook Head Lt., N. 68½° E., 23.1 miles.	6100	Sept. 7	7.48 a.m.	98	.....do............
H. 6303	Tillamook Head Lt., N. 68½° E., 24.2 miles.	6100	...do.....	8.09 a.m.	96	fne. gn. S.........
H. 6304	Tillamook Head Lt., N. 68½° E., 25.1 miles.	6100	...do.....	8.25 a.m.	102	fne. bk. S.........
H. 6305	Tillamook Head Lt., N. 68½° E., 26.2 miles.	6100	...do.....	8.42 a.m.	118	gn. M.............
H. 6306	Tillamook Head Lt., N. 68° E., 27.4 miles.	6100	...do.....	8.58 a.m.	128	fne. bk. S.........
H. 6307	Tillamook Head Lt., N. 68° E., 28.4 miles.	6100	...do.....	9.15 a.m.	145	.....do............
H. 6308	Tillamook Head Lt., N. 68° E., 29.4 miles.	6100	...do.....	9.32 a.m.	175	gn. M., fne. gy. S...
H. 6309	Tillamook Head Lt., N. 66½° E., 28 miles.	6100	...do.....	10.08 a.m.	130	fne. bk. S..........
H. 6310	Tillamook Head Lt., N. 65½° E., 27.4 miles.	6100	...do.....	10.27 a.m.	120	gn. M., fne. gn. S...
H. 6311	Tillamook Head Lt., N. 64½° E., 26.6 miles.	6100	...do.....	10.44 a.m.	111	gn. M., fne. bk. S...
H. 6312	Tillamook Head Lt., N. 63½° E., 25.8 miles.	6100	...do.....	11.01 a.m.	105	.....do............
H. 6313	Tillamook Head Lt., N. 62½° E., 25.3 miles.	6100	...do.....	11.18 a.m.	108	.....do............
H. 6314	Tillamook Head Lt., N. 61° E., 24.5 miles.	6100	...do.....	11.36 a.m.	103	gn. M.............
H. 6315	Tillamook Head Lt., N. 60° E., 23.8 miles.	6100	...do.....	11.52 a.m.	99	.....do............
H. 6316	Tillamook Head Lt., N. 58½° E., 23.1 miles.	6100	...do.....	12.09 p.m.	95	.....do............
H. 6317	Tillamook Head Lt., N. 58½° E., 24.2 miles.	6100	...do.....	12.42 p.m.	99	.....do............
H. 6318	Tillamook Head Lt., N. 58½° E., 25.2 miles.	6100	...do.....	12.58 p.m.	104	gn. M., fne. gy. S...
H. 6319	Tillamook Head Lt., N. 58½° E., 26.2 miles.	6100	...do.....	1.14 p.m.	104	gn. M., fne. gn. S...
H. 6320	Tillamook Head Lt., N. 58½° E., 27.4 miles.	6100	...do.....	1.30 p.m.	106	gn. M., fne. gy. S...
H. 6321	Tillamook Head Lt., N. 59° E., 28.3 miles.	6100	...do.....	1.47 p.m.	111	fne. gy. S..........
H. 6322	Tillamook Head Lt., N. 59° E., 29.5 miles.	6100	...do.....	2.04 p.m.	117	fne. bk. S..........
H. 6323	Tillamook Head Lt., N. 59° E., 30.5 miles.	6100	...do.....	2.21 p.m.	128	gn. M., fne. bk. S...

INVESTIGATIONS OFF OREGON-WASHINGTON COASTS, 1914 AND 1915—Continued.

Temperature.			Salinity.		Apparatus.	Trial.		Drift.		Remarks.
Air.	Surf.	Botm.	Surf.	Botm.		Depth.	Duration.	Direction.	Distance.	
°F.	°F.	°F.					Min.		Mi.	
65	56				El. sdr.; 30-lb. lead.					
66	56				do					
66	56				do					
66	56				do					
64	56				do					Clean lead.
64	56				do					
63	56				do					
63	56				do					
62	56				do					
62	56				do					
62	56				do					
62	56				do					
61	55				do					
61	55				do					
61	55				do					Do.
61	55				do					
					do					
56	53				do					
56	53				do					
56	53				do					
57	53				do					
57	53				do					
57	53				do					
57	53				do					
61	54				do					
61	54				do					
61	54				do					
63	54				do					
63	54				do					
63	54				do					
63	55				do					
63	55				do					
63	55				do					
63	55				do					
63	55				do					
63	55				do					
64	54				do					
64	54				do					

Dredging and Hydrographic Records Secured During Halibut

Station number.	Position.	Chart.	Date.	Time of day.	Depth.	Character of bottom.
		C. S.	1915.		Fms.	
H. 6324	Tillamook Head Lt., N. 59° E., 31.5 miles.	6100	Sept. 7	2.39 p. m.	142	gn. M., fne. bk. S..
H. 6325	Tillamook Head Lt., N. 59° E., 32.5 miles.	6100	...do.....	2.57 p. m.	159	....
H. 6326	Cape Meares Lt., S. 70° E., 28.3 miles.	6100	...do.....	3.35 p. m.	126	gn. M., fne. gy. S...
H. 6327	Cape Meares Lt., S. 69½° E., 27.2 miles.	6100	...do.....	3.53 p. m.	112	....
H. 6328	Cape Meares Lt., S. 69° E., 25.9 miles.	6100	...do.....	4.12 p. m.	109	fne. gy. S..........
H. 6329	Cape Meares Lt., S. 68° E., 24.5 miles.	6100	...do.....	4.29 p. m.	104	gn. M., fne. gy. S...
H. 6330	Cape Meares Lt., S. 67½° E., 23.2 miles.	6100	...do.....	4.45 p. m.	100	.....do.............
H. 6331	Cape Meares Lt., S. 66½° E., 22.1 miles.	6100	...do.....	5.02 p. m.	90	small G...........
H. 6332	Cape Meares Lt., S. 65½° E., 20.7 miles.	6100	...do.....	5.18 p. m.	84	gn. M..............
H. 6333	Cape Meares Lt., S. 69° E., 22.1 miles.	6100	...do.....	6.00 p. m.	104	gn. M., fne. gy. S...
H. 6334	Cape Meares Lt., S. 71° E., 22.8 miles.	6100	...do.....	6.17 p. m.	109	....
H. 6335	Cape Meares Lt., S. 72½° E., 23.6 miles.	6100	...do.....	6.34 p. m.	115	gn. M., fne. gy. S...
H. 6336	Cape Meares Lt., S. 74½° E., 24.3 miles.	6100	...do.....	6.52 p.m.	122	.....do............
H. 6337	Cape Meares Lt., S. 76° E., 25 miles.	6100	...do.....	7.09 p.m.	133	fne. gn. S.........
H. 6338	Cape Meares Lt., S. 77° E., 25.8 miles.	6100	...do.....	7.28 p.m.	180	fne. gy. S.........
H. 6339	Cape Meares Lt., S. 77° E., 23.9 miles.	6100	...do.....	8.04 p.m.	126	.....do............
H. 6340	Cape Meares Lt., S. 77° E., 22.9 miles.	6100	...do.....	8.24 p.m.	115	fne. gy. S., gn. M..
H. 6341	Cape Meares Lt., S. 77° E., 21.9 miles.	6100	...do.....	8.42 p.m.	105	....
H. 6342	Cape Meares Lt., S. 77° E., 20.9 miles.	6100	...do.....	9.00 p.m.	100	gn. M., fne. gy. S..
H. 6343	Cape Meares Lt., S. 77° E., 19.9 miles.	6100	...do.....	9.18 p.m.	95	.....do............
H. 6344	Cape Meares Lt., S. 77° E., 17.9 miles.	6100	...do.....	....	91	gn. M.............
H. 6345	Cape Meares Lt., S. 84½° E., 17.4 miles.	6100	Sept. 8	7.28 a. m.	102	gn. M., fne. gy. S..
H. 6346	Cape Meares Lt., S. 85° E., 18.4 miles.	6100	...do.....	7.46 a. m.	105	fne. bn. S., bn. M.
H. 6347	Cape Meares Lt., S. 85½° E., 19.4 miles.	6100	...do.....	8.02 a. m.	109	gn. M., fne. gy. S..
H. 6348	Cape Meares Lt., S. 86° E., 20.4 miles.	6100	...do.....	8.17 a. m.	118	gy. S..............
H. 6349	Cape Meares Lt., S. 87° E., 21.4 miles.	6100	...do.....	8.34 a. m.	133	gn. M., fne. gy. S..
H. 6350	Cape Meares Lt., S. 87½° E., 22.4 miles.	6100	...do.....	8.51 a. m.	169	.....do............
H. 6351	Cape Meares Lt., E., 20.3 miles.	6100	...do.....	9.11 a. m.	144	gn. M., fne. gy. S..
H. 6352	Cape Meares Lt., N. 88° E., 19.2 miles.	6100	...do.....	9.27 a. m.	120	.....do............
H. 6353	Cape Meares Lt., N. 86° E., 18.2 miles.	6100	...do.....	9.43 a. m.	111	fne. gy. S.........
H. 6354	Cape Meares Lt., N. 84° E., 17.2 miles.	6100	...do.....	10.02 a. m.	104	....
H. 6355	Cape Meares Lt., N. 82° E., 16.2 miles.	6100	...do.....	10.18 a. m.	95	fne. gy. S., gn. M..
H. 6356	Cape Meares Lt., N. 79° E., 15.1 miles.	6100	...do.....	10.36 a. m.	94	.....do............
H. 6357	Cape Meares Lt., N. 77½° E., 16.3 miles.	6100	...do.....	11.01 a. m.	95	....
H. 6358	Cape Meares Lt., N. 75¾° E., 17.8 miles.	6100	...do.....	11.18 a. m.	105	fne. gy. S., gn. M..
H. 6359	Cape Meares Lt., N. 74° E., 18.3 miles.	6100	...do.....	11.35 a. m.	117	....
H. 6360	Cape Meares Lt., N. 72½° E., 19.4 miles.	6100	...do.....	11.53 a. m.	148	fne. gy. S.........
H. 6361	Cape Meares Lt., N. 68½° E., 17.9 miles.	6100	...do.....	12.29 p. m.	116	.....do............

INVESTIGATIONS OFF OREGON-WASHINGTON COASTS, 1914 AND 1915—Continued.

Temperature.			Salinity.		Apparatus.	Trial.		Drift.		Remarks.
Air.	Surf.	Botm.	Surf.	Botm.		Depth.	Duration.	Direction.	Distance.	
°F.	°F.	°F.					Min.		Mi.	
64	54				El. sdr.; 30-lb. lead.					
63	54				do					Clean lead.
63	54				do					
63	54				do					Do.
62	54				do					
62	54				do					
62	54				do					
60	54				do					
61	54				do					
61	54				do					
61	54				do					Do.
61	54				do					
61	54				do					
61	55				do					
61	55				do					
62	53				do					
62	53				do					
62	53				do					Do.
62	53				do					
62	53				do					
					do					No time entered in yeoman's book.
60	53				do					
60	53				do					
58	53				do					
58	53				do					
58	53				do					
58	53				do					
59	53				do					
59	53				do					
59	53				do					
60	54				do					Clean lead.
60	54				do					
60	54				do					
60	54				do					Do.
63	55				do					
63	55				do					Do.
63	55				do					
65	56				do					

DREDGING AND HYDROGRAPHIC RECORDS SECURED DURING HALIBUT

Station number.	Position.	Chart.	Date.	Time of day.	Depth.	Character of bottom.
		C. S.	1915.		*Fms.*	
H. 6362	Cape Meares Lt., N. 66½° E., 17.3 miles.	6100	Sept. 8	12.44 p. m.	110	fne. gy. S., gn. M..
H. 6363	Cape Meares Lt., N. 64° E., 16.5 miles.	6100	...do.....	1.00 p. m.	100	.....do............
H. 6364	Cape Meares Lt., N. 61½° E., 15.9 miles.	6100	...do.....	1.15 p. m.	99	.....do............
H. 6365	Cape Meares Lt., N. 59° E., 15.3 miles.	6100	...do.....	1.30 p. m.	99	.....do............
H. 6366	Cape Meares Lt., N. 55½° E., 14.7 miles.	6100	...do.....	1.40 p. m.	97	.....do............
H. 6367	Hay Stack Rk., S. 64° E., 15.1 miles.	6000	...do.....	2.13 p. m.	105	.....do............
H. 6368	Hay Stack Rk., S. 68° E., 15.8 miles.	6000	...do.....	2.30 p. m.	109	.....do............
H. 6369	Hay Stack Rk., S. 71° E., 16.4 miles.	6000	...do.....	2.48 p. m.	133	gn. M............
H. 6370	Hay Stack Rk., S. 73° E., 17.1 miles.	6000	...do.....	3.06 p. m.	175	fne. gy. S., gn. M..
H. 6371	Hay Stack Rk., S. 76° E., 18 miles.	6000	...do.....	3.25 p. m.	206	....
H. 6372	Hay Stack Rk., S. 77° E., 15.9 miles.	6000	...do.....	3.56 p. m.	147	gn. M., fne. bk. S...
H. 6373	Hay Stack Rk., S. 78° E., 14.9 miles.	6000	...do.....	4.13 p. m.	122	gn. S..............
H. 6374	Hay Stack Rk., S. 79° E., 13.9 miles.	6000	...do.....	4.28 p. m.	106	fne. gy. S..........
H. 6375	Hay Stack Rk., S. 80° E., 13 miles.	6000	...do.....	4.43 p. m.	99	fne. gy. S., gn. M...
H. 6376	Hay Stack Rk., S. 81° E., 12 miles.	6000	...do.....	4.58 p. m.	96	.....do............
H. 6377	Hay Stack Rk., S. 85½° E., 13.8 miles.	6000	...do.....	5.34 p. m.	115	....
H. 6378	Hay Stack Rk., S. 87½° E., 14.7 miles.	6000	...do.....	5.49 p. m.	134	gn. M., fne. gy. S...
H. 6379	Hay Stack Rk., S. 89° E., 15.6 miles.	6000	...do.....	6.06 p. m.	200	gn. M............
H. 6380	Hay Stack Rk., N. 86½° E., 13.9 miles.	6000	...do.....	6.39 p. m.	120	fne. gy. S., gn. M...
H. 6381	Hay Stack Rk., N. 83½° E., 13.1 miles.	6000	...do.....	6.54 p. m.	110	fne. gy. S..........
H. 6382	Hay Stack Rk., N. 80½° E., 12.4 miles.	6000	...do.....	7.08 p. m.	100	fne. gy. S., gn. M...
H. 6383	Hay Stack Rk., N. 76½° E., 11.5 miles.	6000	...do.....	7.23 p. m.	95	.....do............
H. 6384	Hay Stack Rk., N. 73½° E., 13.6 miles.	6000	...do.....	7.56 p. m.	115	....
H. 6385	Hay Stack Rk., N. 72½° E., 14.6 miles.	6000	...do.....	8.15 p. m.	135	....
H. 6386	Hay Stack Rk., N. 71½° E., 15.5 miles.	6000	...do.....	8.32 p. m.	175	fne. gy. S..........
H. 6387	Hay Stack Rk., N. 65° E., 14.6 miles.	6000	...do.....	9.04 p. m.	125	fne. gy. S., gn. M...
H. 6388	Hay Stack Rk., N. 61° E., 14.1 miles.	6000	...do.....	9.20 p. m.	111	fne. bk. S..........
H. 6389	Hay Stack Rk., N. 57½° E., 13.7 miles.	6000	...do.....	9.36 p. m.	102	fne. gy. S., gn. M...
H. 6390	Hay Stack Rk., N. 54° E., 13.3 miles.	6000	...do.....	9.51 p. m.	95	.....do............
H. 6391	Hay Stack Rk., N. 54½° E., 15.2 miles.	6000	...do.....	10.24 p. m.	109	.....do............
H. 6392	Hay Stack Rk., N. 54¾° E., 16.3 miles.	6000	...do.....	10.41 p. m.	120	.....do............
H. 6393	Hay Stack Rk., N. 55° E., 17.4 miles.	6000	...do.....	10.58 p. m.	135	.....do............
H. 6394	Hay Stack Rk., N. 55½° E., 18.4 miles.	6000	...do.....	11.15 p. m.	145	....
H. 6395	Hay Stack Rk., N. 49° E., 18.6 miles.	6000	...do.....	11.59 p. m.	120	gn. M., fne. gy. S...
H. 6396	Hay Stack Rk., N. 46° E., 18.9 miles.	6000	Sept. 9	12.16 a. m.	111	.....do............
H. 6397	Hay Stack Rk., N. 43° E., 19.2 miles.	6000	...do.....	12.31 a. m.	101	.....do............
H. 6398	Hay Stack Rk., N. 40° E., 19.5 miles.	6000	...do.....	12.47 a. m.	92	fne. bk. S..........
H. 6399	Yaquina Lt., S. 33° E., 19.6 miles.	6000	...do.....	1.20 a. m.	104	fne. gy. S., gn. M...

INVESTIGATIONS OFF OREGON-WASHINGTON COASTS, 1914 AND 1915—Continued.

Temperature.			Salinity.		Apparatus.	Trial.		Drift.		Remarks.
Air.	Surf.	Botm.	Surf.	Botm.		Depth.	Duration.	Direction.	Distance.	
°F.	°F.	°F.					Min.		Mi.	
65	56	......	......	......	El. sdr.; 30-lb. lead.	......	......	......	......	
65	56	......	......	......	do	......	......	......	......	
66	56	......	......	......	do	......	......	......	......	
66	56	......	......	......	do	......	......	......	......	
66	56	......	......	......	do	......	......	......	......	
66	56	......	......	......	do	......	......	......	......	
66	56	......	......	......	do	......	......	......	......	
66	56	......	......	......	do	......	......	......	......	
66	56	......	......	......	do	......	......	......	......	
65	56	......	......	......	do	......	......	......	......	Clean lead.
65	56	......	......	......	do	......	......	......	......	
65	56	......	......	......	do	......	......	......	......	
65	56	......	......	......	do	......	......	......	......	
65	56	......	......	......	do	......	......	......	......	
65	55	......	......	......	do	......	......	......	......	
65	55	......	......	......	do	......	......	......	......	Do.
65	55	......	......	......	do	......	......	......	......	
64	54	......	......	......	do	......	......	......	......	
64	54	......	......	......	do	......	......	......	......	
64	54	......	......	......	do	......	......	......	......	
60	54	......	......	......	do	......	......	......	......	
60	54	......	......	......	do	......	......	......	......	
60	54	......	......	......	do	......	......	......	......	Do.
58	53	......	......	......	do	......	......	......	......	Do.
58	53	......	......	......	do	......	......	......	......	
58	53	......	......	......	do	......	......	......	......	
57	53	......	......	......	do	......	......	......	......	
57	53	......	......	......	do	......	......	......	......	
57	53	......	......	......	do	......	......	......	......	
57	53	......	......	......	do	......	......	......	......	
57	53	......	......	......	do	......	......	......	......	
57	53	......	......	......	do	......	......	......	......	
59	53	......	......	......	do	......	......	......	......	Do.
59	53	......	......	......	do	......	......	......	......	
59	53	......	......	......	do	......	......	......	......	
59	53	......	......	......	do	......	......	......	......	
59	53	......	......	......	do	......	......	......	......	
58	53	......	......	......	do	......	......	......	......	

DREDGING AND HYDROGRAPHIC RECORDS SECURED DURING HALIBUT

Station number	Position.	Chart.	Date.	Time of day.	Depth.	Character of bottom.
		C. S.	1915.		*Fms.*	
H.6400	Yaquina Lt., S. 36° E., 20 miles.	6000	Sept. 9.	1.36 a. m.	112	fne. gy. S., gn. M..
H.6401	Yaquina Lt., S. 38½° E., 20.2 miles.	6000	...do.....	1.53 a. m.	122	fne. gy. S..........
H.6402	Yaquina Lt., S. 41° E., 20.5 miles.	6000	...do.....	2.10 a. m.	135	fne. gy. S., gn. M...
H.6403	Yaquina Lt., S. 43½° E., 21 miles.	6000	...do.....	2.26 a. m.	150	.....do............
H.6404	Yaquina Lt., S. 45° E., 20.1 miles.	6000	...do.....	2.48 a. m.	133	.....do............
H.6405	Yaquina Lt., S. 46° E., 19.1 miles.	6000	...do.....	3.04 a. m.	115	.....do............
H.6406	Yaquina Lt., S. 47½° E., 18.1 miles.	6000	...do.....	3.19 a. m.	101	fne. gy. S..........
H.6407	Yaquina Lt., S. 49° E., 17.1 miles.	6000	...do.....	3.34 a. m.	92	.....do............
H.6408	Yaquina Lt., S. 50½° E., 16.2 miles.	6000	...do.....	3.49 a. m.	88	fne. gy. S., gn. M...

DREDGING AND HYDROGRAPHIC RECORDS SECURED DURING ATLANTIC CRUISES,

Station number.	Bearings.	Chart.	Date.	Time of day.	Depth.	Character of bottom.
	Latitude N., Longitude W.	*C. S.*	1919.		*Meters.*	
....	Cape Henry outer buoy.......	....	Oct. 30	....	0	....
C20001	36 49 00 75 36 00	1001	...do.....	2.49 p. m. to 4.53 p. m.	19	S., Sh............
C20002	36 47 00 75 06 00	1001	...do.....	8.00 p. m. to 9.20 p. m.	31	.....do...........
C20003	36 45 00 74 41 30	1001	Oct. 31	12.01 a. m. to 1.30 a. m.	73	.....do...........
C20004	36 41 00 74 34 30	1001	...do.....	3.00 a. m. to 6.00 a. m.	336	gn. S., M ....

[a] Surface temperatures taken while the *Albatross* was under way during the Atlantic cruises are given in the table on page 174.

INVESTIGATIONS OFF OREGON-WASHINGTON COASTS, 1914 AND 1915—Continued.

Temperature.			Salinity.		Apparatus.	Trial.		Drift.		Remarks.
Air.	Surf.	Botm.	Surf.	Botm.		Depth.	Duration.	Direction.	Distance.	
°F.	°F.	°F.					Min.		Mi.	
58	53	......	......	......	El. sdr.; 30-lb. lead.	......	......	......	......	
58	53	......	......	......	....do....	......	......	......	......	
58	53	......	......	......	....do....	......	......	......	......	
58	53	......	......	......	....do....	......	......	......	......	
58	53	......	......	......	....do....	......	......	......	......	
58	53	......	......	......	....do....	......	......	......	......	
58	53	......	......	......	....do....	......	......	......	......	
58	53	......	......	......	....do....	......	......	......	......	
58	53	......	......	......	....do....	......	......	......	......	

SOUTH FROM NORFOLK, 1919, AND NORTH FROM NORFOLK, 1920.[a]

Temperature.			Salinity.		Apparatus.	Trial.		Drift.		Remarks.
	Water.									
Air.	Depth.	Temp.	Depth.	Salinity.		Depth.	Duration.	Direction.	Distance.	
°C.	M.	°C.	M.			M.	Min.		Mi.	
......	......	......	0	26.51	......	......	......	......	......	
21.11	0	19.40	0	31.07	Hvg. ln.; snap. ld.; GB bot.; NZ; R; Tycos.	......	......	......	......	
	6	19.63	7	31.08						
	14	19.58	14	31.09						
					botm. net......	botm.-0	30	......	......	Cable out (botm. net) 100 meters, angle 60°.
					mtr. net......	5-0....	30	......	......	Cable (mtr. net) out 63 meters., angle 60°.
					#10, #20......	0......	20	......	......	#10 out 5 min.
					35′ shr. trl......	(?)....	15	......	......	Cable (35′ shr. trl.) out 306 meters; did not reach bottom.
19.44	0	20.80	0	31.92	Hvg. ln.; snap. ld.; GB bot.; NZ; R; Tycos.	......	......	......	......	
	15	17.21	15	31.98						
	30	16.23	30	32.59						
					vert. net......	30-0....	......	......	......	
					botm. net......	30-0....	30	......	......	
					#10, #20......	0......	25	......	......	
19.44	0	12.80	0	33.62	El. sdr.; snap. ld.; GB bot.; NZ; R; Tycos.	......	......	......	......	El. sdr. dial read 40 fms., but bottles were sent down to 90 meters.
	10	17.82	10	33.57						
	30	16.53	30	33.78						
	60	9.96	60	33.10						
	90	10.93	90	34.02						
					vert. net......	90-0....	......	......	......	
					botm. net......	75-0....	30	......	......	Cable (botm. net) out 100 meters.
					#10, #20......	0......	20	......	......	
19.44	0	17.80	0	33.60	El. sdr.; snap. ld.; GB bot.; NZ; R; Tycos.	......	......	......	......	
	10	17.87	10	33.65						
	50	10.89	50	33.12						
	100	11.26	100	34.25	vert. net. and m. b.	200-0...	......	......	......	
	150	11.99	150	35.39						
	200	11.15	200	35.35	botm. net......	200-0...	30	......	......	
	300	7.68	300	35.07	#10, #20......	0......	30	......	......	

DREDGING AND HYDROGRAPHIC RECORDS SECURED DURING ATLANTIC CRUISES,

Station number.	Bearings.	Chart.	Date.	Time of day.	Depth.	Character of bottom.
	Latitude N., Longitude W.	*C. S.*	1919.		*Meters.*	
C20005	From 36 35 30 74 23 30 To 36 31 00 74 28 00 and From 36 37 30 74 21 30 To 36 35 30 74 23 30	1001	Oct. 31	7.30 a. m. to 5.30 p. m.	2,029	gn. S., M.........
C20006	35 04 00 75 18 00	1001	Nov. 1	10.15 a. m. to 11.10 a. m.	36	S., Sh.............
C20007	35 01 00 75 14 00	1001	...do.....	1.00 p. m. to 3.00 p. m.	223	P., S., Sh.........
20008	From 34 54 30 75 07 00 To 34 59 00 75 02 00	1001	...do.....	7.35 p. m. to 10.50 p. m.	1,890	....
....	Cape Canaveral Anchorage..	....	Nov. ?	....	0	....
....	St. John's Bay, "Brown water."	....	Nov. 9	....	0	....
....	St. John's Bay, "Brown water" (outside).	....	...do.....	....	0	....
....	Mayport, Fla................	....	...do.....	....	0	....
20009	From 29 55 30 81 10 00	1007	...do.....	5.25 p. m. to 5.40 p. m.	17	S., Sh.............
20010	27 34 00 80 10 00	1007	Nov. 10	1.38 p. m. to 1.55 p. m.	18	.....do............
C20011	From 27 34 00 79 55 30 To 27 37 00 79 56 30	1007	...do.....	3.30 p. m. to 4.20 p. m.	85	.....do............

SOUTH FROM NORFOLK, 1919, AND NORTH FROM NORFOLK, 1920—Continued.

Temperature.			Salinity.		Apparatus.	Trial.		Drift.		Remarks.
	Water.									
Air.	Depth.	Temp.	Depth.	Salinity.		Depth.	Duration.	Direction.	Distance.	
°C.	M.	°C.	M.			M.	Min.		Mi.	
21.67	0 50 100 200 400 600 1,000 1,400 1,800	19.40 14.75 13.98 10.18 5.79 4.55 3.94 3.46 3.37	0 50 100 200 400 600 1,000 1,400 1,800	34.20 34.13 35.58 34.90 34.97 34.99 34.95 34.96 34.91	Luc. sdr.; Sigs. rod; GB bot.; NZ; R; SV; Tycos.	....	......	S. 38 W... S. 38 W	6.0 2.5	7.30 a. m. to noon, 1 to 5.30 p. m.; drift. Very stiff northwest wind. At noon ran to northwestward of beginning position to drift down to it.
					vert. net........	400-0...	9	....	....	
					botm. net.......	200-0...	30	....	....	
					mtr. net.........	100-0...	30	....	....	
					#10, #20.........	0.......	25	....	....	
25.56	0 15 30	24.40 24.25 24.72	0 15 30	34.28 34.74 35.33	El. sdr.; NZ; R; Tycos; snap. ld.; GB bot.	....	....	....	....	
					botm. net.......	25-0...	30	....	....	Cable (botm. net) out 40 meters.
					#10, #20.........	0.......	25	....	....	
27.0	0 50 100 150 200	27.80 27.50 26.85 24.85 16.16	0 50 100 150 200	36.03 35.98 35.99 36.02 35.95	El. sdr.; snap. ld.; GB bot.; NZ; R; Tycos.	....	....	....	....	Temp. at 50 meters may have been 0.5 higher; almost too high for therm.
					mtr. net.........	200-0...	....	....	....	Mtr. net used for vertical haul.
					botm. net.......	100-0...	25	....	....	Cable (botm. net) out 220 meters.
					#10, #20.........	0.......	25	....	....	
26.11	0 50 100 150 200 400 600 800 1,000	26.70 26.45 25.58 26.39 18.03 23.86 23.04 16.44 12.90 11.76 8.85 8.61	...... 50 100 150 200 400 600 800 1,000	...... 35.98 36.02 36.13 35.99 35.97 35.62 35.47 35.10	Luc. sdr.; Sigs. rod.; GB bot.; NZ; R; SV; Tycos.	....	....	N. 45 E...	6.2	Sample for salinity at 0 meters lost. During soundings, with 1,060 fms. wire out, wire parted, and carried away with Sigs. rod. Sea so choppy that bottles were sent down to only 1,000 meters; no nets used. Wire with bottles at 400, 600, 800, and 1,000 meters at angle 40°.
......	......	......	0	35.82	....	....	....	....	....	
......	0	41.67	0	34.51	....	....	....	....	....	Ebb tide.
......	......	......	0	34.53	....	....	....	....	....	Do.
......	......	......	0	34.27	....	....	....	....	....	Do.
22.2	0 14	25.30 24.59	0 14	35.26 35.26	Hvg. ln.; snap. ld.; GB bot.; R.; SV; Tycos.	....	....	....	....	
25.5	0 16	25.30 24.81	0 16	35.98 35.96	Hvg. ln.; snap. ld.; GB bot.; R.; SV; Tycos.	....	....	....	....	
26.11	0 14 34 54 74	26.90 26.17 26.17 25.91 25.67	0 14 34 54 74	35.99 35.95 35.95 35.95 35.97	El. sdr.; snap. ld.; GB bot.; NZ; R.; SV; Tycos.	....	....	N. 21 W...	4	Wire with bottles, angle 15°.
					vert. net.........	45-0....	....	....	....	
					m. b............	botm...	....	....	....	

DREDGING AND HYDROGRAPHIC RECORDS SECURED DURING ATLANTIC CRUISES,

Station number.	Bearings.	Chart.	Date.	Time of day.	Depth.	Character of bottom.
C20012	*Latitude N.*, *Longitude W.* From 27 34 00 79 34 00 To 27 41 30 79 36 00	*C. S.* 1007	1919. Nov. 10	7.00 p. m. to 9.00 p. m.	*Meters.* 432	gy. M., S.
....	St. John's River, halfway between Halifax and the sea.	....	Nov. 11	....	0	....
20013	From 27 34 00 79 10 00 To 27 37 30 79 11 00	1007	...do.....	12.23 a. m. to 1.55 a. m.	(?)	S., Sh.
20014	From 25 34 30 80 04 00	1007	...do.....	7.18 p. m. to 7.40 p. m.	100	...do.
C20015	From 25 34 00 79 57 30 To 25 36 00 79 57 30	1007	...do.....	8.05 p. m. to 9.55 p. m.	322	gy. M., S.
C20016	From 25 34 00 79 45 30 To 25 40 30 79 45 30	1007	Nov. 12	12.12 a. m. to 2.51 a. m.	823	gy. M.
C20017	From 25 33 30 79 27 30 To 25 37 00 79 27 30	1007	...do.....	5.18 a. m. to 7.46 a. m.	877	Co., S., Sh.
C20018	24 25 00 81 55 00	1007	Nov. 15	6.18 p. m. to 7.52 p. m.	117	S., Sh.

SOUTH FROM NORFOLK, 1919, AND NORTH FROM NORFOLK, 1920—Continued.

Temperature.			Salinity.		Apparatus.	Trial.		Drift.		Remarks.
	Water.									
Air.	Depth.	Temp.	Depth.	Salinity.		Depth.	Duration.	Direction.	Distance.	
°C.	M.	°C.	M.			M.	Min.		Mi.	
26.11	0	27.75	0	35.84	Luc. sdr.; Sigs. rod; GB bot.; NZ; R.; SV; Tycos.	....	....	N. 14½ W..	7.5	Wire with bottles, angle 25°.
	50	27.24	50	35.85						
	100	24.32	100	36.11						
	150	20.62	150	36.36						
	200	17.73	200	36.26	vert. net.........	250-0...	....	....	.....	On heaving in vert. net, a sudden lurch of the ship sharply jerked the wire, causing the bridle to part at the thimble; net, ring, and sinker were lost.
	250	16.20	......	......						
	300	15.20	300	35.99						
	350	11.74	350	35.46						
	400	8.60	400	35.06						
......	......	......	0	30.72	....	....	....	....	.....	High water.
25.0	0	27.75	0	36.00	Luc. sdr.; Sigs. rod; GB bot.; NZ; R.; SV; Tycos.	....	....	N. 15½ W..	4	Recorded depth (418 fms.) is incorrect. Wire tended far astern and depth shown on chart is 200 to 300 fms.
	20	27.36	20	35.95						
	60	27.37	60	35.98						
	100	26.44	100	36.24						
	150	27.24	150	36.67						
	200	19.79	200	36.63						
	250	17.78	250	36.41						
	300	17.11	300	36.24						
	350	16.19	350	36.13						
24.44	0	26.90	0	35.90	El. sdr.; snap. ld.; GB bot.; NZ; R.; SV; Tycos.	....	....	....		
	30	26.35	30	35.90						
	60	26.43	60	35.95						
	90	24.59	......	......						
24.44	0	26.70	0	35.90	Luc. sdr.; Sigs. rod; GB bot.; NZ; R.; SV; Tycos.	....	....	N.........	2	
	50	26.32	50	35.90						
	100	22.51	100	36.24						
	150	16.33	150	35.95						
	200	10.18	200	35.28	vert. net.........	240-0...	....			
	250	9.13	250	35.10	botm. net.......	botm.-0	30			
		8.97			#10, #20..........	0.......	25			
	300	8.08	......	......						
23.33	0	27.75	0	35.88	Luc. sdr; Sigs. rod; GB bot.; NZ; R; SV; Tycos.	....	....	N.........	6.5	
	50	27.25	50	35.84						
	100	25.87	100	36.33						
	150	21.06	150	36.64						
	200	17.88	200	36.39	vert. net.........	800-0	....	....	.....	Vert. net fouled in bridle.
	300	14.65	300	36.00						
	400	11.59	400	35.43	botm. net.......	550-0	30	....	.....	Cable out (botm. net) 700 meters.
	600	6.99	600	34.87						
	800	5.88	800	34.86	mtr. net.........	175-0	30	....	.....	Cable out (mtr. net) 200 meters.
					#10, #20..........	0	25	....	.....	
25.0	0	28.10	0	36.04	Luc. sdr.; Sigs. rod; GB bot.; NZ; R; SV; Tycos.	....	....	N.........	3.3	
	50	27.24	Samp	le lost						
	100	27.00	100	36.11						
	150	23.25	150	36.63						
	195	20.33	195	36.64	vert. net	800-0	....	....	.....	
	300	17.83	300	36.32	botm. net.......	700-0	30	....	.....	Cable out (botm. net) 800 meters.
	400	14.52	400	35.84						
	600	9.28	600	35.05	mtr. net.........	200-0	30	....	.....	Cable out (mtr. net) 300 meters.
	800	6.93	800	34.85						
					#10, #20..........	0	25	....	.....	
28.5	0	26.90	0	35.99	El. sdr.; snap ld.; GB bot.; NZ; R; SV; Tycos.	....	....	....	.....	
	30	26.26	30	35.95						
	60	25.95	60	35.95						
	90	20.95	90	36.27	vert. net.........	100-0	30	....	.....	
	100	19.26	100	36.26	botm. net.......	100-0	....	....	.....	Cable out (botm. net) 120 meters.
					#10, #20..........	0	25	....	.....	

DREDGING AND HYDROGRAPHIC RECORDS SECURED DURING ATLANTIC CRUISES,

Station number.	Bearings.	Chart.	Date.	Time of day.	Depth.	Character of bottom.
	Latitude N., Longitude W.	*C. S.*	1919.		*Meters.*	
C20019	From 24 10 30 82 00 00 To 24 07 30 81 58 00	1007	Nov. 15–16	9.42 p. m. to 12.53 a. m.	656	gy. M.
C20020	From 23 58 30 81 59 00 To 23 56 30 81 57 00	1007	Nov. 16	2.00 a. m. to 5.08 a. m.	996	.....do.
C20021	From 23 42 30 82 09 30 To 23 38 00 82 08 00	1007	Nov. 16	7.08 a. m. to 10.27 a. m.	1,645	gy. M., pter. Oz.
20022	From 23 30 00 82 14 00 To 23 28 00 82 12 30	1007	...do.	11.45 a. m. to 1.49 p. m.	1,681	.....do.
C20023	From 23 14 00 82 14 00 To 23 13 30 82 27 00	1007	Nov. 21	9.35 a. m. to 1.41 p. m.	1,270	gy. M.
C20024	From 21 50 00 85 08 00 To 21 52 00 85 09 30	1007	Nov. 22	1.06 p. m. to 6.10 p. m.	1,664	co. S.

SOUTH FROM NORFOLK, 1919, AND NORTH FROM NORFOLK, 1920—Continued.

Temperature.			Salinity.		Apparatus.	Trial.		Drift.		Remarks.
	Water.									
Air.	Depth.	Temp.	Depth.	Salinity.		Depth.	Duration.	Direction.	Distance.	
°C.	M.	°C.	M.			M.	Min.		Mi.	
24.44	0	26.70	0	35.90	Luc. sdr.; Sigs. rod; GB bot.; NZ; R; SV; Tycos.	....	......	S. 20 E....	8½	
	50	25.88	50	35.90						
	100	20.45	100	36.29						
	150	16.63	150	36.13						
	200	13.36	200	35.70	vert. net........	600-0	......	....	.....	
	300	11.04	300	35.34	botm. net........	600-0	60	....	.....	Cable out (botm. net) 600 meters.
	400	10.33	400	35.21						
	500	8.83	500	35.03	mtr. net.........	200-0	40	....	.....	Cable out (mtr. net) 200 meters.
	600	7.56	600	34.88						
					#10, #20..........	0	25	....	.....	
25.0	0	27.50	0	35.84	Luc. sdr.; Sigs. rod; GB bot.; NZ; R; SV; Tycos.	....	......	S. 46 E....	2.5	Wire with bottles at 400, 500, 700, and 950 meters at angle 20°.
	50	27.30	50	35.87						
	100	22.96	100	36.26						
	200	14.98	200	36.27						
	300	11.16	300	35.39	botm. net........	900-0	60	....	.....	Cable out (botm. net) 1,000 meters.
	400	9.76	400	35.38						
	500	9.06	500	35.04						
	700	6.94	700	34.87	mtr. net.........	200-0	60	....	.....	Cable out (mtr. net) 300 meters.
	950	5.69	950	34.84						
					#10, #20..........	0	60	....	.....	
25.0	0	28.10	0	36.04	Luc. sdr.; Sigs. rod; GB bot.; NZ; R; SV; Tycos.	....	......	S. 19½ E...	5	Temp. at 50 m. probably not more than 0.2 higher; top of mercury could not be seen.
	50	27.53	50	36.04						
	100	26.54	100	36.22						
	200	18.83	200	36.51						
	300	15.11	300	35.96						
	400	11.10	400	35.34						
	600	8.19	......	......	vert. net.........	500-0	......	....	.....	
	800	6.39	800	34.96	botm. net........	400-0	30	....	.....	Cable out (botm. net) 600 meters.
	1,000	5.77	1,000	34.85						
	1,300	5.30	1,300	34.87	mtr. net.........	200-0	30	....	.....	Cable out (mtr. net) 300 meters.
	1,600	4.27	1,600	34.96						
					#20..............	0	25	....	.....	
					#10..............	0	20	....	.....	
27.0	0	28.60	0	36.06	Luc. sdr.; Sigs. rod; GB bot.; NZ; R; SV; Tycos.	....	......	S. 37½ E...	2.5	Temp. reading at 50 meters probably correct; graduation of therm. runs to 27.4; the 0.03 was estimated.
	50	27.43	50	36.11						
	100	26.46	100	36.20						
	200	20.32	200	36.62						
	300	16.13	300	36.12						
	400	12.49	400	35.54						
	600	8.42	600	35.08						
	800	6.27	800	34.87						
	1,000	5.46	1,000	34.87						
	1,300	4.83	1,300	34.94						
	1,600	4.25	1,600	34.96						
26.67	0	27.75	0	36.08	Luc. sdr.; Sigs. rod; GB bot.; NZ; R; SV; Tycos.	....	......	S. 88 W...	12	Wire with bottles at 400, 600, 900, and 1,200 m., had angle 40°-45°.
	50	27.12	50	36.08						
	100	26.70	100	36.16						
	200	23.50	200	36.69						
	300	18.94	300	36.42	vert. net.........	600-0	......	....	.....	
	400	17.10	400	36.29	botm. net; mtr. net.	1,100-0	30	....	.....	Cable (botm. and mtr. net) out 1,300 meters. Clamp holding mtr. net at intermediate depth slid down wire to botm. net.
	600	11.67	600	35.48						
	900	6.74	900	34.96						
	1,200	5.07	1,200	36.33						
					#10, #20..........	0	30	....	.....	
26.11	0	27.50	0	36.08	Luc. sdr.; Sigs. rod; GB bot.; NZ; R; SV; Tycos.	....	......	N. 32 W...	2.5	Wire with bottles at 800, 1,000, 1,300, and 1,600 meters had angle 15°.
	50	27.28	50	36.04						
	100	27.28	100	36.02						
	200	21.07	200	36.73						
	300	17.70	300	36.39						
	400	15.61	400	36.05	9' Tnr.; m. b ...	botm.	......	....	.....	Cable out (9' Tnr. m. b.) 2,743 meters; fouled 20 mtr. above bridle, causing delay of 15 min. in hauling. When net was brought in the m. b. was found in it.
	600	10.92	600	35.81						
	800	7.77	......	......						
	1,000	4.82	1,000	34.95						
	1,300	4.20	1,300	34.92						
	1,600	4.11	1,600	34.94						

DREDGING AND HYDROGRAPHIC RECORDS SECURED DURING ATLANTIC CRUISES,

Station number.	Bearings.	Chart.	Date.	Time of day.	Depth.	Character of bottom.
	Latitude N., Longitude W.	*C. S.*	1919.		*Meters.*	
C20025	From 21 44 30 85 39 00 To 21 47 30 85 44 00	1007	Nov. 22-23.	9.45 p. m. to 1.55 a. m.	1,600	....
C20026	From 21 31 00 86 08 30 To 21 41 00 86 10 00	1007	Nov. 23	5.32 a. m. to 10.20 a. m.	1,745	....
C20027	From 21 35 30 86 35 00 To 21 42 30 86 37 00	1007	...do.....	2.00 p. m. to 4.05 p. m.	36	Co., St............
C20028	From 23 47 30 84 23 00 To 23 43 00 84 16 00	1007	Nov. 24	3.27 p. m. to 8.05 p. m.	2,842	rd. C..............
C20029	From 24 24 00 83 18 00 To 24 22 00 83 16 00	1007	Nov. 25	7.00 a. m. to 8.40 a. m.	176	wh. M............

SOUTH FROM NORFOLK, 1919, AND NORTH FROM NORFOLK, 1920—Continued.

Temperature. Air.	Temperature. Water. Depth.	Temperature. Water. Temp.	Salinity. Depth.	Salinity. Salinity.	Apparatus.	Trial. Depth.	Trial. Duration.	Drift. Direction.	Drift. Distance.	Remarks.
°C.	M.	°C.	M.			Mtrs.	Min.		Mi.	
26.11	0 50 100 200 300 400 600 800 1,000 1,300 1,600	28.10 27.42 27.39 20.58 18.00 15.51 10.21 7.12 5.33 4.32 4.15	0 50 100 200 300 400 600 800 1,000 1,300 1,600	36.04 36.07 36.07 36.65 36.40 36.00 35.25 34.86 34.88 34.93 35.08	Luc. sdr.; Sigs. rod; GB bot.; NZ; R; SV; Tycos.	....	....	N. 56 W...	6	On beginning to sound wire parted at old splice, carrying away Sigs. rod. No further attempt was made to sound, since deep water was indicated on chart. Wire with bottles at 800, 1,000, 1,300, and 1,600 meters had angle 15°.
					vert. net........	500-0...	....	....	....	
					mtr. net........	1,600-0.	30	....	....	
					#10, #20........	0.......	30	....	....	Bridle of #20 parted, net carried away.
24.44	0 50 100 200 300 400 600 800 1,000 1,300 1,600	28.10 27.33 25.18 18.80 17.30 15.07 11.53 7.08 6.09 4.47 4.23	0 50 100 200 300 400 600 800 1,000 1,300 1,600	36.01 35.99 36.47 36.48 36.26 35.97 35.40 34.82 34.83 34.97 34.95	Luc. sdr.; Sigs. rod; GB bot.; NZ; R; SV; Tycos.	....	....	N. 7½ W...	10.5	While heaving in sounding wire, with 20 fms. out, a sea carried wire into propeller, and Sigs. rod was lost. Wire with bottles at 800, 1,000, 1,300, and 1,600 meters had angle 20°. Stray of the wire indicated current was at depth of 300 meters.
					vert. net........	500-0...	....	....	....	
					botm. net........	botm.-0	30	....	....	Cable out (botm. net) 1,400 meters.
					mtr. net........	200-0...	30	....	....	Cable out (mtr. net) 400 meters.
					#10, #20........	0.......	45	....	....	
28.5	0 15 30	27.75 27.10 26.92	0 15 30	35.97 35.93 35.90	El. sdr.; snap. ld.; GB bot.; NZ; R; Tycos.	....	....	N. 10 W...	7.5	
					botm. net........	25-0....	30	....	....	Cable out (botm. net) 40 meters.
					#10, #20........	0.......	30	....	....	
					9′ Tnr........	botm...	18	....	....	Cable out (9′ Tnr.) 360 meters.
27.0	0 50 100 200 300 400 600 900 1,200 1,500 1,800	28.10 27.17 27.18 22.08 17.61 14.76 9.52 6.21 5.15 4.35 4.19	0 50 100 200 300 400 600 900 1,200 1,500 1,800	36.08 36.06 36.09 36.74 36.32 35.88 35.08 34.85 34.90 34.96 34.97	Luc. sdr.; Sigs. rod; GB bot.; NZ; R; SV.; Tycos.	....	....	S. 53 E....	7.5	Wire with bottles at 200, 300, 400, and 600 meters, had angle 20°.
					vert. net........	500-0...	....	....	....	
					botm. net........	1,700-0	30	....	....	Cable out (botm. net) 1,800 meters.
					mtr. net........	200-0...	30	....	....	Cable out (mtr. net) 300 meters.
					#10, #20........	0.......	35	....	....	
24.44	0 50 100 150	26.70 25.83 20.02 15.75	0 50 100 150	36.05 36.04 36.47 36.07	El. sdr.; snap. ld.; GB bot.; NZ; R; Tycos.	....	....	S. 38 E....	2¼	
					vert net........	150-0...	....	....	....	
					botm. net........	150-0...	30	....	....	Cable out (botm. net) 200 meters.
					mtr. net........	50-0....	30	....	....	Cable out (mtr. net) 100 meters.
					#10, #20........	0.......	35	....	....	

DREDGING AND HYDROGRAPHIC RECORDS SECURED DURING ATLANTIC CRUISES.

Station number.	Bearings.	Chart.	Date.	Time of day.	Depth.	Character of bottom.
	Latitude N., Longitude W.	*C. S.*	1919.		*Meters.*	
C20030	From 24 25 00 82 58 00 To 24 23 00 82 57 00	1007	Nov. 26	4.00 p. m. to 5.40 p. m.	87	wh. M.
C20031	24 23 00 82 21 00	1007	...do.....	10.00 p. m. to 11.23 p. m.	72	.....do.
C20032	24 24 30 81 33 30	1007	Dec. 4	9.30 a. m. to 11.30 a. m.	....	bn. M.
C20033	....	....	Dec. 5	....	....	....
C20034	30 46 00 81 20 00	1007	Dec. 8	11.50 a. m. to 12.47 p. m.	13	bk. M.
C20035	From 32 10 00 79 07 00 To 32 11 00 79 04 00	1001	Dec. 9	7.50 a. m. to 1.30 p. m.	214	gn. M., S.
C20036	33 51 00 78 05 00	1001	Dec. 10	8.30 a. m. to 10.30 a. m.[a]	10	....
C20037	From 33 34 00 76 41 00 To 33 41 00 76 41 00	1001	Dec. 12	5.55 p. m. to 9.05 p. m.	210	S., Sh.
C20038	34 34 30 76 36 30	1001	Dec. 13	8.45 a. m.	16	....
C20039	From 34 25 00 75 45 30 To 34 47 30 75 17 30	1001	...do.....	5.45 p. m. to 11.10 p. m.	316	....

[a] Time approximate.

SOUTH FROM NORFOLK, 1919, AND NORTH FROM NORFOLK, 1920—Continued.

Temperature.			Salinity.		Apparatus.	Trial.		Drift.		Remarks.
Air.	Water. Depth.	Water. Temp.	Depth.	Salinity.		Depth.	Duration.	Direction.	Distance.	
°C.	Mtrs.	°C.	Mtrs.			Mtrs.	Min.		Mi.	
					El. sdr.;snap.ld.; 9' Tnr., m. b.	botm.	45	S. 35 E.	2.5	Cable out (9' Tnr.) 300 fms. (540 meters). One side of frame parted, whole frame crumpled; brought up about 3 cu. ft. white mud.
26.11	0 10 30 60	26.40 25.91 25.86 24.22	0 10 30 60	36.04 36.02 36.02 36.18	El. sdr.;snap.ld.; GB bot.; NZ; R; Tycos.					
					vert. net	60-0.				
					botm. net	50-0.	30			Cable out (botm. net) 60 meters.
					mtr. net	20-0.	30			Cable out (mtr. net) 30 meters.
					#10, #20	0	30			
					35' shr. trl	botm.				Two hauls with trawl towed by motor launch in bight below Cape Canaveral, Fla.
					do	do				Fernandina Harbor, Fla., afternoon.
23.33	0 10	17.78 18.42	0 10	33.90 34.04	El. sdr.;snap.ld.; GB bot.; NZ; R; Tycos.					
					botm. net	botm.-0	30			Cable out (botm. net) 30 meters.
					#10, #20	0	30			
23.89	0 50 100 150 200	22.70 22.46 15.56 14.28 13.21	0 50 100 150 200	36.13 36.09 36.00 35.85 35.69	El. sdr.;snap.ld.; GB bot.; NZ; R; Tycos.			Tow; N. 24 W.	6.5	
					5' Tnr	botm.	25			Cable out (5' Tnr.) 300 fms. (540 meters).
					75' fldr	botm.	120			Cable out (75' fldr.) 325 fms. (585 meters).
					#10, #20	0	45			
23.33	0 10	15.30 14.49	0 10	35.19 35.23	GB bot.; NZ; R; Tycos.			Anchored.		Temps. at ship's anchorage.
					35' shr. trl					Trawl towed from motor boat during morning.
23.33	0	21.90	0	36.31	El. sdr.;snap.ld.; Tycos.			Tow; N.	6.7	
					75' fldr	botm.	105			Cable out (75' fldr.) 325 fms. (585 meters).
20.56	0 15	14.10 13.23	0 15	32.52 32.76	GB bot.; NZ; R; Tycos.			Anchored.		Temps. taken at ship's anchorage.
					35' shr. trl					Trawl towed from motor boat during morning.
21.67	0 50 100 175 250	25.00 24.45 23.19 19.02 12.17	0 50 100 175 250	36.26 36.28 36.44 36.48 35.50	El. sdr.; snap. ld.; GB bot.; NZ; R; Tycos.			Tow and drift; N. 46 E.	31.3	Wire with bottles had angle 15°.
					75' fldr	2,00?-0.	120			Trawl showed no sign of having been on bottom; sounding at 10.30 p. m. gave 600 fms. Supposition is that first sdg. was incorrect. Cable out 325 fms. with trawl.
					# 10, #20	0	45			#20 net fouled in cable carried away.

DREDGING AND HYDROGRAPHIC RECORDS SECURED DURING ATLANTIC CRUISES.

Station number.	Bearings.		Chart.	Date.	Time of day.	Depth.	Character of bottom.
	Latitude N.,	*Longitude W.*	*C. S.*	1919.		*Meters.*	
C20040	35 16 30	75 25 00	1001	Dec. 14	9.10 a. m.	19	gy. S., M.
			H. O.	1920.			
C20041	From 37 50 00 To 37 60 00	74 06 30 74 02 00	1411	Feb. 20	2.35 a. m. to 7.12 a. m.	165	
C20042	From 39 00 00 To 39 01 00	72 56 30 72 49 30	1411	Feb. 20-21	9.35 p. m. to 1.00 a. m.	202	Sh.
C20043	From 39 36 00 To 39 34 00	72 04 30 72 00 00	1411	Feb. 21	7.18 a. m. to 10.55 a. m.	200	
C20044	40 07 00	68 03 00	1411	Feb. 22	12.25 p. m. to 5.00 p. m.	1,828	gy. M.
C20045	40 18 00	68 09 00	1411	...do...	5.45 p. m. to 7.45 p. m.	155	Sh.
C20046	40 37 30	68 20 30	1411	...do...	10.20 p. m. to 11.40 p. m.	80	
C20047	41 08 00	68 34 30	1411	Feb. 23	4.25 a. m. to 5.45 a. m.	54	S., Sh.

SOUTH FROM NORFOLK, 1919, AND NORTH FROM NORFOLK, 1920—Continued.

Temperature.			Salinity.		Apparatus.	Trial.		Drift.		Remarks.
Air.	Water. Depth.	Water. Temp.	Depth.	Salinity.		Depth.	Duration.	Direction.	Distance.	
°C.	Mtrs.	°C.	Mtrs.			Mtrs.	Min.		Mi.	
18.89	0	12.80	18	32.21	GB bot.; NZ; R; Tycos.	....	....	Anchored.	.....	Temp. at anchorage.
	18	13.24	......	......						
0.0	0	3.05	......	......	El. sdr.; snap. ld.; GB bot.; NZ; R; Tycos.	....	....	Tow; S. 88 E.	4	
	20	5.52	20	33.12						
	50	8.34	50	34.05						
	100	9.05	100	34.36	80′ fldr..........	botm...	120	....	.....	275 fms. cable out.
	150	10.20	150	34.72	#20, #6..........	0.......	60	....	.....	#6 badly torn by wind.
2.78	0	5.56	0	None.	El. sdr.; snap. ld.; GB bot.; NZ; R; Tycos.	....	....	Tow; N. 80 E.	6	
	50	6.12	20	33.45						
	20	6.37	50	33.55						
	100	9.47	100	34.43	80′ cod..........	botm...	60	....	.....	Ring on port board of trawl carried away; no catch; 275 fms. cable out.
	150	10.60	150	35.16	#6, #20..........					
	200	8.87	200	33.64						
4.44	0	5.56	......	......	El. sdr.; snap. ld.; GB bot.; NZ: R; Tycos.	....	....	Tow; S. 55 E.	4	
	20	5.61	20	33.12						
	50	8.50	50	34.20						
	100	11.45	100	35.05	80′ cod..........	botm...	120	....	.....	
	150	11.35	150	35.80	#6, #20..........	0.......	30	....	.....	
	200	9.87	200	35.21						
9.44	0	4.44	......	......	Luc. sdr.; Sigs. rod; GB bot.; NZ; R; Tycos.	....	....	....	.....	On 1st sdg. wire parted; 330 fms. wire and sdg. rod carried away. Wire bottles at 500, 1,000, 1,400, and 1,800 mtrs., angle 55°, with bottles at 50, 100, 200, and 300, angle 45°.
	50	9.76	50	34.45						
	100	12.39	100	35.18						
	200	12.39	200	35.27						
	300	10.91	300	35.32						
	500	7.24	500	35.00						
	1,000	4.21	1,000	34.90						
	1,400	3.92	1,400	34.92						
	1,800	3.62	1,800	34.90						
					vert. net.........	1,200-0.	....	....	.....	
					botm. net.......	600-0...	30	....	.....	
					mtr. net.........	100-0...	30	....	.....	
					#6, #20..........	0.......	30	....	.....	
9.44	0	5.00	0	32.34	El. sdr.; snap. ld.; GB bot.; NZ; R; Tycos.	....	....	....	.....	
	20	4.59	20	32.92						
	50	9.40	50	34.42						
	100	12.35	100	35.34	vert. net.........	150-0...	....	....	.....	
	150	11.55	150	35.25	botm. net.......	....	30	....	.....	
					mtr. net.........	....	30	....	.....	
					#6, #20..........	0.......	30	....	.....	
3.89	0	5.00	0	32.34	El. sdr.; snap. ld.; GB bot.; NZ; R; Tycos.	....	....	....	.....	
	10	3.37	10	32.88						
	40	4.50	40	32.77						
	50	7.11	50	33.76	vert. net.........	50-0....	....	....	.....	
	70	8.03	70	32.63	botm. net.......	60-0....	30	....	.....	Cable out (botm. net) 100 meters.
					#6, #20..........	0.......	30	....	.....	
2.78	0	4.44	0	32.39	El. sdr.; snap. ld.; Tycos; GB bot.	....	....	....	.....	At this and all succeeding stations in Gulf of Maine and en route to Baltimore sounded with sinker at end of ¼″ wire (st'b'd. winch). Therms. were inadvertently reversed (by whom could not be ascertained) before readings were recorded.
	......	......	20	32.38						
	......	......	50	32.47						
					vert. net.........	50-0....	....	....	.....	
					botm. net.......	botm...	30	....	.....	Botm. net full of sand.
					#6, #20..........	0.......	30	....	.....	

DREDGING AND HYDROGRAPHIC RECORDS SECURED DURING ATLANTIC CRUISES,

Station number.	Bearings.		Chart.	Date.	Time of day.	Depth.	Character of bottom.
	Latitude N.	*Longitude W.*	*H. O.*	1920.		*Meters.*	
C20048	41 41 00	68 49 00	1411	Feb. 23	10.45 a. m. to 12.35 p. m.	170	gy. M
C20049	42 30 00	69 34 30	1411	...do....	10.00 p. m. to 11.45 p. m.	242	...do...
C20050	42 30 00	70 18 00	941	Mar. 1	2.33 p. m. to 4.20 p. m.	176	
C20051	42 30 30	70 08 30	941	Mar. 1-2	7.00 p. m. to 7.30 a. m.	79	
					7.15 p. m.		
					7.45 p. m.		
					8.20 p. m.		
					8.50 p. m.		
					9.30 p. m.		
					10.05 p. m.		
					10.35 p. m.		
					11.00 p. m.		
					11.30 p. m.		
					12.05 a. m.		
					12.30 a. m.		
					1.02 a. m.		
					1.55 a. m.		
					2.20 a. m.		
					3.00 a. m.		
					3.20 a. m.		
					4.20 a. m.		
					4.40 a. m.		
					5.10 a. m.		
					5.45 a. m.		
					6.13 a. m.		
					6.45 a. m.		
					7.15 a. m.		
C20052	42 43 00	68 41 00	941	Mar. 2	6.15 p. m. to 9.30 p. m.	210	
C20053	42 45 00	67 28 00	941	Mar. 3	5.00 a. m. to 7.15 a. m.	235	

SOUTH FROM NORFOLK, 1919, AND NORTH FROM NORFOLK, 1920—Continued.

Temperature.			Salinity.		Apparatus.	Trial.		Drift.		Remarks.
	Water.									
Air.	Depth.	Temp.	Depth.	Salinity.		Depth.	Duration.	Direction.	Distance.	
°C.	M.	°C.	M.			M.	Min.		Mi.	
2.22	0	3.33	0	32.47	El. sdr.; snap.					
	20	3.48	20	32.47	ld.; GB bot.;					
	50	3.49	50	32.47	NZ; R; Tycos.					
	75	3.55	75	32.43	vert. net	170-0				
	100	3.54	100	32.49	botm. net		30			
	150	4.87	150	32.97	mtr. net		30			
					#10, #20	0	30			
2.78	0	3.33	0	32.52	El. sdr.; snap.					
	20	2.79	20	32.51	ld.; GB bot.;					
	50	2.79	50	32.52	NZ; R; Tycos.					
	100	3.04	100	32.54	vert. net	200-0				
	150	5.66	150	33.40	botm. net	200-0	30			Cable out (botm. net) 300 m.
	200	5.63	200	33.78						
					mtr. net	50-0	30			Cable out (mtr. net) 150 m.; net carried away.
					#10, #20	0	30			
6.7	0	2.50	0	32.35	GB bot.; NZ;					
	20	1.95	20	32.34	Tycos.					
	40	1.89	40	32.36	vert. net	150-0	2			
	100	1.52	100	32.34	mtr. net	75-0	30			Cable out 150 meters, angle 60°-80°.
	150	1.68	150	32.39						
					#10, #20	0	30	Anchored. *Current.*		
					Ek. mtr					For this station the "direction" is magnetic and that from which current flows; "distance" is velocity of current in miles per hour.
						5	13.0	ENE	0.5	
						50	12.8	W	0.5	
						5	15.6	SW	0.97	
						50	13.06	SW	1.10	
						5	11.8	WNW	1.10	
						50	11.7	W by S	1.30	
						5	11.2	NW	0.70	
						50	11.3	NW	0.70	
						5	10.5	NW	1.20	
						50	11.4	NW	0.70	
						5	11.0	NW	0.50	
						50	11.3	NW	0.60	
						5	11.5	?	0.60	
						50	11.5	E	0.60	
						5	10.5	E	0.70	
						50	11.8	NE by E	0.60	
						5	11.0	ENE	0.50	
						5	11.5	NE	0.50	
						50	11.3	ESE	0.60	
						5	11.0	ENE	0.50	
						50	11.1	ESE	0.50	
						5	10.3	NE	0.60	
						50	10.6	SE	0.50	
−3.3	0	2.62	0	32.49	GB bot.; NZ; R.					
	20	2.24	20	32.52	vert. net	200-0	5			
	40	2.48	40	32.52	clsg. net	170	30			Cable out (clsg. net) 200 meters; successful haul.
	100	2.47	100	32.52						
	150	3.60	150	32.66						
	200	5.24	200	33.44	mtr. net					Mtr. net carried away; cable out 125 meters.
					#20, #10	0	30			
					#10	100-0				
0.0	0	2.78	0	32.54	GB bot.; NZ;					
	20	2.20	20	32.59	Tycos.					
	40	2.34	40	32.57	vert. net	225-0				
	100	2.28	100	32.61	clsg. net	225	30			Cable out 250 meters.
	150	4.96	150	33.87						
	225	5.39	225	34.36	#20, #10	0	30			
					clsg. net	75	20			
					#10	0	15			

DREDGING AND HYDROGRAPHIC RECORDS SECURED DURING ATLANTIC CRUISES,

Station number.	Bearings.		Chart.	Date.	Time of day.	Depth.	Character of bottom.
	Latitude N.	*Longitude W.*	*H. O.*	1920.		*Meters.*	
C20054	43 15 00	67 45 00	941	Mar. 3	11.10 a. m. to 2.10 p. m.	260	gy. M............
C20055	43 42 00	67 55 00	941	Mar. 3	5.54 p. m. to 7.30 p. m.	230	....
C20056	44 05 00	68 08 00	941	...do.....	10.45 p. m. to 12.00 m.	100	....
C20057	43 21 00	68 58 00	941	Mar. 4	7.15 a. m. to 8.30 a. m.	130	gy. M............
C20058	43 41 00	69 38 00	941	...do.....	1.10 p. m. to 2.18 p. m.	50	S., Sh............
C20059	43 25 00	70 12 00	941	...do.....	6.00 p. m. to 7.05 p. m.	95	gy. gn. M. and S..
C20060	43 02 00	70 27 00	941	...do.....	10.30 p. m. to 12.00 m.	98	gy. M............
C20061	43 00 00	70 11 00	941	Mar. 5	1.30 a. m. to 3.00 a. m.	175	.....do............
C20062	42 26 00	70 42 30	941	...do.....	8.30 a. m. to 9.50 a. m.	50	bn. M., Sh........
....	42 20 00	70 40 00	....	Mar. 10	....	0	....
....	42 17 00	70 07 00	....	...do.....	....	0	....
....	42 12 00	69 06 00	....	...do.....	....	0	....
C20063	42 06 00	68 10 00	941	Mar. 11	1.30 a. m. to 3.40 a. m.	205	gy. M............

SOUTH FROM NORFOLK, 1919, AND NORTH FROM NORFOLK, 1920—Continued.

Temperature.			Salinity.		Apparatus.	Trial.		Drift.		Remarks.
	Water.									
Air.	Depth.	Temp.	Depth.	Salinity.		Depth.	Duration.	Direction.	Distance.	
°C.	M.	°C.	M.			M.	Min.		Mi.	
3.9	0	2.50	0	32.41	GB bot.; NZ; Tycos.					Clsg. net sent down, but failed to open. No sample at 250 m. Sample taken later at 225.
	20	1.84	20	32.39						
	40	1.84	40	32.39						
	100	1.77	100	32.41						
	175	5.40	175	33.75						
	250	5.48	225	34.00						
					vert. net	250-0				
					#20, #10	0	30			
					#10	100-0	25			Cable out 150 m.
3.9	0	2.50	0	32.38	GB bot.; NZ; Tycos.					
	20	1.85	20	32.39						
	40	1.82	40	32.41	vert. net	225-0				
	100	4.39	100	33.16	clsg. net	175	30			Cable out 210 meters.
	150	5.46	150	33.77						
	220	5.59	220	33.91	#20, #10	0	30			
3.3	0	1.15	0	32.21	GB bot.; NZ; Tycos.					
	20	.50	......	......						
	40	.49	......	......	vert. net	100-0				
	100	1.95	......	......	clsg. net, open	75-0	30			Open haul with clsg net.
					#20, #10	0	30			
4.4	0	2.22	0	32.39	GB bot.; NZ, Tycos.					
	20	1.91	20	32.40						
	40	1.91	40	32.41	vert. net	120-0	3			
	75	1.89	75	32.41	clsg. net, open	75-0	30			Do.
	125	2.00	125	32.43	#20, #10	0	30			
6.1	0	1.39	0	31.31	GB bot.; NZ; Tycos.					
	15	.68	15	32.00						
	45	1.43	45	32.34	vert. net	45-0				
					clsg. net, open	30-0	30			Open haul with clsg net. Cable out 45 meters.
					#20, #10	0	30			
5.6	0	1.11	0	32.09	GB bot.; NZ; Tycos.					
	20	.47	20	32.10						
	40	.61	......	......	vert. net	90-0				
	90	2.33	90	32.32	clsg. net, open	60-0	30			Open haul with clsg net.
					#20, #10	0	30			
5.6	0	1.39	0	32.28	GB bot.; NZ; Tycos.					
	20	1.25	20	32.27						
	40	1.28	40	32.30	vert. net	90-0	3			
	90	1.15	90	32.30	clsg. net, open	90-0	30			Do.
					#20, #10	0	30			
6.1	0	1.30	......	......	GB bot.; NZ; Tycos.					Deepest temp. repeated as check.
	20	.85	20	32.17						
	40	1.33	40	32.34	vert. net	175-0				
	100	1.96	100	32.41	clsg. net, open	100-0	30			
	165	4.29	......	......	#20, #10	0	35			
	175	4.26	175	32.91						
6.1	0	.78	0	32.14	GB bot.; NZ; Tycos.					
	20	.55	......	......						
	50	.33	50	32.16	vert. net	50-0				
					clsg. net, open	30-0	30			Open haul with clsg net. Cable out 40 meters.
					#20	0	15			
					#10	0	30			
......	0	1.1	0	32.00						
......	0	2.2	0	32.43						
......	0	2.2	0	32.65						
7.2	0	3.61	0	32.61	GB bot.; NZ; Tycos.					Alkalinity: Surf. and 190 meters, 7.9
	15	3.49	15	32.59						
	35	3.09	35	32.66						
	95	3.05	95	32.63	vert. net	190-0				
	140	4.30	140	33.16	clsg. net	190	25			Cable out (clsg. net) 200 meters, angle 20°, touched bottom.
	190	4.63	190	34.61						
	190	4.65	......	......						
					#20, #10	0	45			

DREDGING AND HYDROGRAPHIC RECORDS SECURED DURING ATLANTIC CRUISES;

Station number.	Bearings.		Chart.	Date.	Time of day.	Depth.	Character of bottom.
	Latitude N.	*Longitude W.*	*H. O.*	1920.		*Meters.*	
C20064	42 20 00	67 13 00	941	Mar. 11	10.00 a. m. to 12.40 p. m.	315	gn. M............
C20065	41 55 00	66 53 00	941	...do.....	5.15 p. m. to 6.25 p. m.	80	....
C20066	41 34 00	66 45 00	941	...do.....	9.00 p. m. to 12.00 m.	75	....
C20067	41 15 00	66 31 00	941	Mar. 12	2.55 a. m. to 4.15 a. m.	95	....
C20068	41 02 00	66 20 00	941	...do.....	7.45 a. m. to 9.00 a. m.	191	....
C20069	40 47 00	66 08 00	941	...do.....	11.30 a. m. to 2.05 p. m.	1,000	....
C20070	42 03 00	66 15 00	941	Mar. 13	2.00 a. m. to 3.09 a. m.	....	....
C20071	42 19 00	66 02 00	941	Mar. 13	5.00 a. m. to 6.30 a. m.	225	....
C20072	42 36 00	65 50 00	941	...do.....	8.20 a. m. to 9.30 a. m.	91	....
C20073	43 30 00	65 06 00	941	Mar. 17	12.57 p. m. to 2.20 p. m.	75	....

SOUTH FROM NORFOLK, 1919, AND NORTH FROM NORFOLK, 1920—Continued.

Temperature.			Salinity.		Apparatus	Trial.		Drift.		Remarks.
	Water.									
Air.	Depth.	Temp.	Depth.	Salinity.		Depth.	Duration.	Direction.	Distance.	
°C.	M.	°C.	M.			M.	Min.		Mi.	
8.9	0	3.50	0	32.84	GB bot.; NZ; Tycos.					Alkalinity: Surf., 7.9; 330 meters, 8.0.
	20	2.80	20	32.83						
	40	2.78	40	32.84						
	100	3.18	100	32.95	vert. net	340-0				
	150	4.26	150	33.66	clsg. net	165	30			
	200	4.32	200	34.69	#20, #10	0	30			
	265	4.24	265	34.76	clsg. net, open	125-0	20			Open haul with clsg. net.
	330	4.02	330	34.78						
8.3	0	3.61	0	32.63	GB bot.; NZ; Tycos.					Alkalinity: Surf. and 180 meters, 7.9.
	20	2.97	220	32.66						
	40	2.95	40	32.65						
	80	2.73	80	32.69	vert. net	80-0				
					mtr. net	40-0	30			Cable out (mtr. net) 75 meters, angle 40-45°.
					#20, #10	0	30			
8.3	0	3.33	0	32.57	GB bot.; NZ; Tycos.					Alkalinity: Surf. and 70 meters, 7.9.
	20	2.78	20	32.61						
	40	2.73	40	32.61						
	70	2.53	70	32.59	vert. net	70-0				
					mtr. net	60-0	30			Cable out (mtr. net) 70 meters.
					#20, #10	0	30			
					80' cod	botm.	60			Several ripe haddock taken.
8.3	0	3.05	0	32.68	GB bot.; NZ; Tycos.					Alkalinity: Surf. and 90 meters, 7.9.
	20	3.07	20	32.68						
	40	2.83	40	32.75						
	90	2.80	90	32.79	vert. net	90-0				
					mtr. net	50-0	35			Cable out 90 meters.
					#20, #10	0	40			
9.4	0	3.33	0	32.65	GB bot.; NZ; Tycos.					Alkalinity: Surf. 150, and 190 meters, 7.9.
	20	2.90	20	32.66						
	40	2.92	40	32.66						
	100	3.56	100	32.83	vert. net	150-0				
	150	4.40	150	33.86	mtr. net		30			Cable out 150 meters.
	190	4.92	190	34.23						
					#20, #10	0	30			
11.1	0	3.33			GB bot.; NZ; R; Tycos.					Alkalinity: Surf., and 1,000 meters, 7.9.
	50	3.11	50	32.79						
	100	7.09	100	33.86						Open haul with clsg. net.
	150	7.01	150	34.63	clsg. net, open	1,000-0				
	200	5.92	200	34.67						
	300	4.73	300	34.67	mtr. net	500-0	30			
	400	4.32	400	34.71	#20, #10	0	30			
	500	4.26	500	34.81						Between stations 20069 and 20070, Mar. 12, at 7.00-7.20 p. m., towed #10, ship slowed down.
	1,000	3.77	1,000	34.92						
9.4	0	3.05	0	32.66	GB bot.; NZ; Tycos.					Sea too rough to risk large nets.
	20	2.78	20	32.67						
	40	2.74	40	32.66	#20, #10	0	30			
	90	2.59	90	32.70						
10.0	0	3.33	0	32.81	GB bot.; NZ; R; Tycos.					
	20	2.90	20	32.83						
	40	3.15	40	32.86	vert. net	150-0				
	100	6.48	100	34.29	#20, #10	0	30			
	150	6.85	150	34.42						
	215	6.84	215	34.70						
9.4	0	1.95	0	32.32	GB bot.; NZ; R; Tycos.					Sea too rough to risk townets. Alkalinity: Surf., 7.95; 90 meters, 8.1.
	20	1.88	20	32.34						
	40	2.14	40	32.57						
	90	3.40	90	33.02						
					vert. net	75-0				
11.1	0	2.22	0	32.44	GB bot.; NZ; R; Tycos.					Alkalinity: Surf., 7.9.
	20	2.10	20	32.43						
	40	2.10	40	32.48	vert. net	70-0				
	70	2.52	70	32.71	#20, #10	0	30			
					#10	70-0	30			

DREDGING AND HYDROGRAPHIC RECORDS SECURED DURING ATLANTIC CRUISES,

Station number.	Bearings.	Chart.	Date.	Time of day.	Depth.	Character of bottom.
	Latitude N., Longitude W.	*H. O.*	1920.		*Meters.*	
C20074	43 18 00 64 58 00	941	Mar. 19	10.00 a. m. to 11.28 a. m.	160	....
C20075	42 55 00 64 36 00	941	...do.....	2.28 p. m. to 3.47 p. m.	95	....
C20076	42 33 00 64 30 00	941	...do.....	6.26 p. m. to 8.19 p. m.	250	....
C20077	42 24 00 64 19 00	941	Mar. 19-20.	9.50 p. m. to 12.30 a. m.	0 / 1000	....
C20078	42 58 00 65 48 00	941	Mar. 20	8.39 a. m. to 9.50 a. m.	170	....
C20079	44 21 00 66 37 00	941	Mar. 22	12.35 p. m. to 2.55 p. m.	210	rd. C........
C20080	44 21 00 67 37 00	941	...do.....	8.15 p. m. to 9.14 p. m.	61	....
C20081	44 08 00 67 26 00	941	Mar. 22-23.	11.10 p. m. to 1.15 a. m.	206	....
C20082	43 54 00 66 53 00	941	Mar. 23	4.50 a. m. to 6.13 a. m.	125	....
C20083	43 41 00 66 21 00	941	...do.....	9.00 a. m. to 10.07 a. m.	68	....

SOUTH FROM NORFOLK, 1919, AND NORTH FROM NORFOLK, 1920—Continued.

Temperature.			Salinity.		Apparatus.	Trial.		Drift.		Remarks.
Air.	Water. Depth.	Water. Temp.	Depth.	Salinity.		Depth.	Duration.	Direction.	Distance.	
°C.	M.	°C.	M.			M.	Min.		Mi.	
3.9	0	1.39	0	32.09	GB bot.; NZ; R; Tycos.					Alkalinity: Surf. and 150 meters, 7.9.
	20	1.24	20	32.07						
	40	1.10	40	32.07						
	100	2.86	100	32.94	vert. net	150–0				
	150	4.68	150	33.69	mtr. net	125–0	30			Cable out 160 meters, angle 40°.
					#20, #10	0	30			
3.9	0	0.56	0	31.80	GB bot.; NZ; R; Tycos.					Alkalinity: Surf. and 90 meters, 8.0.
	20	0.27	20	31.83						
	40	0.45	40	31.82						
	90	3.76	90	33.21	vert. net					Angle 20°.
					mtr. net	90–0				Cable out 100 meters, angle 40°.
					#20, #10	80–0	30			
2.8	0	1.28	0	32.06	GB bot.; NZ; R. Tycos.	0	30			
	20	0.99	20	32.08						
	40	1.20	40	32.20	vert. net	250–0				
	100	7.39	......	......	clsg. net, open	120–0	30			Open haul; cable out 240 meters, angle 65°.
	150	8.61	150	34.34						
	200	8.92	200	34.70						
	250	6.20	250	34.65	mtr. net	70–0	30			Cable out 140 meters, angle 65°.
		5.28								
		5.53			#20		30			
5.0	0	1.67	0	32.16	GB bot.; NZ; R; Tycos.					
	40	1.29	40	32.19						
	100	5.82	100	33.78	clsg. net, open	800–0	30			Open haul with clsg. net, cable out 1,500 meters, angle 60°.
	150	6.05	150	34.88						
	200	7.89	200	34.85						
	300	6.32	300	34.85						
	500	4.23	500	34.83	mtr. net	500–0	30			Cable out 1,000 meters, angle 60°.
	1,000	3.90	1,000	34.88						
					#20, #10	0	30			
2.2	0	1.95	0	32.45	GB bot.; NZ; Tycos.					Alkalinity: Surf., 8.0.
	20	1.82	20	32.45						
	40	2.12	40	32.43	#10	110–0	30			
	100	2.67	100	32.72	#20, #10	0	30			
	165	4.59	165	33.58						
7.78	0	2.50	0	32.56	GB bot.; NZ; R; Tycos.					
	20	2.14	20	32.54						
	40	2.17	40	32.53	vert. net	210–0				
	100	2.55	100	32.70	clsg. net	170	25			Cable out 200 meters, angle 20°.
	150	3.32	150	33.01						
	200	4.29	200	33.31	#20, #10	0	45			
					clsg. net, open	180–0	30			Open haul; cable out 200 meters, angle 20-30°.
5.56	0	1.39	0	32.05	GB bot.; NZ; Tycos.					
	30	1.26	30	32.16						
	60	1.43	60	32.25	vert. net	60–0				
					mtr. net	30–0	30			Cable out 50 meters, angle 40°.
					#20, #10	0	30			
5.56	0	1.95	0	32.32	GB bot.; NZ; R; Tycos.					
	20	1.76	20	32.32						
	40	1.63	40	32.36	vert. net	200–0				
	100	2.26	100	32.59	clsg. net	170	30			Cable out 200 meters, angle 30-45°.
	150	5.07	150	33.67						
	200	5.39	200	33.84						
					#20, #10	0	35			
					mtr. net	160–0	30			Cable out 200 meters, angle 40°.
6.67	0	2.67	0	32.59	GB bot.; NZ; R; Tycos.					Alkalinity: Surf., 7.9.
	20	2.35	20	32.61						
	50	2.52	50	32.72	vert. net	120–0				
	120	3.35	120	33.15	mtr. net	70–0	30			Cable out 110 meters, angle 40°.
					#20, #10	0	30			
7.22	0	1.95	0	32.17	GB bot.; NZ; R; Tycos.					Alkalinity: Surf., 7.9.
	20	1.54	20	32.18						
	40	1.54	40	32.22	vert. net	65–0				
	65	2.04	65	32.54	mtr. net	30–0	25			Cable out 40 meters, angle 20-40°.
					#20, #10	0	35			

DREDGING AND HYDROGRAPHIC RECORDS SECURED DURING ATLANTIC CRUISES,

Station number.	Bearings.		Chart.	Date.	Time of day.	Depth.	Character of bottom.
	Latitude N.	*Longitude W.*	*C. S.*	1920.		*Meters.*	
C20084	43 18 00	66 09 00	1106	Mar. 23	2.00 p. m. to 3.00 p. m.	55	....
C20085	43 17 00	66 33 00	1106	...do.....	5.15 p. m. to 6.08 p. m.	70	....
C20086	43 10 30	67 12 00	1106	...do.....	9.30 p. m. to 11.20 p. m.	176	....
C20087	42 37 00	69 27 00	1106	Mar. 24	3.50 p. m. to 5.30 p. m.	255	gy. M.............
C20088	42 15 00	69 54 00	1106	Mar. 24	9.40 p. m. to 11.00 p. m.	180	....
C20089	42 26 00	70 42 30	1106	Apr. 6	3.17 p. m. to 4.25 p. m.	60	....
C20090	42 30 00	70 19 00	1106	Apr. 9	10.15 a. m. to 11.55 a. m.	134	....
C20091	42 43 00	70 22 00	1106	...do.....	1.50 p. m. to 2.55 p. m.	60	....
C20092	42 49 00	70 37 00	1106	...do.....	5.03 p. m. to 7.45 p. m.	85	....
C20093	42 57 00	70 07 30	1106	...do.....	10.30 p. m. to 11.50 p. m.	167	....
C20094	43 08 00	69 39 30	1106	Apr. 10	3.00 a. m. to 4.15 a. m.	98	....

SOUTH FROM NORFOLK, 1919, AND NORTH FROM NORFOLK, 1920—Continued.

Temperature.			Salinity.		Apparatus.	Trial.		Drift.		Remarks.
Air.	Water. Depth.	Water. Temp.	Depth.	Salinity.		Depth.	Duration.	Direction.	Distance.	
°C.	M.	°C.	M.			M.	Min.		Mi.	
8.33	0 20 50	2.11 1.74 1.81	0 20 50	32.16 32.16 32.23	GB bot.; NZ; R; Tycos.	....	....	....	....	
					vert. net........	50-0....	....	....	....	
					mtr. net........	40-0....	30	....	....	Cable out 50 meters, angle 20-40°.
					#20, #10........	0.......	30	....	....	Alkalinity: Surf., 7.9.
8.89	0 30 70	2.50 2.40 2.48	...... 30 70	...... 32.63 32.63	GB bot.; NZ; R; Tycos.	....	....	....	....	
					mtr. net........	60-0....	30	....	....	Cable out 70 meters, angle 30°.
					#20, #10........	0.......	30	....	....	
8.33	0 20 40 100 170	3.61 3.40 3.39 4.29 5.01	...... 20 40 100 170	...... 33.10 33.10 33.63 34.00	GB bot.; NZ; R; Tycos.	....	....	....	....	
					vert. net........	170-0...	....	....	....	
					mtr. net........	150-0...	30	....	....	Cable out 170 meters, angle 30°.
					#20, #10........	0.......	35	....	....	Alkalinity: Surf. and 250 meters, 7.9.
11.67	0 20 40 100 150 200 250	3.05 2.74 2.74 2.80 5.87 5.39 5.06	0 20 40 100 150 200 250	32.49 32.56 32.54 32.63 33.53 34.05 34.22	GB bot.; NZ; R; Tycos.	....	....	....	....	
					vert. net........	250-0...	....	....	....	
					mtr. net........	200-0...	30	....	....	Cable out 250 meters, angle 35°.
					clsg. net........	105.....	30	....	....	Cable out 125 meters, angle 35°.
					#20, #10........	0.......	35	....	....	
8.33	0 20 40 100 180	2.50 2.20 2.20 3.61 4.97	0 20 40 100 180	32.86 32.39 32.44 32.92 33.58	GB bot.; NZ; R; Tycos.	....	....	....	....	
					vert. net........	160-0...	....	....	....	Cable out 150 meters, angle 35°.
					mtr. net........	125-0...	30	....	....	
					#20, #10........	0.......	30	....	....	Alkalinity: Surf., 7.95.
5.56	0 10 25 60	3.05 2.39 2.31 1.49	0 10 25 60	31.25 31.26 31.80 32.31	GB bot.; NZ; Tycos.	....	....	....	....	
					vert. net........	60-0....	....	....	....	
					mtr. net........	50-0....	30	....	....	Cable out 60 meters, angle 30°.
					#20, #10........	0.......	30	....	....	Alkalinity: Surf. and 120 meters, 7.9.
4.4	0 10 30 90 120	3.33 2.50 2.42 2.34 2.25	0 10 30 90 120	32.36 32.34 32.34 32.47 32.48	GB bot.: NZ; R; Tycos.	....	....	....	....	
					vert. net........	120-0...	....	....	....	
					clsg. net........	60......	30	....	....	Cable out 75 meters, angle 35°.
					#20, mtr. net.....	0.......	30	....	....	Alkalinity: Surf., 8.0.
6.1	0 20 60	3.33 2.48 2.50	0 20 60	31.97 32.08 32.45	GB bot.; NZ; R; Tycos.	....	....	....	....	
					mtr. net........	30-0....	30	....	....	Cable out 40 meters, angle 40°.
					#20, mtr. net.....	0.......	35	....	....	Alkalinity: Surf., 7.95.
5.6	0 20 40 80	3.05 1.94 2.46 2.35	0	31.01	GB bot.; NZ; Tycos.	....	....	....	....	
					vert. net........	80-0....	....	....	....	
					75′ fldr........	botm...	90	....	....	Cable out 270 meters.
					#20, mtr. net.....	0.......	50	....	....	Mtr. net full of trash, was out over again.
3.9	0 20 40 100 160	3.05 2.42 2.26 3.59 4.29	0 20 40 100 160	31.92 32.02 32.35 32.81 33.10	GB bot.; NZ; R.; Tycos.	....	....	....	....	
					vert. net........	160-0...	....	....	....	
					mtr. net........	125-0...	30	....	....	Cable out 150 meters, angle 30°.
					#20, mtr. net.....	0.......	35	....	....	
3.9	0 20 40 90	2.78 2.34 2.46 2.82	0 20 40 90	32.16 32.17 32.41 32.56	GB bot.; NZ; Tycos.	....	....	....	....	
					vert. net........	90-0....	....	....	....	
					mtr. net........	55-0....	30	....	....	Cable out 70 meters, angle 35°.
					#20, #10........	0.......	30	....	....	

DREDGING AND HYDROGRAPHIC RECORDS SECURED DURING ATLANTIC CRUISES,

Station number.	Bearings.		Chart.	Date.	Time of day.	Depth.	Character of bottom.
	Latitude N.	*Longitude W.*	*C. S.*	1920.		*Meters.*	
C20095	43 25 00	70 12 00	1106	Apr. 10	7.45 a. m. to 8.55 a. m.	93	....
C20096	43 40 00	69 37 00	1106	...do.....	12.20 p. m. to 1.35 p. m.	80	....
C20097	43 19 00	68 54 30	1106	Apr. 10-11.	11.00 p. m. to 12.25 a. m.	130	....
C20098	43 42 30	67 55 00	1106	Apr. 11	7.00 a. m. to 9.30 a. m.	216	....
C20099	44 15 00	67 53 00	1106	Apr. 12	12.50 p. m. to 1.55 p. m.	73	....
C20100	44 09 00	67 26 00	1106	...do.....	4.25 p. m. to 6.00 p. m.	230	....
C20101	43 53 00	66 51 00	1106	...do.....	9.30 p. m. to 10.45 p. m.	150	....
C20102	43 42 00	66 21 00	1106	Apr. 13	2.15 a. m. to 3.20 a. m.	66	....
C20103	43 20 00	66 36 00	1106	Apr. 15	1.00 p. m. to 2.00 p. m.	92	....
C20104	43 13 00	65 59 00	1106	...do.....	6.00 p. m. to 7.00 p. m.	46	....
C20105	42 58 00	65 58 00	1106	...do.....	9.12 p. m. to 10.35 p. m.	134	....

SOUTH FROM NORFOLK, 1919, AND NORTH FROM NORFOLK, 1920—Continued.

Temperature.			Salinity.		Apparatus.	Trial.		Drift.		Remarks.
	Water.									
Air.	Depth.	Temp.	Depth.	Salinity.		Depth.	Duration.	Direction.	Distance.	
°C.	M.	°C.	M.			M.	Min.		Mi.	
5.0	0	3.05	0	30.07	GB bot.; NZ; Tycos.					Alkalinity: Surf., 8.0.
	20	2.71								
	40	2.25	40	32.50	vert. net	90-0				
	90	2.22			mtr. net	55-0	30			Cable out 70 meters, angle 40°.
					#20, #10	0	30			
12.2	0	2.78	0	29.94	GB bot.; NZ; Tycos.					Alkalinity: Surf., 8.0.
	20	2.02	20	31.60						
	60	2.39	60	32.41	vert. net	80-0				
					mtr. net	35-0	30			Cable out 45 meters, angle 30°.
					#20, mtr. net	0	30			
4.4	0	3.33	0	32.43	GB bot.; NZ; R; Tycos.					
	20	2.40	20	32.43						
	40	2.13			vert. net	130-0				
	100	3.46			mtr. net	80-0	30			Cable out 100 meters, angle 30°.
	125	4.51	125	33.26						
					#20, mtr. net	0	35			
6.7	0	3.05	0	32.39	GB bot.; NZ; Tycos.					Alkalinity: Surf., 7.95.
	20	2.33	20	32.44						
	40	2.53			clsg. net	125	30			Operation of net prevented by seaweed.
	100	3.53								
	150	4.91	150	33.89						
	210	5.28	210	34.22	#20, mtr. net	0	35			
					mtr. net	80-0	30			Cable out 125 meters, angle 40-60°.
10.0	0	3.61	0	31.46	GB bot.; NZ; R; Tycos.					Alkalinity: Surf., 7.9.
	20	2.23	20	31.90						
	40	2.34	40	32.38	vert. net	70-0				
	70	2.60	70	32.56	mtr. net	40-0	30			Cable out 50 meters, angle 30-40°.
					#20, mtr. net	0	30			
7.8	0	3.89	0	32.49	GB bot.; NZ; R; Tycos.					Alkalinity: Surf., 7.9.
	15	3.07	15	32.59						
	35	3.29	35	32.87	vert. net	225-0				
	95	4.50	95	33.55	clsg. net, open	115-0	30			Open haul, cable out 175 meters, angle 45°.
	145	5.06	145	33.98						
	195	5.12	195	34.06						
	225	5.14	225	34.09	mtr. net	50-0	30			Cable out 75 meters, angle 45°.
					#20, mtr. net	0	30			
7.8	0	4.28	0	32.89	GB bot.; NZ; R; Tycos.					
	20	3.39	20	32.94						
	40	3.67	40	33.03	vert. net	150-0				
	100	4.58			mtr. net	105-0	30			Cable out 130 meters, angle 35°.
	140	4.71	140	33.78						
					#20, mtr. net	0	30			
7.8	0	3.89	0	32.36	GB bot.; NZ; Tycos.					
	20	3.26								
	40	3.00	40	32.56	vert. net	60-0				
	60	2.83	60	32.56	mtr. net	35-0	30			
					#20, mtr. net	0	30			
10.6	0	3.89	0	32.74	GB bot.; NZ; R; Tycos.					Alkalinity: Surf., 7.9.
	20	3.85	20	32.72						
	40	3.44	40	32.79	vert. net	90-0				
	90	3.46	90	32.79	mtr. net	50-0	30			Cable out 60 meters, angle 25°.
					#20	0	30			Surf. mtr. net carried away.
7.8	0	3.05	0	32.32	GB bot.; NZ; R; Tycos.					Alkalinity: Surf., 7.9.
	15	2.80	15	32.34						
	45	2.83	45	32.38	vert. net	45-0				
					mtr. net	25-0	30			Cable out 30 meters, angle 40°
					#20, Helgo. net	0	30			
7.8	0	3.61	0	32.43	GB bot.; NZ; R; Tycos.					
	20	3.61	20	32.42						
	35	3.11	35	32.77	vert. net	125-0				
	95	3.16	95	32.83	mtr. net	50-0	30			Cable out 75 meters, angle 40°.
	125	3.15	125	32.84						
					#20, Helgo. net	0	30			

DREDGING AND HYDROGRAPHIC RECORDS SECURED DURING ATLANTIC CRUISES.

Station number.	Bearings.	Chart.	Date.	Time of day.	Depth.	Character of bottom.
	Latitude N., Longitude W.	*C. S.*	1920.		*Meters.*	
C20106	42 39 00 66 01 00	1106	Apr. 16	12.30 a. m. to 1.35 a. m.	83	....
C20107	42 19 00 66 02 00	1106	Apr. 16	4.36 a. m. to 5.55 a. m.	240	....
		H. O.				
C20108	41 57 00 66 05 00	941	...do.....	8.50 a. m. to 9.40 a. m.	130	....
C20109	41 17 00 66 09 00	941	...do.....	5.00 p. m. to 5.55 p.m.	150	....
C20110	41 38 00 66 26 00	941	...do.....	8.30 p. m. to 9.40 p. m.	80	....
C20111	41 58 30 66 43 00	941	Apr. 17	1.15 a. m. to 2.30 a. m.	70	....
		C. S.				
C20112	42 22 00 67 02 00	1106	...do.....	5.35 a. m. to 7.35 a. m.	290	....
C20113	42 53 00 67 37 00	1106	...do.....	1.00 p. m. to 2.30 p. m.	230	....
C20114	42 40 30 68 40 00	1106	...do.....	8.05 p. m. to 9.30 p. m.	180	....
....	42 28 00 69 17 00	1106	Apr. 18	1.00 a. m.	....	....
C20115	42 37 00 69 32 30	1106	Apr. 18	3.40 a. m. to 5.18 a. m.	290	....

SOUTH FROM NORFOLK, 1919, AND NORTH FROM NORFOLK, 1920—Continued.

Temperature.			Salinity.		Apparatus.	Trial.		Drift.		Remarks.
	Water.									
Air.	Depth.	Temp.	Depth.	Salinity.		Depth.	Duration.	Direction.	Distance.	
°C.	M.	°C.	M.			M.	Min.		Mi.	
7.2	0	3.61	0	32.72	GB bot.; NZ; R; Tycos.					
	20	3.40	20	32.74						
	40	3.35	40	32.73	vert. net	80-0				
	80	3.32	80	32.75	mtr. net	40-0	30			Cable out 50 meters, angle 35°.
					#20, Helgo. net	0	30			Alkalinity: Surf., 7.9.
8.9	0	3.33	0	32.34	GB bot.; NZ; R; Tycos.					
	20	3.10	20	32.34						
	40	3.21	40	32.56	vert. net	240-0				Cable out 200 meters, angle 50°.
	100	5.86	100	33.86	mtr. net	135-0	30			
	170	7.45	170	34.59						
	240	6.07	240	34.69	#20, Helgo. net	0	30			Alkalinity: Surf. and 130 meters, 7.9. Sea too rough for mtr. net.
10.6	0	4.17	0	32.58	GB bot.; NZ; Tycos.					
	20	3.62	20	32.59						
	50	3.08	50	32.60						
	130	3.75	130	33.05						
					vert. net	135-0				
					#20, Helgo. net	0	30			Alkalinity: Surf. and 150 meters, 7.9. Sea too rough for mtr. net.
10.0	0	4.17	0	32.65	GB bot.; NZ; Tycos.					
	20	3.63	20	32.66						
	40	3.54	40	32.65						
	100	4.22	100	33.46						
	150	6.47	150	34.52						
					vert. net	155-0				
					#20; Helgo.net	0	20			
10.0	0	3.89	0	32.67	GB bot.; NZ; Tycos.					
	20	3.54	20	32.70						
	40	3.42	40	32.69	vert. net	80-0				
	80	3.59	80	32.70	mtr. net	55-0	30			Cable out 70 meters, angle 35°.
					#20; Helgo. net	0	30			
7.8	0	4.17	0	32.60	GB bot.; NZ; Tycos.					
	20	3.62	20	32.61						
	40	3.76	40	32.61	vert. net	65-0				
	70	3.75	70	32.64	mtr. net	40-0	30			Cable out 50 meters, angle 40°.
					#20; Helgo. net	0	30			Alkalinity: Surf., 7.9.
4.4	0	3.61	0	32.54	GB bot.;NZ; R; Tycos.					
	20	3.39	20	32.52						
	40	3.26	40	32.56	vert. net	290-0				Cable out 250 meters, angle 40°.
	100	3.15	100	32.86	mtr. net	200-0	30			
	175	5.28	175	34.56						
		5.17			clsg. net, open	105-0	30			Cable out 125 meters, angle 40°.
	225	4.72	225	34.70						
		4.60			#20; Helgo. net	0	30			
	290	4.70	290	34.70						
		4.78								Alkalinity: Surf. 7.9.
7.2	0	3.33	0	32.50	GB bot.;NZ; R; Tycos.					
	20	2.88	20	32.47						
	40	2.93	40	32.48	vert. net	230-0				
	100	4.32	100	33.51	mtr. net	130-0	30			Cable out 175 meters, angle 40°.
	165	5.16	165	34.23						
	230	5.16	230	34.43	clsg. net, open	60-0	30			Cable out 75 meters, angle 40°.
					#20; Helgo. net	0	25			
6.7	0	3.33	0	32.41	GB bot.;NZ; R; Tycos.					
	20	3.28	20	32.45						
	40	2.91	40	32.43	vert. net	175-0				
	100	4.12	100	33.19	mtr. net	125-0	25			Cable out 150 meters, angle 40°.
	175	4.96	175	34.18						
					#20; Helgo. net	0	25			
					Helgo. net	0	20			Across Fippennies ledge, ship slowed down, 20 min. toow.
......	......	......	......	......						
5.6	0	3.61	0	32.45	GB bot.;NZ;R; Tycos.					
	20	3.33	20	32.48						
	40	3.20	40	32.47	vert. net	295-0				Angle 10°.
	100	3.02	100	32.80	mtr. net	200-0	30			Cable out 250 meters, angle 35°.
	150	5.88	150	33.69						
	200	6.36	200	33.93	#20 Helgo. net	0	30			
	290	4.92	290	34.34						

DREDGING AND HYDROGRAPHIC RECORDS SECURED DURING ATLANTIC CRUISES,

Station number.	Bearings.		Chart.	Date.	Time of day.	Depth.	Character of bottom.
	Latitude N.,	*Longitude W.*	*C. S.*	1920.		*Meters.*	
C20116	42 03 00	69 38 00	1106	Apr. 18	9.55 a. m. to 11.10 a. m.	200	....
C20117	42 08 30	69 58 00	1106	...do.....	1.00 p. m. to 1.55 p. m.	89	....
C20118	41 51 00	70 18 00	1208	Apr. 20	10.50 a. m. to 12.00 m.	28	....
C20119	42 18 00	70 28 00	1106	...do.....	8.20 p. m. to 9.30 p. m.	90	....
C20120	42 27 00	70 25 00	*H. O.* 941	May 4	9.20 a. m. to 2.25 p. m.	70–50	....
C20121	42 27 00	70 25 00	941	...do.....	7.30 p. m. to 9.25 p. m.	60	....
C20122	42 49 00	70 37 00	941	May 7–8	9.50 p. m. to 2.10 a. m.	85	....
C20123	42 27 30	70 43 00	*C. S.* 1107	May 16	10.20 a. m. to 11.20 a. m.	55	....

SOUTH FROM NORFOLK, 1919, AND NORTH FROM NORFOLK, 1920—Continued.

Temperature.			Salinity.		Apparatus.	Trial.		Drift.		Remarks.
	Water.									
Air.	Depth.	Temp.	Depth.	Salinity.		Depth.	Duration.	Direction.	Distance.	
°C.	M.	°C.	M.			M.	Min.		Mi.	
6.7	0	3.61	0	32.14	GB bot.; NZ; R; Tycos.	...	...	...	...	Alkalinity: Surf., 8; 195 meters, 7.9.
	20	3.60	20	32.14						
	40	3.13	40	32.16	vert. net	200-0	...	...	...	
	100	3.42	100	32.79	mtr. net	125-0	25	...	...	Cable out 150 meters, angle 40°.
	195	4.25	195	33.91						
					#20, #6	0	20	...	...	
8.3	0	3.61	0	31.87	GB bot.; NZ; R; Tycos.	...	...	...	...	Alkalinity: Surf., 8.0.
	20	3.13	20	31.86						
	40	3.00	40	32.08	vert. net	85-0	...	...	...	
	85	3.24	85	32.78	mtr. net	40-0	25	...	...	Cable out 50 meters, angle 35°.
					#20, #6	0	25	...	...	
12.8	0	4.44	0	31.55	GB bot.; NZ; R; Tycos.	...	...	...	...	Alkalinity: Surf. 8.05.
	15	3.76	15	31.52						
	28	3.46	28	31.50	mtr. net	15-0	30	...	...	Cable out 20 meters, angle 35°.
					#20, #6	0	30	...	...	
10.6	0	3.61	0	31.43	GB bot.; NZ; R; Tycos.	...	...	...	...	
	20	2.87	20	31.56						
	40	1.58	40	32.03	vert. net	90-0	...	...	...	
	90	1.78	90	32.29	mtr. net	40-0	30	...	...	Cable out 50 meters, angle 40°.
					#20, #6	0	25	...	...	
7.8	0	6.39	0	29.16	GB bot.; NZ; R; Tycos.	...	...	...	...	Owing to wind and strong current ship drifted into shoal water several times. *At this station* experiments were made on flotation of haddock eggs.
	5	6.12	5	29.11						
	10	5.88	10	29.17						
	15	5.90	15	29.18						
	20	4.67	20	29.55						
	30	4.52	30	31.13						
	50	3.96	50	31.36						
	70	2.72	...	...						
					vert. net	48-0	...	...	...	
					mtr. net	40-0	30	...	...	Cable out 45 meters, angle 40°.
					clsg. net	25	30	...	...	Cable out 30 meters, angle 40°.
					clsg. net	15-10	30	...	...	Cable out 15 meters, angle 10°.
					#20, #6	0	35	...	...	
7.8	0	5.56	0	29.08	GB bot.; NZ; Tycos.	...	...	...	...	Alkalinity: Surf. and 60 meters, 8.15.
	30	3.92	30	30.99						
	60	2.39	60	32.24						
					vert. net	55-0	...	...	...	
					mtr. net	33-0	30	...	...	Cable out 40 meters, angle 35°.
					clsg. net	17	30	...	...	Cable out 20 meters, angle 35°.
					#20, #6	0	30	...	...	
					clsg. net	10-6	30	...	...	Cable out 15 meters.
12.8	0	7.22	0	28.26	GB bot.; NZ; R; Tycos.	...	...	...	...	Alkalinity: Surf., 8.15; 85 meters, 7.9.
	5	6.54	5	28.45						
	10	5.61	10	30.59						
	15	4.42	15	31.17	vert. net	95-0	...	...	...	
	20	4.18	20	31.24	mtr. net	65-0	30	...	...	Cable out 80 meters, angle 35-45°.
	35	3.10	...	...						
	50	3.13	50	32.17						
	65	2.43	65	32.25	clsg. net	33-26	30	...	...	Cable out 40 meters, angle 35-45°.
	85	2.30	85	32.38						
					#20, #6	0	30	...	...	
					clsg. net	20	30	...	...	Cable out 20 meters, angle 20°.
					80′ cod	botm	60	...	...	Cable out 270 meters. Most of bag carried away.
20.0	0	8.89	0	29.94	GB bot.; NZ; Tycos.	...	...	...	...	Alkalinity: Surf., 8.0; 55 meters, 7.9.
	20	4.83	20	30.72						
	55	2.85	55	32.18						
					vert. net	55-0	...	...	...	
					#20	0	20	...	...	

DREDGING AND HYDROGRAPHIC RECORDS SECURED DURING ATLANTIC CRUISES,

Station number.	Bearings.		Chart.	Date.	Time of day.	Depth.	Character of bottom.
	Latitude N.	*Longitude W.*	*C. S.*	1920.		*Meters.*	
C20124	42 28 00	70 18 00	1107	May 16	1.55 p. m. to 4.25 p. m.	100	....
C20125	42 00 00	69 41 00	1107	...do.....	9.50 p. m. to 11.00 p. m.	140	....
C20126	41 38 30	69 22 00	1107	May 17	2.20 a. m. to 3.40 a. m.	160	....
C20127	41 20 00	69 05 30	1107	...do.....	6.15 a. m. to 7.40 a. m.	145	....
C20128	40 34 00	68 52 30	1107	May 17	1.30 p. m. to 4.20 p. m.	70	....
C20129	40 05 00	69 03 30	1107	...do.....	7.30 p. m. to 9.00 p. m.	170	....
C20130	37 50 00	74 08 00	1109	May 19	6.50 a. m. to 7.40 a. m.	180	....

SOUTH FROM NORFOLK, 1919; AND NORTH FROM NORFOLK, 1920—Continued.

Temperature.			Salinity.		Apparatus.	Trial.		Drift.		Remarks.
Air.	Water. Depth.	Water. Temp.	Depth.	Salinity.		Depth.	Duration.	Direction.	Distance.	
°C.	M.	°C.	M.			M.	Min.		Mi.	
18.9	0	9.72	0	29.87	GB bot.; NZ; R; Tycos.	....	....	....	....	Alkalinity: Surf., 7.9; 100 meters, 7.9.
	20	5.12	20	30.77						
	40	2.89	40	32.07						
	100	2.65	100	32.45	75' fldr. trl.	botm.	75	....	....	Cable out 270 meters, no catch.
					vert. net	100-0	....	....	....	
					mtr. net	72-0	20	....	....	Cable out 110 meters, angle 50°.
					clsg. net	40	20	....	....	Cable out 60 meters, angle 50°.
					#20; #6	0	20	....	....	Meter haul full of sand and gravel; not saved.
12.8	0	9.17	0	30.25	GB bot.; NZ; R; Tycos.	....	....	....	....	Alkalinity: Surf. and 140 meters, 7.9.
	20	5.73	20	32.07						
	40	3.78	40	32.34						
	100	3.58	100	32.92	vert. net	140-0	....	....	....	
	140	4.04	140	33.21	#6	100-0	20	....	....	Cable out 120 meters, angle 35°.
					clsg. net, open	50-0	20	....	....	Cable out 60 meters, angle 35°.
					#20; mtr. net	0	20	....	....	
12.8	0	8.33	0	31.53	GB bot.; NZ; R; Tycos.	....	....	....	....	Alkalinity: Surf. and 160 meters, 7.9.
	20	5.90	20	32.16						
	40	4.30	40	32.54						
	100	3.60	100	32.81	vert. net	155-0	....	....	....	
	160	4.10	160	33.49	#6	115-0	20	....	....	Cable out 140 meters, angle 35°.
					clsg. net, open	55-0	20	....	....	Cable out 70 meters, angle 35°.
					#20; mtr. net	0	15	....	....	
12.8	0	7.22	0	31.89	GB bot.; NZ; R; Tycos.	....	....	....	....	Alkalinity: Surf. and 145 meters, 7.9.
	20	5.75	20	32.24						
	40	4.10	......	......						
	100	3.80	100	32.88	vert. net	145-0	....	....	....	
	145	3.80	145	32.98	#6	105-0	15	....	....	Cable out 130 meters, angle 25°.
					clsg. net, open	54-0	15	....	....	Cable out 65 meters, angle 25°.
					#20; mtr. net	0	15	....	....	
14.4	0	7.78	0	32.48	GB bot.; NZ; R; Tycos.	....	....	....	....	Alkalinity: Surf. 7.9; 70 meters, 8.1.
	20	5.55	20	32.47						
	40	5.40	40	32.49						
	70	5.04	70	32.50	75' fldr	botm.	90	....	....	Cable out 270 meters; no catch.
					vert. net	70-0	....	....	....	
					#6	40-0	15	....	....	Cable out 50 meters, angle 15°.
					clsg. net, open	20-0	15	....	....	Cable out 25 meters, angle 15°.
					#20; mtr. net	0	15	....	....	
12.2	0	7.78	0	32.61	GB bot.; NZ; Tycos.	....	....	....	....	Alkalinity: Surf. and 160 meters, 7.9.
	10	7.56	10	32.61						
	30	5.28	30	32.74	vert. net	160-0	....	....	....	Drifted into shoaler water before bottles were sent down.
		5.33								
	90	7.32	90	33.84						
	160	8.28	160	34.72						
					#6	100-0	15	....	....	Cable out 150 meters, angle 40°.
					clsg. net, open	50-0	15	....	....	Cable out 75 meters, angle 40°.
					#20; mtr. net	0	15	....	....	
15.6	0	12.22	0	33.17	GB bot.; NZ; Tycos.	....	....	....	....	Alkalinity: Surf. 8.0.
	20	9.75	20	33.55						
	40	9.82	40	34.04	vert. net	180-0	....	....	....	
	100	9.48	100	34.59						
	180	9.11	......	......						

SURFACE TEMPERATURES TAKEN WHILE UNDER WAY DURING ATLANTIC CRUISES, SOUTH FROM NORFOLK, 1919, AND NORTH FROM NORFOLK, 1920.

Date.	Hour.	Latitude.	Longitude.	Temperature (°C.). Air.	Temperature (°C.). Surface.	Stations between which taken.
		° ′ ″	° ′ ″			
1919.						
Oct. 30						C20001.
	5.30 p. m.	36 49 00	75 31 00		19.7	
	6.00 p. m.	36 48 00	75 25 30	20.0	21.1	
	6.30 p. m.	36 48 00	75 21 00		19.2	
	7.00 p. m.	36 48 00	75 16 00	19.4	17.8	
	7.30 p. m.	36 47 00	75 11 00		17.8	
						C20002.
	10.00 p. m.	36 46 00	75 01 05	19.4	17.2	
	10.30 p. m.	36 46 00	74 56 00		17.8	
	11.00 p. m.	36 45 00	74 51 00	18.9	17.2	
	11.30 p. m.	36 45 40	74 45 00		17.8	
Oct. 31						C20003.
	2.00 a. m.	36 43 00	74 38 00	19.4	17.8	
						C20004.
	6.30 a. m.	36 38 30	74 29 00		18.6	
	7.00 a. m.	36 37 00	74 26 00	20.0	18.6	
	7.30 a. m.	36 35 30	74 23 30		18.9	
						C20005.
	6.00 p. m.	36 35 00	74 25 00	21.7	19.4	
	6.30 p. m.	36 32 30	74 29 00		19.4	
	7.00 p. m.	36 30 00	74 37 00	21.1	18.9	
	7.30 p. m.	36 28 00	74 35 30		19.4	
	8.00 p. m.	36 25 30	74 39 00	21.1	18.9	
	8.30 p. m.	36 23 00	74 43 00		19.4	
	9.00 p. m.	36 20 30	74 46 30	21.1	18.0	
	9.30 p. m.	36 18 00	74 50 00		18.3	
	10.00 p. m.	36 16 00	74 53 00	21.1	18.9	
	10.30 p. m.	36 13 00	74 57 00		19.4	
	11.00 p. m.	36 11 00	75 01 00	21.1	19.4	
	11.30 p. m.	36 08 00	75 04 30		19.7	
	12.00 m.	36 06 00	75 08 00	20.6	20.6	
Nov. 1	12.30 a. m.	36 03 00	75 11 30		20.6	
	1.00 a. m.	36 01 00	75 15 00	15.6	20.6	
	1.30 a. m.	35 59 00	75 18 30		20.0	
	2.00 a. m.	35 56 30	75 22 00	18.3	20.3	
	2.30 a. m.	35 53 30	75 23 00		20.6	
	3.00 a. m.	35 49 00	75 21 00	21.1	21.1	
	3.30 a. m.	35 44 00	75 19 05		21.1	
	4.00 a. m.	45 40 00	75 11 00	21.1	21.1	
	4.30 a. m.	35 36 00	75 09 00		21.1	
	5.00 a. m.	35 32 00	75 08 30	22.2	21.1	
	5.30 a. m.	35 28 00	75 16 00		21.1	
	6.00 a. m.	35 25 00	75 15 00	22.2	21.1	
	6.30 a. m.	35 21 00	75 14 00		21.7	
	7.00 a. m.	35 17 00	75 12 00	22.8	22.2	
	7.30 a. m.	35 14 00	75 12 30		27.8	
	8.00 a. m.	35 12 00	75 13 30	23.3	25.0	
	8.30 a. m.	35 09 00	75 14 30		23.3	
	9.00 a. m.	35 07 00	75 15 00	26.7	23.0	
	9.30 a. m.	35 04 30	75 16 30		23.3	
						C20006.
	11.30 a. m.	35 03 00	75 16 30		24.2	
	12.00 m.	35 02 00	75 15 00	26.1	23.9	
						C20007.
	3.30 p. m.	35 00 00	75 13 30		27.0	
	4.00 p. m.	34 59 30	75 12 20	26.7	25.3	
	4.30 p. m.	34 59 00	75 11 30		25.0	
	5.00 p. m.	34 58 00	75 10 30	26.1	27.0	
	5.30 p. m.	34 57 00	75 10 00		26.7	
	6.00 p. m.	34 56 00	75 09 00	27.8	27.0	
	6.30 p. m.	34 56 00	75 08 00		27.5	
	7.00 p. m.	34 55 00	75 07 00	26.7	26.7	
						20008.
	11.30 p. m.	34 59 00	75 03 00		28.6	
	12.00 m.	35 00 00	75 04 00	26.1	28.3	
Nov. 2	12.30 a. m.	35 00 00	75 05 20		27.5	
	1.00 a. m.	35 00 30	75 07 00	26.7	26.1	
	1.30 a. m.	35 01 00	75 08 00		26.7	
	2.00 a. m.	35 01 00	75 09 00	27.0	25.6	
	2.30 a. m.	35 02 00	75 10 00		25.0	
	3.00 a. m.	35 02 00	75 11 30	27.0	25.3	
	3.30 a. m.	35 03 00	75 13 00		25.0	
	4.00 a. m.	35 03 00	75 14 00	27.0	25.6	

SURFACE TEMPERATURES TAKEN WHILE UNDER WAY DURING ATLANTIC CRUISES, SOUTH FROM NORFOLK, 1919, AND NORTH FROM NORFOLK, 1920—Continued.

Date.	Hour.	Latitude.	Longitude.	Temperature (°C.). Air.	Temperature (°C.). Surface.	Stations between which taken.
1919.		° ′ ″	° ′ ″			
Nov. 2	4.30 a. m.	(a)	(a)		25.3	
	5.00 a. m.	(a)	(a)	27.0	25.6	
	5.30 a. m.	(a)	(a)		25.6	
	6.00 a. m.	(a)	(a)	27.0	25.3	
	6.30 a. m.	(a)	(a)		25.6	
	7.00 a. m.	(a)	(a)	27.0	25.3	
	7.30 a. m.	(a)	(a)		25.0	
	8.00 a. m.	35 02 00	75 25 00	23.9	25.0	
	8.30 a. m.	34 58 00	75 26 00		24.7	
	9.00 a. m.	34 57 00	75 29 00	24.4	25.0	
	9.30 a. m.	34 55 00	75 32 00		26.7	
	10.00 a. m.	34 53 00	75 35 00	23.9	26.7	
	10.30 a. m.	34 50 00	75 38 00		26.7	
	11.00 a. m.	34 48 00	75 41 00	23.9	26.7	
	11.30 a. m.	34 45 00	75 44 00		26.7	
	12.00 m.	34 43 00	75 47 00	23.9	26.7	
	12.30 p. m.	34 41 00	75 49 30		26.9	
	1.00 p. m.	34 38 00	75 52 30	22.2	26.7	
	1.30 p. m.	34 35 00	75 56 00		26.7	
	2.00 p. m.	34 34 30	75 58 00	21.1	26.7	
	2.30 p. m.	34 31 00	76 01 00		26.7	
	3.00 p. m.	34 29 00	75 04 00	21.1	25.8	
	3.30 p. m.	34 27 00	76 06 00		26.1	
	4.00 p. m.	34 25 00	76 10 30	20.6	26.1	
	4.30 p. m.	34 23 00	76 13 00		25.8	
	5.00 p. m.	34 21 00	76 16 00	20.0	25.3	
	5.30 p. m.	84 20 00	76 19 30		25.6	
	6.00 p. m.	34 17 00	76 22 00	20.0	24.4	
	6.30 p. m.	34 15 00	76 25 00		25.0	
	7.00 p. m.	34 13 30	76 28 30	20.0	25.3	
	7.30 p. m.	34 11 00	76 31 30		25.6	
	8.00 p. m.	34 09 00	76 34 40	20.0	23.3	
	8.30 p. m.	34 07 00	76 38 00		24.4	
	9.00 p. m.	34 04 00	76 42 00	20.6	25.3	
	9.30 p. m.	34 02 00	76 45 00		24.7	
	10.00 p. m.	33 59 00	76 48 30	20.6	24.4	
	10.30 p. m.	33 53 00	76 52 00		23.9	
	11.00 p. m.	33 54 00	76 56 00	20.0	23.6	
	11.30 p. m.	33 52 00	76 59 00		23.3	
	12.00 m.	33 49 00	77 03 00	20.0	22.2	
Nov. 3	12.30 a. m.	33 47 00	77 06 00		22.8	
	1.00 a. m.	33 44 30	77 10 00	19.4	22.5	
	1.30 a. m.	33 42 00	77 13 30		25.6	
	2.00 a. m.	33 39 30	77 17 00	19.4	23.0	
	2.30 a. m.	33 37 00	77 20 30		23.3	
	3.00 a. m.	33 34 30	77 24 00	20.0	22.8	
	3.30 a. m.	33 32 00	77 27 00		23.0	
	4.00 a. m.	33 29 00	77 32 00	20.6	22.8	
	4.30 a. m.	33 26 00	77 37 30		24.4	
	5.00 a. m.	33 24 30	77 43 00	20.6	23.3	
	5.30 a. m.	33 22 00	77 48 00		24.4	
	6.00 a. m.	33 20 00	77 53 00	20.0	24.7	
	6.30 a. m.	33 18 00	77 57 30		24.7	
	7.00 a. m.	33 16 00	78 03 00	20.6	24.4	
	7.30 a. m.	33 14 00	78 08 00		24.7	
	8.00 a. m.	33 11 30	78 13 00	21.1	25.0	
	8.30 a. m.	33 09 00	78 18 00		24.7	
	9.00 a. m.	33 07 00	78 23 00	21.1	25.3	
	9.30 a. m.	33 05 00	78 28 00		25.0	
	10.00 a. m.	33 02 30	78 33 00	21.1	24.4	
	10.30 a. m.	33 00 00	78 37 00		25.7	
	11.00 a. m.	32 58 00	78 43 00	21.1	25.3	
	11.30 a. m.	32 56 00	78 47 30		25.0	
	12.00 m.	32 54 00	78 52 00	21.1	25.0	
	12.30 p. m.	32 51 30	78 57 30		25.3	
	1.00 p. m.	32 50 00	79 03 30	22.2	24.4	
	1.30 p. m.	32 48 00	79 08 00		24.4	
	2.00 p. m.	32 46 30	79 13 00	22.2	24.7	
	2.30 p. m.	32 45 00	79 17 30		24.7	
	3.00 p. m.	32 43 00	79 23 00	22.8	25.0	
	3.30 p. m.	32 41 80	79 28 00		24.7	
	4.00 p. m.	32 40 00	79 33 00	22.8	24.7	
	4.30 p. m.	32 38 00	79 39 00		24.7	

[a] Standing on and off Diamond Shoal (Cape Hatteras).

SURFACE TEMPERATURES TAKEN WHILE UNDER WAY DURING ATLANTIC CRUISES, SOUTH FROM NORFOLK, 1919, AND NORTH FROM NORFOLK, 1920—Continued.

Date.	Hour.	Latitude.			Longitude.			Temperature (°C.).		Stations between which taken.
								Air.	Surface.	
1919.		°	′	″	°	′	″			
Nov. 3	5.00 p. m.	32	35	30	79	44	00	22.2	25.0	
	5.30 p. m.	32	33	30	79	48	00		24.4	
	6.00 p. m.	32	30	00	79	51	30	22.2	24.4	
	6.30 p. m.	32	27	30	79	55	00		24.4	
	7.00 p. m.	32	23	00	79	59	30	22.2	23.9	
	7.30 p. m.	32	20	00	80	03	00		24.2	
	8.00 p. m.	32	17	00	80	07	00	25.6	24.4	
	8.30 p. m.	32	14	00	80	11	00		23.9	
	9.00 p. m.	32	10	30	80	15	00	25.6	24.4	
	9.30 p. m.	32	07	30	80	19	00		24.4	
	10.00 p. m.	32	04	30	80	23	00	25.6	24.7	
	10.30 p. m.	32	01	00	80	25	00		24.7	
	11.00 p. m.	31	57	00	80	29	00	25.6	25.0	
	11.30 p. m.	31	53	00	80	30	00		24.7	
	12.00 m.	31	50	00	80	32	00	25.6	24.4	
Nov. 4	12.30 a. m.	31	46	30	80	34	30		25.0	
	1.00 a. m.	31	43	00	80	37	00	23.3	25.0	
	1.30 a. m.	31	40	00	80	39	00		25.0	
	2.00 a. m.	31	36	00	80	42	00	22.8	25.6	
	2.30 a. m.	31	32	30	80	44	00		25.6	
	3.00 a. m.	31	28	30	80	47	00	22.2	25.3	
	3.30 a. m.	31	25	00	80	49	30		25.6	
	4.00 a. m.	31	21	30	80	51	30	22.2	25.3	
	4.30 a. m.	31	18	00	80	54	00		25.8	
	5.00 a. m.	31	14	00	80	56	30	21.7	25.8	
	5.30 a. m.	31	09	30	80	59	00		25.8	
	6.00 a. m.	31	07	00	81	02	00	20.6	26.1	
	6.30 a. m.	31	03	00	81	04	00		26.1	
	7.00 a. m.	31	00	00	81	07	00	20.6	26.1	
	7.30 a. m.	30	56	00	81	08	00		26.4	
	8.00 a. m.	30	52	00	81	09	00	20.6	26.1	
	8.30 a. m.	30	47	00	81	11	00		26.1	
	9.00 a. m.	30	44	30	81	12	00	21.7	25.8	
	9.30 a. m.	30	40	30	81	13	30		26.1	
	10.00 a. m.	30	36	00	81	15	00	22.2	25.6	
	10.30 a. m.	30	32	30	81	17	00		26.1	
	11.00 a. m.	30	29	00	81	18	00	22.8	25.8	
	11.30 a. m.	30	25	00	81	21	00		26.7	
Nov. 9	2.00 p. m.	30	22	30	81	21	30	23.3	24.4	
	2.30 p. m.	30	18	30	81	20	00		24.4	
	3.00 p. m.	30	14	30	81	18	00	23.9	24.4	
	3.30 p. m.	30	11	00	81	17	00		25.0	
	4.00 p. m.	30	07	30	81	15	30	23.3	25.3	
	4.30 p. m.	30	04	00	81	13	30		24.2	
	5.00 p. m.	30	00	00	81	12	00	22.8	24.7	
										20009.
	6.30 p. m.	29	49	00	81	06	00		25.8	
	7.00 p. m.	29	45	30	81	04	00	22.8	25.3	
	7.30 p. m.	29	42	00	81	01	30		25.0	
	8.00 p. m.	29	38	30	80	59	30	23.3	25.0	
	8.30 p. m.	29	34	30	80	57	30		24.7	
	9.00 p. m.	29	31	30	80	55	00	23.9	25.6	
	9.30 p. m.	29	28	30	80	53	00		24.4	
	10.00 p. m.	29	25	30	80	51	30	23.3	25.0	
	10.30 p. m.	29	22	30	80	49	30		25.0	
	11.00 p. m.	29	19	30	80	47	30	23.9	25.0	
	11.30 p. m.	29	16	00	80	45	30		25.3	
	12.00 m.	29	12	30	80	43	00	23.9	25.0	
Nov. 10	12.30 a. m.	29	09	00	80	41	30		25.0	
	1.00 a. m.	29	05	00	80	39	00	26.7	25.0	
	1.30 a. m.	29	01	00	80	36	30		25.0	
	2.00 a. m.	28	58	00	80	34	30	25.0	25.0	
	2.30 a. m.	28	54	00	80	32	00		25.0	
	3.00 a. m.	28	50	30	80	30	00	25.0	25.3	
	3.30 a. m.	28	47	30	80	27	30		24.4	
	4.00 a. m.	28	44	00	80	25	00	23.9	25.0	
	4.30 a. m.	28	40	30	80	23	00		24.4	
	5.00 a. m.	28	36	30	80	21	00	22.2	24.7	
	5.30 a. m.	28	33	00	80	19	00		24.7	
	6.00 a. m.	28	30	00	80	18	30	22.8	25.3	
	6.30 a. m.	28	26	00	80	18	00		25.0	
	7.00 a. m.	28	23	00	80	17	30	22.2	25.0	
	7.30 a. m.	28	19	00	80	17	00		25.3	
	8.00 a. m.	28	15	00	80	16	00	22.2	25.0	
	8.30 a. m.	28	11	00	80	15	30		25.3	
	9.00 a. m.	28	07	00	80	15	00	25.6	25.3	

SURFACE TEMPERATURES TAKEN WHILE UNDER WAY DURING ATLANTIC CRUISES, SOUTH FROM NORFOLK, 1919, AND NORTH FROM NORFOLK, 1920—Continued.

Date.	Hour.	Latitude. °	′	″	Longitude. °	′	″	Temperature (°C.). Air.	Surface.	Stations between which taken.
1919.										
Nov. 10	9.30 a. m.	28	03	30	80	14	30	....	25.3	
	10.00 a. m.	27	59	00	80	14	00	26.1	25.0	
	10.30 a. m.	27	55	30	80	13	30	....	25.3	
	11.00 a. m.	27	51	30	80	13	00	26.7	25.8	
	11.30 a. m.	27	47	80	80	12	30	....	25.3	
	12.00 m.	27	44	00	80	12	00	26.7	25.3	
	12.30 p. m.	27	40	30	80	11	30	....	25.0	
	1.00 p. m.	27	37	30	80	11	00	26.1	25.0	
	1.30 p. m.	27	34	00	80	10	00	....	25.0	
	....	....			....			....	....	20010.
	2.30 p. m.	27	34	30	80	05	00	....	25.0	
	3.00 p. m.	27	34	00	80	00	30	27.0	26.7	
	3.30 p. m.	27	34	00	79	56	00	....	27.8	
	....	....			....			....	....	C20011.
	5.00 p. m.	27	86	30	79	52	30	27.0	26.7	
	5.30 p. m.	27	36	00	79	48	00	....	26.9	
	6.00 p. m.	27	35	30	79	43	30	26.7	26.7	
	6.30 p. m.	27	35	00	79	38	30	....	26.7	
	....	....			....			....	....	C20012.
	9.30 p. m.	27	40	30	79	32	00	25.6	27.5	
	10.00 p. m.	27	39	00	79	28	00	25.0	27.0	
	10.30 p. m.	27	88	00	79	24	30	....	27.0	
	11.00 p. m.	27	37	00	79	20	00	25.0	26.7	
	11.30 p. m.	27	35	30	79	16	00	....	26.9.	
	12.00 m.	27	34	30	79	12	00	25.0	26.7	
Nov. 11	....	....			....			....	....	20013.
	2.30 a. m.	27	34	00	79	15	30	....	27.0	
	3.00 a. m.	27	32	00	79	19	00	24.4	27.0	
	3.30 a. m.	27	29	00	79	22	30	....	27.0	
	4.00 a. m.	27	27	00	79	26	00	24.4	27.0	
	4.30 a. m.	27	24	00	79	29	30	....	25.6	
	5.00 a. m.	27	21	30	79	83	00	25.0	26.7	
	5.30 a. m.	27	19	00	79	86	00	....	26.7	
	6.00 a. m.	27	16	30	79	39	30	25.6	26.7	
	6.30 a. m.	27	13	30	79	43	00	....	26.1	
	7.00 a. m.	27	12	00	79	46	00	26.1	26.7	
	7.30 a. m.	27	09	00	79	50	00	....	26.7	
	8.00 a. m.	27	06	00	79	53	30	26.1	26.1	
	8.30 a. m.	27	03	30	79	57	00	....	26.1	
	9.00 a. m.	27	00	00	80	00	00	26.1	25.6	
	9.30 a. m.	26	56	30	80	01	00	....	26.1	
	10.00 a. m.	26	52	00	80	01	30	25.6	26.7	
	10.30 a. m.	26	47	30	80	01	30	....	26.1	
	11.00 a. m.	26	43	00	80	01	30	25.6	26.4	
	11.30 a. m.	26	39	30	80	01	30	....	26.1	
	12.00 m.	26	35	00	80	01	30	25.6	26.1	
	12.30 p. m.	26	31	00	80	02	00	....	26.7	
	1.00 p. m.	26	26	30	80	02	00	26.1	26.7	
	1.30 p. m.	26	22	30	80	02	00	....	26.7	
	2.00 p. m.	26	18	30	80	02	30	26.1	26.7	
	2.30 p. m.	26	15	00	80	02	30	....	26.4	
	3.00 p. m.	26	11	00	80	02	30	26.1	26.1	
	3.30 p. m.	26	07	00	80	03	00	....	26.7	
	4.00 p. m.	26	02	00	80	03	00	26.7	26.4	
	4.30 p. m.	25	57	30	80	03	00	....	26.7	
	5.00 p. m.	25	53	00	80	03	00	26.1	26.7	
	5.30 p. m.	25	49	00	80	03	00	....	26.1	
	6.00 p. m.	25	44	30	80	03	30	24.4	26.1	
	....	....			....			....	....	20014.
	....	....			....			....	....	C20015.
	10.30 p. m.	25	36	00	79	55	00	....	26.7	
	11.00 p. m.	25	35	00	79	51	30	23.3	26.9	
	11.30 p. m.	25	34	30	79	48	00	....	26.7	
	12.00 m.	25	34	00	79	45	00	23.3	27.0	
Nov. 12	....	....			....			....	....	C20016.
	3.30 a. m.	25	39	30	79	42	00	....	26.7	
	4.00 a. m.	25	38	00	79	38	00	25.6	26.7	
	4.30 a. m.	25	36	00	79	34	00	....	26.9	
	5.00 a. m.	25	35	00	79	30	00	25.0	26.7	
	....	....			....			....	....	C20017.
	8.30 a. m.	25	32	30	79	34	00	....	27.8	
	9.00 a. m.	25	30	30	79	38	00	27.8	27.8	
	9.30 a. m.	25	29	00	79	40	80	....	27.8	
	10.00 a. m.	25	27	30	79	43	30	28.3	28.0	
	10.30 a. m.	25	25	00	79	46	30	....	27.8	

SURFACE TEMPERATURES TAKEN WHILE UNDER WAY DURING ATLANTIC CRUISES, SOUTH FROM NORFOLK, 1919, AND NORTH FROM NORFOLK, 1920—Continued.

Date.	Hour.	Latitude.	Longitude.	Temperature (°C.).		Stations between which taken
				Air.	Surface.	
1919.		° ' "	° ' "			
Nov. 12	11.00 a. m.	25 23 30	79 50 00	29.4	27.8	
	11.30 a. m.	25 22 00	79 52 30	....	27.8	
	12.00 m.	25 20 00	79 56 00	30.0	27.5	
	12.30 p. m.	25 18 00	79 59 00	....	27.8	
	1.00 p. m.	25 16 00	80 02 00	30.0	27.5	
	1.30 p. m.	25 14 00	80 05 00	....	27.0	
	2.00 p. m.	25 12 00	80 09 00	30.0	26.7	
	2.30 p. m.	25 09 30	80 11 30	....	26.1	
	3.00 p. m.	25 06 30	80 14 00	28.8	26.1	
	3.30 p. m.	25 04 00	80 16 00	....	26.7	
	4.00 p. m.	25 01 00	80 18 30	27.0	26.4	
	4.30 p. m.	24 58 00	80 22 00	....	26.4	
	5.00 p. m.	24 55 30	80 25 30	25.6	26.1	
	5.30 p. m.	24 53 00	80 29 00	....	26.1	
	6.00 p. m.	24 50 00	80 34 00	25.6	26.7	
	6.30 p. m.	24 47 30	80 38 00	....	26.7	
	7.00 p. m.	24 45 00	80 42 00	25.6	26.7	
	7.30 p. m.	24 42 30	80 46 30	....	26.7	
	8.00 p. m.	24 40 00	80 50 30	25.6	26.4	
	8.30 p. m.	24 39 00	80 54 00	....	26.4	
	9.00 p. m.	24 38 30	80 57 30	25.6	26.4	
	9.30 p. m.	24 37 00	81 01 00	....	26.7	
	10.00 p. m.	24 36 30	81 03 00	25.6	26.7	
	10.30 p. m.	24 35 00	81 06 00	....	26.7	
	11.00 p. m.	24 34 30	81 09 00	25.6	26.7	
	11.30 p. m.	24 34 00	81 12 00	....	26.7	
	12.00 m.	24 33 00	81 15 00	25.6	26.9	
Nov. 13	12.30 a. m.	24 32 00	81 18 00	....	26.7	
	1.00 a. m.	24 31 30	81 21 00	25.6	26.4	
	1.30 a. m.	24 30 00	81 24 30	....	26.7	
	2.00 a. m.	24 29 00	81 28 00	25.6	26.7	
	2.30 a. m.	24 28 00	81 31 00	....	26.7	
	3.00 a. m.	24 29 00	81 34 30	24.4	26.7	
	3.30 a. m.	24 27 30	81 37 00	....	26.7	
	4.00 a. m.	24 26 30	81 40 00	23.3	26.7	
	4.30 a. m.	24 26 30	81 44 00	....	26.7	
	5.00 a. m.	24 25 00	81 47 30	24.4	26.7	
	5.30 a. m.	24 24 30	81 51 30	....	26.7	
Nov. 15	....	....	....	....	....	C20018.
	8.30 p. m.	24 19 00	81 57 00	25.0	26.1	
	9.00 p. m.	24 17 30	81 58 00	24.4	25.8	
	9.30 p. m.	24 12 00	82 00 00	23.9	25.8	
Nov. 15 to 16	....	....	....	....	....	C20019.
Nov. 16	1.30 a. m.	24 02 30	81 59 00	25.0	26.7	
	....	....	....	....	....	C20020.
	6.00 a. m.	23 50 00	82 03 30	25.0	27.5	
	6.30 a. m.	23 47 00	82 06 00	....	27.8	
	....	....	....	....	....	C20021.
	11.00 a. m.	23 34 30	82 10 00	27.0	28.3	
	11.30 p. m.	23 31 00	82 12 30	....	28.3	
	....	....	....	....	....	20022.
	2.30 p. m.	23 24 00	82 15 00	....	28.0	
	3.00 p. m.	23 21 00	82 16 00	27.0	28.0	
	3.30 p. m.	23 18 00	82 17 00	....	28.0	
	4.00 p. m.	23 15 30	82 18 30	27.8	28.0	
	4.30 p. m.	23 12 30	82 20 00	....	28.0	
Nov. 21	9.00 a. m.	23 12 30	82 17 00	....	27.0	
	....	....	....	....	....	C20023.
	2.30 p. m.	23 13 00	82 32 00	26.7	27.8	
	3.00 p. m.	23 12 00	82 36 00	27.8	27.0	
	3.30 p. m.	23 11 00	82 41 00	27.8	27.0	
	4.00 p. m.	23 10 00	82 45 30	27.8	27.0	
	4.30 p. m.	23 09 00	82 50 00	....	27.5	
	5.00 p. m.	23 08 00	82 54 00	27.8	27.5	
	5.30 p. m.	23 08 00	82 58 00	....	27.5	
	6.00 p. m.	23 07 00	83 03 00	27.8	27.5	
	6.30 p. m.	23 06 00	83 07 00	....	27.5	
	7.00 p. m.	23 05 00	83 11 30	26.1	26.9	
	7.30 p. m.	23 04 00	83 15 00	....	27.5	
	8.00 p. m.	23 03 00	83 19 00	25.6	27.5	
	8.30 p. m.	23 02 00	83 22 00	....	27.5	
	9.00 p. m.	23 01 00	83 25 00	26.1	27.5	
	9.30 p. m.	23 00 00	83 29 00	....	27.0	
	10.00 p. m.	22 59 00	83 32 30	25.6	27.0	
	10.30 p. m.	22 58 00	83 36 00	....	27.5	

SURFACE TEMPERATURES TAKEN WHILE UNDER WAY DURING ATLANTIC CRUISES, SOUTH FROM NORFOLK, 1919, AND NORTH FROM NORFOLK, 1920—Continued.

Date.	Hour.	Latitude.	Longitude.	Temperature (°C.). Air.	Temperature (°C.). Surface.	Stations between which taken
1919.		° ′ ″	° ′ ″			
Nov. 21	11.00 p. m.	22 57 00	83 39 00	25.0	27.0	
	11.30 p. m.	22 56 00	83 43 00		27.0	
	12.00 m.	22 54 30	83 46 30	25.0	27.0	
Nov. 22	12.30 a. m.	22 53 00	83 50 00		27.0	
	1.00 a. m.	22 52 00	83 53 00	26.7	27.0	
	1.30 a. m.	22 51 30	83 57 00		27.0	
	2.00 a. m.	22 50 00	84 00 00	25.7	27.5	
	2.30 a. m.	22 49 00	84 04 00		27.5	
	3.00 a. m.	22 48 00	84 08 30	25.6	27.0	
	3.30 a. m.	22 46 00	84 13 30		27.0	
	4.00 a. m.	22 45 00	84 17 30	26.1	26.9	
	4.30 a. m.	22 43 30	84 22 00		27.0	
	5.00 a. m.	22 40 00	84 24 00	26.1	27.0	
	5.30 a. m.	22 37 30	84 27 00		27.0	
	6.00 a. m.	22 34 00	84 30 00	25.6	27.0	
	6.30 a. m.	22 31 30	84 32 00		27.5	
	7.00 a. m.	22 28 00	84 35 00	25.6	26.9	
	7.30 a. m.	22 25 00	84 37 30		26.9	
	8.00 a. m.	22 22 00	84 40 30	25.6	27.0	
	8.30 a. m.	22 19 00	84 43 00		27.0	
	9.00 a. m.	22 15 30	84 46 00	25.6	27.0	
	9.30 a. m.	22 13 00	84 48 00		27.5	
	10.00 a. m.	22 09 00	84 51 00	25.6	26.9	
	10.30 a. m.	22 06 00	84 54 00		26.9	
	11.00 a. m.	22 03 00	84 57 00	25.6	27.0	
	11.30 a. m.	22 00 00	84 59 00		26.7	
	12.00 m.	21 56 30	85 02 30	25.6	26.7	
	12.30 p. m.	21 53 30	85 05 00		26.4	
						C20024.
	7.00 p. m.	21 49 30	85 17 00	26.7	26.7	
	7.30 p. m.	21 48 30	85 21 00		27.8	
	8.30 p. m.	21 47 00	85 28 30	26.4	27.8	
	9.00 p. m.	21 46 00	85 32 30	26.1	27.8	
	9.30 p. m.	21 45 00	85 36 30		27.8	
Nov. 22 to 23						C20025.
Nov. 23	2.30 a. m.	21 46 00	85 46 30		27.5	
	3.00 a. m.	21 43 00	85 50 00	25.5	27.5	
	3.30 a. m.	21 40 30	85 54 00		27.5	
	4.00 a. m.	21 38 00	85 57 30	25.0	27.8	
	4.30 a. m.	21 36 00	86 01 00		27.8	
	5.00 a. m.	21 33 00	86 05 00	24.4	27.8	
						C20026.
	11.00 a. m.	21 40 00	86 13 30	25.0	26.9	
	11.30 a. m.	21 39 30	86 17 30		26.9	
	12.00 m.	21 39 00	86 21 00	24.4	27.0	
	12.30 p. m.	21 38 00	86 24 00		27.0	
	1.00 p. m.	21 37 00	86 28 00	27.8	27.0	
	1.30 p. m.	21 36 00	86 32 00		27.5	
						C20027.
	5.30 p. m.	23 46 00	86 32 00		27.0	
	6.00 p. m.	23 51 00	86 27 00	26.1	27.5	
	6.30 p. m.	23 53 30	86 24 30		27.0	
	7.00 p. m.	23 56 00	86 22 00	25.6	27.0	
	7.30 p. m.	23 58 00	86 19 30		27.5	
	8.00 p. m.	22 01 30	86 16 30	25.6	27.5	
	8.30 p. m.	22 04 00	86 13 30		27.5	
	9.00 p. m.	22 06 00	86 11 00	25.0	27.5	
	9.30 p. m.	22 08 30	86 08 30		27.5	
	10.00 p. m.	22 11 30	86 06 00	25.0	27.5	
	10.30 p. m.	22 14 00	86 03 00		27.5	
	11.00 p. m.	22 18 00	86 01 00	25.0	27.5	
	11.30 p. m.	22 19 00	85 58 00		27.5	
	12.00 m.	22 21 30	85 55 30	25.0	26.7	
Nov. 24	12.30 a. m.	22 24 00	85 53 00		26.9	
	1.00 a. m.	22 26 00	85 51 00	24.4	26.9	
	1.30 a. m.	22 28 30	85 48 00		26.9	
	2.00 a. m.	22 31 00	85 45 00	24.4	26.7	
	2.30 a. m.	22 34 00	85 43 00		26.7	
	3.00 a. m.	22 36 00	85 40 00	23.9	27.0	
	3.30 a. m.	22 38 30	85 38 00		27.0	
	4.00 a. m.	22 42 00	85 34 30	23.9	27.0	
	4.30 a. m.	22 44 00	85 32 00		27.0	
	5.00 a. m.	22 46 00	85 30 00	23.9	27.0	
	5.30 a. m.	22 48 00	85 27 00		27.0	
	6.00 a. m.	22 51 00	85 24 00	23.9	26.9	
	6.30 a. m.	22 54 00	85 21 00		26.9	

SURFACE TEMPERATURES TAKEN WHILE UNDER WAY DURING ATLANTIC CRUISES, SOUTH FROM NORFOLK, 1919, AND NORTH FROM NORFOLK, 1920—Continued.

Date.	Hour.	Latitude.	Longitude.	Temperature (°C.). Air.	Temperature (°C.). Surface.	Stations between which taken.
1919.		° ′ ″	° ′ ″			
Nov. 24	7.00 a. m.	22 57 00	85 18 30	23.9	27.0	
	7.30 a. m.	22 59 00	85 15 30	...	27.0	
	8.00 a. m.	23 02 30	85 12 00	24.4	27.0	
	8.30 a. m.	23 05 00	85 09 30	...	27.5	
	9.00 a. m.	23 08 30	85 06 00	25.0	27.5	
	9.30 a. m.	23 11 00	85 03 30	...	27.8	
	10.00 a. m.	23 14 00	85 00 00	25.6	27.5	
	10.30 a. m.	23 17 00	84 57 00	...	27.5	
	11.00 a. m.	23 20 30	84 53 00	28.3	27.5	
	11.30 a. m.	23 24 00	84 49 00	...	27.5	
	12 00 m.	23 27 00	84 46 00	28.3	27.0	
	12.30 p. m.	23 30 00	84 42 00	...	27.5	
	1.00 p. m.	23 33 00	84 39 00	28.3	27.5	
	1.30 p. m.	23 36 30	84 35 30	...	27.5	
	2.00 p. m.	23 39 30	84 32 00	27.0	27.5	
	2.30 p. m.	23 43 30	84 28 00	...	27.5	
	3.00 p. m.	23 45 00	84 25 00	27.0	27.5	
	...	...	...	...	...	C20028.
	9.00 p. m.	23 45 00	84 13 00	25.0	27.0	
	9.30 p. m.	23 47 00	84 11 00	...	27.0	
	10.00 p. m.	23 49 00	84 08 00	24.4	27.0	
	10.30 p. m.	23 51 00	84 05 30	...	27.0	
	11.00 p. m.	23 53 00	84 02 30	24.4	26.9	
	11.30 p. m.	23 55 00	84 00 00	...	26.7	
	12.00 m.	23 57 00	83 57 00	24.4	26.7	
Nov. 25	2.30 a. m.	24 06 30	83 43 00	...	25.6	
	3.00 a. m.	24 08 30	83 40 30	26.1	25.3	
	3.30 a. m.	24 10 30	83 37 00	...	25.0	
	4.00 a. m.	24 12 30	83 34 30	26.1	25.3	
	4.30 a. m.	24 14 30	83 31 30	...	25.0	
	5.00 a. m.	24 16 00	83 29 00	23.3	25.0	
	5.30 a. m.	24 18 00	83 26 30	...	25.0	
	6.00 a. m.	24 19 30	83 23 30	23.3	25.3	
	6.30 a. m.	24 21 00	88 21 00	...	25.6	
	...	...	...	...	...	C20029.
	10.00 a. m.	24 27 30	83 08 00	26.1	25.8	
	10.30 a. m.	24 30 00	83 04 00	...	25.6	
Nov. 26	...	...	...	...	...	C20030.
	...	...	...	...	...	C20031.
Nov. 30	12.00 m.	24 27 00	81 43 00	27.8	26.1	
	1.00 p. m.	24 24 80	81 35 00	28.8	26.7	
	2.00 p. m.	24 25 00	81 29 00	32.2	26.7	
	3.00 p. m.	24 27 00	81 19 00	31.1	26.7	
	4.00 p. m.	24 29 00	81 09 00	29.4	26.7	
	5.00 p. m.	24 34 00	80 57 00	27.0	26.9	
	6.00 p. m.	24 38 00	80 47 00	26.7	26.9	
	7.00 p. m.	24 44 00	80 36 00	26.7	26.9	
	8.00 p. m.	24 50 00	80 27 00	26.7	26.7	
	9.00 p. m.	24 57 00	80 19 00	25.6	26.4	
	10.00 p. m.	25 03 30	80 11 30	25.6	26.4	
	11.00 p. m.	25 10 00	80 06 00	26.1	26.7	
	12.00 m.	25 16 80	80 04 00	26.1	26.7	
Dec. 1	1.00 a. m.	25 24 00	80 02 00	26.1	26.7	
	2.00 a. m.	25 31 00	79 59 00	25.6	26.7	
	3.00 a. m.	25 36 00	80 00 00	25.6	26.7	
	4.00 a. m.	25 39 30	80 01 00	25.6	26.7	
	5.00 a. m.	25 42 00	80 03 00	23.9	26.4	
	6.00 a. m.	25 44 00	80 03 30	23.9	26.4	
	7.00 a. m.	(a)	(a)	24.4	25.6	
	8.00 a. m.	(a)	(a)	24.4	25.0	
	9.00 a. m.	(a)	(a)	24.4	25.0	
	10.00 a. m.	(a)	(a)	24.4	25.0	
	11.00 a. m.	(a)	(a)	21.1	25.0	
	12.00 m.	(a)	(a)	24.7	24.7	
	1.00 p. m.	(a)	(a)	21.1	24.7	
	2.00 p. m.	(a)	(a)	23.9	24.7	
	3.00 p. m.	(a)	(a)	23.9	24.7	
	4.00 p. m.	(a)	(a)	23.9	24.7	
	5.00 p. m.	(a)	(a)	23.9	25.0	
	6.00 p. m.	(a)	(a)	23.9	25.0	
	7.00 p. m.	(a)	(a)	23.3	25.0	
	8.00 p. m.	(a)	(a)	23.3	25.0	
	9.00 p. m.	(a)	(a)	23.3	25.0	

a (Chart C. S. 166.) Fowey Rocks Lt. bears SSE., distant 10.4 mi. Rt. tang. Virginia Key S62½W. distant 1.6 mi.

SURFACE TEMPERATURES TAKEN WHILE UNDER WAY DURING ATLANTIC CRUISES, SOUTH FROM NORFOLK, 1919, AND NORTH FROM NORFOLK, 1920—Continued.

Date.	Hour.	Latitude.			Longitude.			Temperature (°C.).		Stations between which taken.
								Air.	Surface.	
1919.		°	′	″	°	′	″			
Dec. 1	10.00 p. m.	(a)			(a)			23.3	25.0	
	11.00 p. m.	(a)			(a)			23.3	25.0	
	12.00 m.	(a)			(a)			23.3	25.0	
Dec. 3	11.00 a. m.	25	51	00	80	07	00	26.7	25.6	
	12.00 m.	25	59	00	80	04	30	26.7	25.6	
	1.00 p. m.	26	08	00	80	02	00	26.1	25.3	
	2.00 p. m.	26	17	00	80	00	00	25.6	25.8	
	3.00 p. m.	26	21	00	79	59	30	25.6	24.4	
	4.00 p. m.	26	30	30	79	59	00	25.6	25.6	
	5.00 p. m.	26	37	00	79	58	30	25.0	25.6	
	6.00 p. m.	26	44	00	79	58	00	24.4	25.0	
	7.00 p. m.	26	51	00	79	57	00	23.9	25.5	
	8.00 p. m.	26	56	00	79	56	30	23.9	25.0	
	9.00 p. m.	27	03	00	79	58	00	23.3	25.0	
	10.00 p. m.	27	10	00	80	00	00	23.3	24.4	
	11.00 p. m.	27	17	00	80	02	00	22.8	23.9	
	12.00 m.	27	24	00	80	04	00	22.8	23.3	
Dec. 4	1.00 a. m.	27	31	00	80	05	30	22.8	23.0	
	2.00 a. m.	27	38	00	80	07	00	22.8	23.3	
	3.00 a. m.	27	45	00	80	09	00	22.8	22.2	
	4.00 a. m.	27	52	00	80	13	00	22.2	22.8	
	5.00 a. m.	27	58	20	80	17	00	22.2	23.3	
	6.00 a. m.	28	05	00	80	21	00	21.1	23.6	
	7.00 a. m.	28	11	30	80	25	00	21.7	23.6	
	8.00 a. m.	28	18	00	80	29	00	21.7	23.6	
	9.00 a. m.	28	24	30	80	33	00	23.3	21.9	
	....							....	....	C20032
	12.00 m.	28	25	00	80	32	00	25.0	21.9	
	1.00 p. m.	28	26	00	80	24	00	22.8	22.2	
	2.00 p. m.	28	33	00	80	23	00	23.3	22.2	
	3.00 p. m.	28	39	00	80	22	00	24.4	22.2	
	4.00 p. m.	28	45	00	80	27	00	23.3	21.7	
	5.00 p. m.	28	51	00	80	32	00	21.7	21.7	
	6.00 p. m.	28	56	30	80	37	00	20.6	21.7	
	7.00 p. m.	29	02	30	80	42	30	20.0	21.7	
	8.00 p. m.	29	08	30	80	48	00	20.0	21.7	
	9.00 p. m.	29	15	30	80	51	00	19.4	21.1	
	10.00 p. m.	29	22	00	80	53	30	19.4	21.1	
	11.00 p. m.	29	28	30	80	56	30	18.9	20.6	
	12.00 m.	29	35	00	80	59	30	18.9	20.6	
Dec. 5	1.00 a. m.	29	42	00	81	03	00	18.3	20.6	
	2.00 a. m.	29	49	00	81	06	00	17.8	20.0	
	3.00 a. m.	29	56	00	81	09	00	17.2	20.0	
	4.00 a. m.	30	03	00	81	11	30	16.7	20.0	
	5.00 a. m.	30	10	00	81	14	30	16.1	19.4	
	6.00 a. m.	30	18	00	81	17	30	15.0	19.4	
	7.00 a. m.	30	24	00	81	20	00	14.4	19.4	
	8.00 a. m.	30	31	00	81	21	00	12.2	18.3	
	9.00 a. m.	30	38	00	81	21	00	11.7	18.3	
	10.00 a. m.	30	44	30	81	22	00	11.1	17.8	
	....							....	....	C20033.
Dec. 8	....							....	....	C20034.
	1.00 p. m.	30	47	00	81	19	00	22.2	18.9	
	2.00 p. m.	30	51	00	81	12	00	22.8	18.9	
	3.00 p. m.	30	55	00	81	05	00	22.2	19.2	
	4.00 p. m.	30	59	00	80	57	30	22.2	19.4	
	5.00 p. m.	31	03	00	80	50	30	22.8	19.4	
	6.00 p. m.	31	07	30	80	43	30	22.8	18.9	
	7.00 p. m.	31	12	00	80	36	00	22.8	18.9	
	8.00 p. m.	31	16	00	80	29	00	22.8	18.9	
	9.00 p. m.	31	20	30	80	22	00	22.2	20.0	
	10.00 p. m.	31	24	30	80	15	00	21.7	20.0	
	11.00 p. m.	31	29	00	80	08	00	22.2	20.0	
	12.00 m	31	33	00	80	01	00	22.2	20.0	
Dec. 9	1.00 a. m.	31	37	00	79	54	00	22.8	20.0	
	2.00 a. m.	31	41	30	79	46	00	23.9	20.0	
	3.00 a. m.	31	46	00	79	39	30	23.9	20.0	
	4.00 a. m.	31	50	00	79	32	00	23.9	20.0	
	5.00 a. m.	31	54	00	79	25	00	24.4	23.3	
	6.00 a. m.	31	59	00	79	17	30	23.9	23.3	
	7.00 a. m.	32	03	00	79	10	00	23.3	23.0	
	....							....	....	C20035.
	2.00 p. m.	32	13	30	79	05	00	23.3	24.7	

a (Chart C. S. 166.). Fowey Rocks Lt. bears SSE., distant 10.4 mi. Rt. tang. Virginia Key S62½W. distant 1.6 mi.

SURFACE TEMPERATURES TAKEN WHILE UNDER WAY DURING ATLANTIC CRUISES, SOUTH FROM NORFOLK, 1919, AND NORTH FROM NORFOLK, 1920—Continued.

Date.	Hour.	Latitude.	Longitude.	Temperature (°C.). Air.	Temperature (°C.). Surface.	Stations between which taken.
		° ′ ″	° ′ ″			
1919.						
Dec. 9	3.00 p.m.	32 22 00	79 09 00	21.7	24.7	
	4.00 p.m.	32 30 00	79 13 00	21.1	24.7	
	5.00 p.m.	32 36 30	79 12 00	22.2	24.7	
	6.00 p.m.	32 48 30	79 07 30	21.7	21.9	
	7.00 p.m.	33 00 00	79 03 00	22.2	17.8	
	8.00 p.m.	33 06 30	78 56 00	21.7	17.8	
	9.00 p.m.	33 13 00	78 48 00	21.7	17.8	
	10.00 p.m.	33 19 00	78 41 30	21.7	17.5	
	11.00 p.m.	33 25 00	78 34 30	21.1	17.5	
	12.00 m.	33 31 00	78 28 00	21.1	17.2	
Dec. 10	1.00 a.m.	33 37 30	78 20 30	19.4	17.2	
	2.00 a.m.	33 43 00	78 14 00	18.9	17.2	
	3.00 a.m.	33 49 00	78 07 00	18.9	17.2	
						C20036.
Dec. 12	8.00 a.m.	33 49 30	78 03 00	10.0	14.4	
	9.00 a.m.	33 42 00	77 58 30	10.0	14.4	
	10.00 a.m.	33 37 00	77 53 30	16.7	17.2	
	11.00 a.m.	33 34 00	77 45 00	20.0	17.2	
	12.00 m.	33 34 00	77 35 30	20.0	17.2	
	1.00 p.m.	33 34 00	77 26 00	22.8	21.7	
	2.00 p.m.	33 34 00	77 17 00	23.3	21.7	
	3.00 p.m.	33 34 00	77 08 00	23.9	22.2	
	4.00 p.m.	33 34 00	76 58 00	23.9	22.2	
	5.00 p.m.	33 34 00	76 49 00	23.9	22.2	
						C20037.
	10.00 p.m.	33 49 00	76 40 30	23.9	22.8	
	11.00 p.m.	33 58 00	76 40 00	23.9	22.8	
	12.00 m.	34 06 45	76 39 00	23.9	22.8	
Dec. 13	1.00 a.m.	34 15 00	76 38 00	22.2	22.8	
	2.00 a.m.	34 24 00	76 37 30	20.6	22.8	
						C20038.
	12.00 m.	34 29 00	76 31 30	17.2	11.7	
	1.00 p.m.	34 26 00	76 26 30	18.9	16.1	
	2.00 p.m.	34 26 00	76 18 00	18.9	17.2	
	3.00 p.m.	34 26 00	76 09 30	19.4	17.8	
	4.00 p.m.	34 26 00	76 01 00	22.2	17.8	
	5.00 p.m.	34 26 00	75 52 00	21.7	20.0	
						C20039.
	12.00 m.	34 55 00	75 13 00	23.3	23.3	
Dec. 14	1.00 a.m.	35 04 00	75 05 30	22.2	22.8	
	2.00 a.m.	35 11 00	75 16 00	18.9	15.0	
						20040.
	2.00 p.m.	35 23 00	75 24 00	10.0	11.1	
	3.00 p.m.	35 29 00	75 23 00	9.4	10.0	
	4.00 p.m.	35 34 00	75 22 00	9.4	10.0	
	5.00 p.m.	35 37 30	75 22 00	7.2	9.4	
	6.00 p.m.	35 41 00	75 23 00	6.7	9.4	
	7.00 p.m.	35 44 00	75 24 00	6.1	8.9	
	8.00 p.m.	35 48 00	75 24 30	6.1	8.9	
	9.00 p.m.	35 51 00	75 25 00	5.0	11.1	
	10.00 p.m.	35 57 00	75 27 00	5.0	10.6	
	11.00 p.m.	36 02 30	75 28 00	4.4	10.6	
	12.00 m.	36 07 30	75 30 00	3.9	9.4	
Dec. 15	1.00 a.m	36 13 00	75 31 00	3.9	9.4	
	2.00 a.m.	36 18 00	75 32 30	3.9	8.3	
	3.00 a.m.	36 23 00	75 34 00	3.9	8.3	
	4.00 a.m.	36 27 00	75 35 00	1.7	8.9	
	5.00 a.m.	36 31 20	75 36 00	1.1	8.9	
	6.00 a.m.	36 35 30	75 37 00	.6	8.3	
	7.00 a.m	36 42 30	75 45 00	.5	7.8	
	8.00 a.m.	36 44 30	75 52 30	.5	7.2	
1920.						
Feb. 19	6.00 p.m.	37 15 00	75 29 00	4.4	3.6	
	7.00 p.m.	37 19 00	75 19 30	3.3	3.6	
	8.00 p.m.	37 23 00	75 10 00	3.3	3.6	
	9.00 p.m.	37 27 00	75 00 00	2.2	3.6	
	10.00 p.m.	37 31 30	74 51 00	1.7	3.6	
	11.00 p.m.	37 35 30	74 41 00	1.1	3.0	
	12.00 m.	37 40 00	74 31 00	.6	3.0	
Feb. 20	1.00 a.m.	37 43 30	74 22 00	.6	3.0	
	2.00 a.m.	37 48 00	74 12 00	.6	3.0	
						C20041.
	8.00 a.m.	37 54 00	73 58 30	.0	3.0	
	9.00 a.m.	37 59 00	73 51 30	.0	4.4	
	10.00 a.m.	38 04 00	73 48 00	2.8	5.0	
	11.00 a.m.	38 09 00	73 44 30	2.8	5.0	

SURFACE TEMPERATURES TAKEN WHILE UNDER WAY DURING ATLANTIC CRUISES, SOUTH FROM NORFOLK, 1919, AND NORTH FROM NORFOLK, 1920—Continued.

Date.	Hour.	Latitude. ° ′ ″	Longitude. ° ′ ″	Temperature (°C.). Air.	Temperature (°C.). Surface.	Stations between which taken.
1920.						
Feb. 20	12.00 m.	38 14 00	73 40 00	3.9	5.3	
	1.00 p.m.	38 19 00	73 35 00	.6	3.9	
	2.00 p.m.	38 24 00	73 31 00	.0	3.9	
	3.00 p.m.	38 29 00	73 26 00	1.1	3.9	
	4.00 p.m.	38 34 00	73 21 00	1.1	3.3	
	5.00 p.m.	38 39 00	73 16 30	2.2	3.3	
	6.00 p.m.	38 44 00	73 12 00	1.7	3.3	
	7.00 p.m.	38 49 00	73 07 00	1.1	3.0	
	8.00 p.m.	38 54 00	73 03 00	.6	2.8	
	9.00 p.m.	38 59 00	72 58 00	2.2	2.8	
Feb. 20 to 21	......	......	......	......	......	C20042.
Feb. 21	2.00 a.m.	39 09 00	72 40 00	3.3	5.6	
	3.00 a.m.	39 14 00	72 33 00	2.8	5.3	
	4.00 a.m.	39 20 00	72 26 00	2.2	5.3	
	5.00 a.m.	39 25 00	72 19 00	2.2	5.0	
	6.00 a.m.	39 30 30	72 12 00	1.7	5.0	
	7.00 a.m.	39 35 30	72 05 30	1.7	5.0	
	......	......	......	......	......	C20043.
	12.00 m.	39 35 00	71 50 30	5.6	5.6	
	1.00 p.m.	39 36 30	71 41 00	7.2	6.1	
	2.00 p.m.	39 38 00	71 31 00	6.7	7.8	
	3.00 p.m.	39 39 00	71 21 30	5.0	7.2	
	4.00 p.m.	39 41 00	71 12 00	3.9	5.0	
	5.00 p.m.	39 42 00	71 02 00	2.2	5.0	
	6.00 p.m.	39 43 00	70 52 00	2.2	5.0	
	7.00 p.m.	39 45 00	70 42 30	2.2	5.0	
	8.00 p.m.	39 46 00	70 32 30	2.8	5.0	
	9.00 p.m.	39 47 30	70 22 30	3.3	5.0	
	10.00 p.m.	39 49 00	70 13 00	3.3	5.0	
	11.00 p.m.	39 50 00	70 03 00	3.9	5.0	
	12.00 m.	39 51 30	69 53 00	3.9	5.0	
Feb. 22	1.00 a.m.	39 53 00	69 44 00	5.6	5.0	
	2.00 a.m.	39 54 00	69 34 00	5.6	5.0	
	3.00 a.m.	39 56 00	69 24 00	5.6	4.4	
	4.00 a.m.	39 57 00	69 15 00	6.1	5.0	
	5.00 a.m.	39 58 00	69 05 00	6.7	5.0	
	6.00 a.m.	40 00 00	68 50 00	7.2	4.7	
	7.00 a.m.	40 01 00	68 45 30	7.2	4.4	
	8.00 a.m.	40 02 30	68 36 00	7.2	4.4	
	9.00 a.m.	40 04 00	68 26 00	8.3	4.4	
	10.00 a.m.	40 05 00	68 16 00	8.3	4.4	
	11.00 a.m.	40 06 30	68 06 00	8.3	4.4	
	......	......	......	......	......	C20044.
	......	......	......	......	......	C20045.
	8.00 p.m.	40 21 00	68 11 00	5.0	5.0	
	9.00 p.m.	40 28 30	68 15 00	4.4	5.0	
	......	......	......	......	......	C20046.
	12.00 m.	40 40 30	68 22 00	3.3	5.0	
Feb. 23	1.00 a.m.	40 46 30	68 24 00	3.3	5.0	
	2.00 a.m.	40 53 00	68 27 30	3.3	5.0	
	3.00 a.m.	41 00 00	68 30 30	2.8	5.0	
	4.00 a.m.	41 06 00	68 33 00	2.2	5.0	
	......	......	......	......	......	C20047.
	7.00 a.m.	41 16 30	68 38 00	3.3	4.4	
	8.00 a.m.	41 23 00	68 41 00	2.8	4.4	
	9.00 a.m.	41 29 00	68 44 00	2.2	3.9	
	10.00 a.m.	41 36 00	68 47 00	2.2	3.6	
	......	......	......	......	......	C20048
	1.00 p.m.	41 44 00	68 54 00	2.8	3.3	
	2.00 p.m.	41 49 00	69 03 00	2.8	3.3	
	3.00 p.m.	41 54 00	69 12 00	2.2	2.8	
	4.00 p.m.	41 59 00	69 21 00	2.2	2.8	
	5.00 p.m.	42 04 00	69 30 00	2.2	2.8	
	6.00 p.m.	42 07 00	69 40 30	2.2	3.3	
	7.00 p.m.	42 09 00	69 51 00	2.2	3.3	
	8.00 p.m.	42 14 00	69 52 00	2.2	3.3	
	9.00 p.m.	42 22 00	69 43 00	2.2	3.3	
	......	......	......	......	......	C20049.
Feb. 24	1.00 a.m.	42 28 00	69 47 30	2.8	3.3	
	2.00 a.m.	42 26 00	70 01 00	2.8	3.3	
	3.00 a.m.	42 24 00	70 14 00	3.3	3.3	
	4.00 a.m.	42 21 00	70 27 00	3.3	3.3	
	5.00 a.m.	42 19 00	70 40 00	3.3	3.3	
......	......	......	......	......	......	[Boston].

SURFACE TEMPERATURES TAKEN WHILE UNDER WAY DURING ATLANTIC CRUISES, SOUTH FROM NORFOLK, 1919, AND NORTH FROM NORFOLK, 1920—Continued.

Date.	Hour.	Latitude. °	′	″	Longitude. °	′	″	Temperature (°C.). Air.	Surface.	Stations between which taken.
1920.										
Mar. 1	12.00 m.	42	21	30	70	48	30	6.7	1.1	
	1.00 p.m.	42	25	00	70	32	00	8.3	1.1	
	2.00 p.m.	42	28	00	70	23	00	8.9	1.1	
										C20050.
Mar. 1 to 2										C20051.[a]
Mar. 2										C20052.
	10.00 p.m.	42	44	00	68	33	30	3.3	2.8	
	11.00 p.m.	42	44	00	68	24	00	2.2	2.8	
	12.00 m.	42	44	00	68	15	00	1.1	2.8	
Mar. 3	1.00 a.m.	42	44	00	68	05	30	.5	2.8	
	2.00 a.m.	42	44	00	67	56	00	.5	2.8	
	3.00 a.m.	42	44	00	67	47	00	.5	2.8	
	4.00 a.m.	42	44	00	67	37	00	.5	2.8	
										C20053.
	8.00 a.m.	42	49	00	67	30	00	.6	2.8	
	9.00 a.m.	42	58	00	67	34	00	1.7	3.0	
	10.00 a.m.	43	06	00	67	38	00	1.7	2.5	
	11.00 a.m.	43	14	00	67	42	00	3.9	2.2	
										C20054.
	3.00 p.m.	43	23	30	67	45	00	3.9	2.2	
	4.00 p.m.	43	31	00	67	48	00	3.9	2.2	
	5.00 p.m.	43	38	00	67	50	30	3.9	2.2	
										C20055.
	8.00 p.m.	43	47	30	67	55	00	3.9	2.2	
	9.00 p.m.	43	54	00	68	00	00	3.9	2.5	
	10.00 p.m.	44	01	00	68	05	00	3.3	2.2	
										C20056.
Mar. 4	1.00 a.m.	43	59	00	68	16	00	3.9	1.1	
	2.00 a.m.	43	53	00	68	24	00	4.4	1.1	
	3.00 a.m.	43	47	00	68	32	00	4.4	1.1	
	4.00 a.m.	43	42	00	68	40	00	4.4	1.1	
	5.00 a.m.	43	36	00	68	48	00	4.4	1.1	
	6.00 a.m.	43	29	00	68	53	30	4.4	....	
	7.00 a.m.	43	22	00	68	56	00	4.4	....	
										C20057.
	9.00 a.m.	43	21	30	68	59	00	4.4	1.1	
	10.00 a.m.	43	26	00	69	08	00	5.0	1.1	
	11.00 a.m.	43	30	30	69	18	00	5.0	1.1	
	12.00 m.	43	35	30	69	28	00	4.4	1.1	
										C20058.
	3.00 p.m.	43	38	00	69	45	00	6.1	1.9	
	4.00 p.m.	43	34	00	69	53	00	6.1	1.1	
	5.00 p.m.	43	29	00	70	02	00	6.7	1.1	
										C20059.
	8.00 p.m.	43	18	00	70	16	00	5.6	1.1	
	9.00 p.m.	43	12	00	70	20	00	5.6	1.1	
	10.00 p.m.	43	05	00	70	25	00	5.6	1.1	
										C20060.
	12.00 m.	43	02	00	70	25	00	5.6	1.1	
Mar. 5	1.00 a.m.	43	01	00	70	15	00	6.1	1.7	
										C20061.
	4.00 a.m.	42	54	00	70	16	00	5.6	1.7	
	5.00 a.m.	42	47	30	70	22	00	6.1	1.7	
	6.00 a.m.	42	41	00	70	28	00	6.1	1.7	
	7.00 a.m.	42	35	00	70	34	00	6.1	1.7	
	8.00 a.m.	42	29	00	70	40	00	6.1	....	
										C20062. [Boston.]
Mar. 10	12.00 m.							9.4	1.1	
	1.00 p.m.	42	19	00	70	35	30	11.7	1.1	
	2.00 p.m.	42	18	00	70	24	00	12.2	1.7	
	3.00 p.m.	42	17	00	70	12	30	9.4	1.7	
	4.00 p.m.	42	16	00	70	01	00	10.6	2.2	
	5.00 p.m.	42	15	00	69	49	00	10.6	2.2	
	6.00 p.m.	42	13	30	69	37	30	9.4	2.2	
	7.00 p.m.	42	12	30	69	26	00	8.9	2.2	
	8.00 p.m.	42	11	00	69	15	00	8.3	2.2	
	9.00 p.m.	42	10	00	69	03	00	7.2	2.2	
	10.00 p.m.	42	09	00	68	51	30	7.2	2.2	
	11.00 p.m.	42	08	00	68	40	00	7.2	2.2	
	12.00 m.	42	07	00	68	28	00	7.2	2.2	

[a] Temperatures discarded between stations 20051 and 20052.

SURFACE TEMPERATURES TAKEN WHILE UNDER WAY DURING ATLANTIC CRUISES, SOUTH FROM NORFOLK, 1919, AND NORTH FROM NORFOLK, 1920—Continued.

Date.	Hours.	Latitude.	Longitude.	Temperature (°C.). Air.	Temperature (°C.). Surface.	Stations between which taken.
		° ′ ″	° ′ ″			
1920.						
Mar. 11	1.00 a. m.	42 06 00	68 16 30	6.7	....	
						C20063.
	4.00 a. m.	42 05 00	68 09 00	6.7	3.3	
	5.00 a. m.	42 07 00	67 59 30	6.7	3.3	
	6.00 a. m.	42 09 00	67 50 00	6.7	3.3	
	7.00 a. m.	42 11 00	67 40 00	7.2	3.3	
	8.00 a. m.	42 13 00	67 30 00	7.2	3.3	
	9.00 a. m.	42 15 00	67 20 00	9.4	3.9	
						C20064.
	1.00 p. m.	42 28 00	67 12 00	9.4	3.3	
	2.00 p. m.	42 13 00	67 08 00	8.9	....	
	3.00 p. m.	42 07 00	67 03 00	8.3	....	
	4.00 p. m.	42 02 00	66 59 00	7.8	....	
	5.00 p. m.	41 56 30	66 54 00	8.3	....	
						C20065.
	7.00 p. m.	41 49 00	66 51 00	8.3	....	
	8.00 p. m.	41 40 30	66 47 00	8.3	....	
						C20066.
Mar. 12	1.00 a. m.	41 26 00	66 39 00	9.4	....	
	2.00 a. m.	41 20 00	66 35 00	8.9	2.8	
						C20067.
	5.00 a. m.	(a)	(a)	9.4	2.8	
	6.00 a. m.	(a)	(a)	10.0	2.8	
	7.00 a. m.	(a)	(a)	9.4	2.8	
						C20068.
	10.00 a. m.	40 55 30	66 15 00	10.0	3.3	
	11.00 a. m.	40 49 00	66 10 00	11.1	3.3	
						C20069.
	3.00 p. m.	40 54 00	66 08 00	10.6	3.3	
	4.00 p. m.	41 01 00	66 08 00	10.0	3.3	
	5.00 p. m.	41 09 00	66 08 00	10.0	3.3	
	6.00 p. m.	41 17 00	66 08 00	9.4	3.3	
	7.00 p. m.	41 24 00	66 08 00	9.4	3.3	
	8.00 p. m.	41 32 00	66 08 00	9.4	3.3	
	9.00 p. m.	41 39 30	66 08 00	9.4	3.3	
	10.00 p. m.	41 47 00	66 08 00	9.4	3.3	
	11.00 p. m.	41 54 30	66 08 00	8.9	3.3	
	12.00 m.	42 02 00	66 08 00	10.0	3.3	
Mar. 13	1.00 a. m.	42 06 30	66 08 00	4.4	2.8	
						C20070.
	4.00 a. m.	42 11 00	66 09 00	10.0	2.8	
						C20071.
	7.00 a. m.	42 22 00	66 00 00	10.0	2.8	
	8.00 a. m.	42 33 00	65 52 00	10.0	....	
						C20072.
	10.00 a. m.	42 40 00	65 48 00	9.4	2.8	
	11.00 a. m.	42 48 00	65 45 00	9.4	2.8	
	12.00 m.	42 56 00	65 40 00	9.4	2.8	
	1.00 p. m.	43 04 00	65 36 00	9.4	2.8	
	2.00 p. m.	43 12 00	65 32 00	9.4	2.8	
	3.00 p. m.	43 20 00	65 27 00	10.0	2.8	
	4.00 p. m.	43 27 30	65 21 00	10.0	2.8	
	5.00 p. m.	43 35 00	65 15 00	10.6	2.8	
	6.00 p. m.	(b)	(b)	10.6	2.8	
	7.00 p. m.	(b)	(b)	11.1	2.8	
	8.00 p. m.	(b)	(b)	11.1	2.8	
	9.00 p. m.	(b)	(b)	12.2	2.8	
	10.00 p. m.	(b)	(b)	12.2	2.8	
	11.00 p. m.	(b)	(b)	12.2	2.8	
	12.00 m.	(b)	(b)	12.2	2.8	
Mar. 14	1.00 a. m.	(b)	(b)	7.2	2.8	
	2.00 a. m.	(b)	(b)	7.2	2.8	
	3.00 a. m.	(b)	(b)	7.2	2.8	
	4.00 a. m.	(b)	(b)	4.4	2.2	
	5.00 a. m.	(b)	(b)	4.4	2.2	
	6.00 a. m.	(b)	(b)	3.9	2.2	
	7.00 a. m.	(b)	(b)	2.2	....	
	8.00 a. m.	(b)	(b)	2.8	2.2	
	9.00 a. m.	(b)	(b)	2.2	2.2	
	10.00 a. m.	(b)	(b)	2.2	2.2	

[a] Position at this hour doubtful. Surface temperature 37° F. between stations 20067 (lat. 41° 15′, long. 66° 31′) and 20068 (lat. 41° 02′, long. 66° 20′).
[b] Anchorage, Shelburne Harbor, N. S.

SURFACE TEMPERATURES TAKEN WHILE UNDER WAY DURING ATLANTIC CRUISES, SOUTH FROM NORFOLK, 1919, AND NORTH FROM NORFOLK, 1920—Continued.

Date.	Hour.	Latitude.	Longitude.	Temperature (°C.). Air.	Temperature (°C.). Surface.	Stations between which taken.
1920.		° ′ ″	° ′ ″			
Mar. 14	11.00 a. m.	(a)	(a)	1.7	2.2	
	12.00 m.	(a)	(a)	1.7	2.2	
	1.00 p. m.	(a)	(a)	2.2	2.2	
	2.00 p. m.	(a)	(a)	.6	2.2	
	3.00 p. m.	(a)	(a)	.6	2.2	
	4.00 p. m.	(a)	(a)	.6	2.2	
	5.00 p. m.	(a)	(a)	.6	2.2	
	6.00 p. m.	(a)	(a)	.0	2.2	
	7.00 p. m.	(a)	(a)	.0	2.2	
	8.00 p. m.	(a)	(a)	.5	2.2	
	9.00 p. m.	(a)	(a)	.6	2.2	
	10.00 p. m.	(a)	(a)	.0	2.2	
	11.00 p. m.	(a)	(a)	1.1	2.2	
	12.00 m.	(a)	(a)	1.1	2.2	
Mar. 15	1.00 a. m.	(a)	(a)	2.2	2.2	
	2.00 a. m.	(a)	(a)	2.2	1.7	
	3.00 a. m.	(a)	(a)	2.2	1.7	
	4.00 a. m.	(a)	(a)	2.2	1.7	
	5.00 a. m.	(a)	(a)	2.2	1.7	
	6.00 a. m.	(a)	(a)	2.2	1.7	
	7.00 a. m.	(a)	(a)	1.6	1.7	
	8.00 a. m.	(a)	(a)	1.1	1.7	
	9.00 a. m.	(a)	(a)	.5	1.7	
	10.00 a. m.	(a)	(a)	.5	1.1	
	11.00 a. m.	(a)	(a)	.0	1.1	
	12.00 m.	(a)	(a)	.6	1.1	
	1.00 p. m.	(a)	(a)	2.2	1.1	
	2.00 p. m.	(a)	(a)	4.4	1.1	
	3.00 p. m.	(a)	(a)	4.4	1.1	
	4.00 p. m.	(a)	(a)	4.4	1.1	
	5.00 p. m.	(a)	(a)	4.4	1.1	
	6.00 p. m.	(a)	(a)	4.4	1.1	
	7.00 p. m.	(a)	(a)	4.4	1.1	
	8.00 p. m.	(a)	(a)	3.9	1.1	
	9.00 p. m.	(a)	(a)	3.3	1.1	
	10.00 p. m.	(a)	(a)	1.1	1.1	
	11.00 p. m.	(a)	(a)	.5	1.1	
	12.00 m.	(a)	(a)	.5	1.1	
Mar. 17	12.00 m.	43 37 30	65 15 30	10.6	2.8	
						C20073.
	3.00 p. m.	43 34 00	65 11 00	10.0	2.8	
	4.00 p. m.	43 38 00	65 15 30	9.4	2.8	
						[Shelburne.]
Mar. 19	8.00 a. m.	43 32 00	65 08 30	21.6	2.8	
	9.00 a. m.	43 25 00	65 03 00	17.8	1.4	
						C20074.
	12.00 m.	43 14 00	64 54 00	15.6	.8	
	1.00 p. m.	43 07 00	64 47 00	4.4	.6	
	2.00 p. m.	42 59 00	64 40 00	3.9	.6	
						C20075.
	4.00 p. m.	42 53 00	64 36 30	3.9	.6	
	5.00 p. m.	42 45 00	64 34 00	3.3	.8	
	6.00 p. m.	42 36 30	64 31 00	2.8	.6	
						C20076.
	9.00 p. m.	42 30 00	64 26 30	4.4	1.1	
Mar. 19 to 20						C20077.
Mar. 20	1.00 a. m.	42 26 00	64 25 00	5.0	1.1	
	2.00 a. m.	42 30 00	64 36 00	5.0	1.1	
	3.00 a. m.	42 35 00	64 46 00	5.0	1.1	
	4.00 a. m.	42 38 30	64 57 00	4.4	1.1	
	5.00 a. m.	42 43 00	65 07 30	4.4	1.1	
	6.00 a. m.	42 47 00	65 18 00	4.4	....	
	7.00 a. m.	42 51 00	65 29 00	3.3	....	
	8.00 a. m.	42 55 00	65 39 00	2.8	....	
						C20078.
	11.00 a. m.	43 05 30	66 01 00	1.7	1.7	
	12.00 m.	43 12 00	66 10 00	2.8	1.7	
	1.00 p. m.	43 18 00	66 19 30	1.1	1.7	
	2.00 p. m.	43 24 00	66 29 00	1.1	2.2	
	3.00 p. m.	43 30 30	66 34 00	2.8	2.2	
	4.00 p. m.	43 36 30	66 34 00	3.5	2.5	
	5.00 p. m.	43 42 00	66 33 00	3.9	2.2	
	6.00 p. m.	43 46 30	66 27 00	3.9	2.2	
	7.00 p. m.	43 52 00	66 24 00	3.3	2.2	

[a] Anchorage, Shelburne Harbor, N. S.

SURFACE TEMPERATURES TAKEN WHILE UNDER WAY DURING ATLANTIC CRUISES, SOUTH FROM NORFOLK, 1919, AND NORTH FROM NORFOLK, 1920—Continued.

Date.	Hour.	Latitude.	Longitude.	Temperature (°C.). Air.	Temperature (°C.). Surface.	Stations between which taken.
1920.		° ′ ″	° ′ ″			
Mar. 20	8.00 p. m.	43 58 00	66 24 00	3.8	1.7	
	9.00 p. m.	44 04 00	66 24 00	1.1	1.7	
	10.00 p. m.	44 06 30	66 19 00	1.1	1.7	
....	....	....	....	....	....	[C. St. Mary.]
....	....	....	....	....	....	[St. Mary Bay.]
Mar. 21	6.00 a. m.	44 10 30	66 16 30	1.1	.6	
	7.00 a. m.	44 16 00	66 17 00	1.1	.6	
Mar. 22	11.00 a. m.	44 09 00	66 29 00	9.44	1.67	
	12.00 m.	44 17 00	66 34 00	10.56	1.95	
	....	....	....	....	....	C20079.
	4.00 p. m.	44 21 00	66 49 00	7.22	2.5	
	5.00 p. m.	44 21 00	67 00 00	6.11	2.22	
	6.00 p. m.	44 21 00	67 12 00	6.11	2.22	
	7.00 p. m.	44 21 00	67 23 00	6.11	2.5	
	....	....	....	....	....	C20080.
	10.00 p. m.	44 16 00	67 33 00	5.56	....	
	11.00 p. m.	44 09 00	67 27 00	5.56	1.95	
Mar. 22 to 23	....	....	....	....	....	C20081.
Mar. 23	2.00 a. m.	44 05 00	67 19 00	6.11	1.67	
	3.00 a. m.	44 01 30	67 10 00	6.11	1.67	
	4.00 a. m.	47 57 00	67 01 00	6.11	1.67	
	....	....	....	....	....	C20082.
	7.00 a. m.	43 51 00	66 43 00	7.22	2.22	
	8.00 a. m.	43 47 00	66 30 30	7.22	2.22	
	....	....	....	....	....	C20083.
	11.00 a. m.	43 35 30	66 18 00	7.78	1.95?	
	12.00 m.	43 30 00	66 15 00	7.78	....	
	1.00 p. m.	43 24 00	66 12 00	8.33	2.22	
	....	....	....	....	....	C20084.
	4.00 p. m.	43 18 00	66 20 00	9.44	....	
	5.00 p. m.	43 17 00	66 30 00	8.89	....	
	....	....	....	....	....	C20085.
	7.00 p. m.	43 15 00	66 45 00	8.89	....	
	8.00 p. m.	43 13 00	66 51 00	8.89	....	
	9.00 p. m.	43 11 00	67 07 00	8.33	3.5?	
	....	....	....	....	....	C20086.
	12.00 m.	43 18 00	67 17 00	7.78	2.5	
Mar. 24	1.00 a. m.	43 10 00	67 25 00	7.78	2.5	
	2.00 a. m.	43 02 30	67 33 00	7.78	2.22	
	3.00 a. m.	42 59 00	67 40 00	7.22	2.22	
	4.00 a. m.	42 56 00	67 48 00	7.22	2.22	
	5.00 a. m.	42 53 00	67 56 00	7.22	2.22	
	6.00 a. m.	42 50 30	68 04 00	7.22	2.22	
	7.00 a. m.	42 47 00	68 13 00	8.89	2.5	
	8.00 a. m.	42 44 00	68 20 00	8.89	2.5	
	9.00 a. m.	42 41 00	68 28 00	12.22	3.05	
	10.00 a. m.	42 41 00	68 37 00	12.22	3.05	
	11.00 a. m.	42 40 00	68 46 00	12.22	3.05	
	12.00 m.	42 39 00	68 55 00	11.67	3.05	
	1.00 p. m.	42 38 00	69 04 00	11.11	4.44	
	2.00 p. m.	42 38 00	69 13 00	11.11	3.89	
	3.00 p. m.	42 37 00	69 21 00	11.67	3.33	
	....	....	....	....	....	C20087.
	6.00 p. m.	42 34 00	69 31 00	8.33	2.5	
	7.00 p. m.	42 28 00	69 38 00	8.33	2.5	
	8.00 p. m.	42 23 00	69 45 00	8.33	2.22	
	9.00 p. m.	42 17 00	69 51 00	8.33	2.22	
	....	....	....	....	....	C20088.
	12.00 m.	42 16 00	70 09 00	7.22	2.22	
Mar. 25	1.00 a. m.	42 18 00	70 24 00	6.67	2.22	
	2.00 a. m.	42 19 00	70 31 00	6.67	2.5	
	3.00 a. m.	42 20 00	70 39 00	6.11	2.78	
....	....	....	....	....	....	[Boston.]
Apr. 6	3.00 p. m.	42 25 00	70 44 30	6.11	3.33	
	....	....	....	....	....	C20089.
	5.00 p. m.	42 31 00	70 41 30	5.00	2.78	
Apr. 9 and 10	....	....	....	....	....	C20090 to C20096, inclusive.[a]
Apr. 10	6.00 p. m.	43 45 00	69 38 00	7.22	2.22	
	7.00 p. m.	43 40 00	69 29 30	6.11	2.22	
	8.00 p. m.	43 35 00	69 20 30	5.00	....	
	9.00 p. m.	43 29 30	69 12 00	4.44	....	
	10.00 p. m.	43 24 00	69 03 00	4.44	....	

[a] Temperatures discarded between these stations.

SURFACE TEMPERATURES TAKEN WHILE UNDER WAY DURING ATLANTIC CRUISES, SOUTH FROM NORFOLK, 1919, AND NORTH FROM NORFOLK, 1920—Continued.

Date.	Hour.	Latitude.			Longitude.			Temperature (°C.).		Stations between which taken.
								Air.	Surface.	
1920.		°	′	″	°	′	″			
Apr. 10 to 11										C20097.
Apr. 11	2.00 a. m.	43	24	30	68	41	00	6.11		
	3.00 a. m.	43	29	30	68	31	00	6.11		
	4.00 a. m.	43	32	30	68	21	00	6.11		
	5.00 a. m.	43	35	30	68	12	30	6.11		
	6.00 a. m.	43	39	30	68	03	30	6.11		
										C20098.
	10.00 a. m.	43	46	30	67	56	30	3.89	3.33	
	11.00 a. m.	43	54	30	68	59	00	11.11	3.33	
	12.00 m.	44	02	30	68	02	00	15.00	3.33	
	1.00 p. m.	44	10	30	68	03	30	15.56	3.33	
	2.00 p. m.	44	18	30	68	07	00	15.56	3.33	
										[Bar Harbor.]
Apr. 12	12.00 m.	44	18	00	68	01	00	6.67	2.78	
										C20099.
	3.00 p. m.	44	13	00	67	42	00	8.89	3.89	
	4.00 p. m.	44	10	00	67	31	00	8.33	3.89	
										C20100.
	7.00 p. m.	44	05	00	67	15	00	7.78	2.78	
	8.00 p. m.	44	00	00	67	05	00	7.22	2.78	
	9.00 p. m.	43	55	00	6d	55	00	6.67	2.78	
										C20101.
	11.00 p. m.	43	53	00	66	48	00	7.78	4.17	
	12.00 m.	43	49	00	66	40	00	7.78	3.89	
Apr. 13	1.00 a. m.	43	46	00	66	32	00	7.22	3.89	
										C20102. [Yarmouth.]
Apr. 15	9.00 a. m.	43	47	00	66	09	00	10.00	3.89	
	10.00 a. m.	43	40	00	66	16	00	10.00	3.89	
	11.00 a. m.	43	34	00	66	22	00	9.44	3.89	
	12.00 m.	43	27	00	66	29	00	10.00	3.89	
										C20103.
	3.00 p. m.	43	18	00	66	26	00	8.89	3.89	
	4.00 p. m.	43	16	00	66	17	00	8.89	3.89	
	5.00 p. m.	43	14	00	66	08	00	8.33	3.61	
										C20104.
	8.00 p. m.	43	06	00	65	59	00	7.22	3.33	
										C20105.
	11.00 p. m.	42	53	00	65	59	00	8.33	3.33	
	12.00 m.	42	44	00	66	01	00	8.33	3.33	
Apr. 16										C20106.
	2.00 a. m.	42	36	00	66	01	00	7.22		
	3.00 a. m.	42	29	00	66	02	00	7.22		
	4.00 a. m.	42	22	00	66	02	00	7.22		
										C20107.
	7.00 a. m.	42	11	00	66	03	00	10.00	3.89	
	8.00 a. m.	42	04	00	66	04	00	10.56	3.89	
										C20108.
	10.00 a. m.	41	55	00	66	05	00	10.56	4.17	
	11.00 a. m.	41	50	00	66	05	30	11.67	4.17	
	12.00 m.	41	44	00	66	06	00	11.67	4.17	
	1.00 p. m.	41	39	00	66	06	30	9.44	4.17	
	2.00 p. m.	41	33	00	66	07	00	10.00	4.17	
	3.00 p. m.	41	28	00	66	08	00	10.00	4.17	
	4.00 p. m.	41	22	00	66	08	00	10.00	4.17	
										C20109.
	7.00 p. m.	41	25	00	66	16	00	11.11	3.89	
										C20110.
	10.00 p. m.	41	40	00	66	28	00	8.89	3.89	
	11.00 p. m.	41	46	00	66	32	00	8.33	3.89	
	12.00 m.	41	52	00	66	38	00	7.78	3.89	
Apr. 17										C20111.
	3.00 a. m.	42	03	00	66	46	00	7.22	3.89	
	4.00 a. m.	42	10	00	66	52	00	7.22	3.89	
	5.00 a. m.	42	18	00	66	59	00	7.22	3.89	
										C20112.
	8.00 a. m.	42	25	00	67	05	00	7.78		
	9.00 a. m.	42	30	00	67	12	00	8.33	3.61	
	10.00 a. m.	42	36	00	67	18	00	8.89	3.61	
	11.00 a. m.	42	42	00	67	24	00	8.89	3.61	
	12.00 m.	42	47	00	67	31	00	8.33	3.61	
										C20113.
	3.00 p. m.	42	52	00	67	43	00	7.22	3.33	
	4.00 p. m.	42	50	00	67	54	00	6.67	3.33	

SURFACE TEMPERATURES TAKEN WHILE UNDER WAY DURING ATLANTIC CRUISES, SOUTH FROM NORFOLK, 1919, AND NORTH FROM NORFOLK, 1920—Continued.

Date.	Hour.	Latitude.	Longitude.	Temperature (°C.). Air.	Temperature (°C.). Surface.	Stations between which taken.
1920.		° ′ ″	° ′ ″			
Apr. 17	5.00 p.m.	42 47 00	68 06 00	7.22	3.33	
	6.00 p.m.	42 45 00	68 17 00	7.22	3.33	
	7.00 p.m.	42 43 00	68 29 00	7.22	3.33	
						C20114.
	10.00 p.m.	42 42 00	68 46 00	7.22	3.05	
	11.00 p.m.	42 44 00	68 58 00	7.22	3.33	
	12.00 m.	42 47 00	69 11 00	7.22	3.33	
Apr. 18	1.00 a.m.	42 44 00	69 12 00	6.67	3.33	
	2.00 a.m.	42 39 00	69 18 00	6.11	3.33	
	3.00 a.m.	42 37 00	69 28 00	6.11	3.33	
						C20115.
	6.00 a.m.	42 32 00	69 38 00	6.67	3.33	
	7.00 a.m.	42 24 00	69 45 00	6.67	....	
	8.00 a.m.	42 16 00	69 51 30	6.11	....	
	9.00 a.m.	42 09 00	69 45 00	6.11	....	
						C20116.
	12.00 m.	42 06 00	69 48 00	7.78	3.33	
						C20117.
	3.00 p.m.	42 07 30	70 09 00	8.89	3.05	
	4.00 p.m.	42 04 00	70 17 00	8.89	3.05	
						[Provincetown.]
Apr. 20						C20118.
May 16	10.00 a.m.	42 26 00	70 41 00	20.0	8.89	
						C20123.
	1.00 p.m.	42 28 00	70 35 00	20.0	10.00	
						C20124.
	8.00 p.m.	42 10 00	69 57 00	13.3	8.90	
	9.00 p.m.	42 05 00	69 52 00	10.6	9.2	
						C20125.
	12.00 m.	41 53 00	69 39 00	12.8	8.3	
May 17	1.00 a.m.	41 47 00	69 32 00	12.8	8.3	
	2.00 a.m.	41 40 00	69 24 00	12.8	8.3	
						C20126.
	4.00 a.m.	41 35 00	69 20 00	12.8	8.3	
	5.00 a.m.	41 28 00	69 13 00	12.8	8.3	
						C20127.
	8.00 a.m.	41 17 00	69 03 00	15.0	8.3	
	9.00 a.m.	41 09 00	69 02 00	13.3	7.8	
						C20128.
	5.00 p.m.	40 27 00	68 55 00	13.9	8.9	
	6.00 p.m.	40 18 00	68 58 00	12.8	8.3	
	7.00 p.m.	40 09 00	69 02 00	12.2	8.3	
						C20129.
	10.00 p.m.	40 01 00	69 12 00	11.7	7.8	
	11.00 p.m.	39 57 00	69 21 00	12.2	7.5	
	12.00 m.	39 53 00	69 31 00	12.2	7.8	
May 18	1.00 a.m.	39 49 00	69 40 00	12.2	7.8	
	2.00 a.m.	39 45 00	69 49 00	12.2	7.8	
	3.00 a.m.	39 40 00	69 58 00	12.8	7.8	
	4.00 a.m.	39 36 00	70 08 00	12.8	8.3	
	5.00 a.m.	39 32 00	70 17 00	14.4	8.9	
	6.00 a.m.	39 28 00	70 26 00	17.2	8.9	
	7.00 a.m.	39 24 00	70 34 00	17.8	8.9	
	8.00 a.m.	39 20 00	70 44 00	19.4	10.0	
	9.00 a.m.	39 16 00	70 53 00	20.0	10.6	
	10.00 a.m.	39 12 00	71 02 00	15.0	11.1	
	11.00 a.m.	39 08 00	71 11 00	20.0	11.1	
	12.00 m.	39 04 00	71 20 00	20.6	12.8	
	1.00 p.m.	38 59 00	71 30 00	20.6	12.8	
	2.00 p.m.	38 55 00	71 39 00	20.6	12.8	
	3.00 p.m.	38 50 00	71 47 00	20.6	12.8	
	4.00 p.m.	38 46 00	71 57 00	20.0	12.8	
	5.00 p.m.	38 42 00	72 06 00	20.0	13.0	
	6.00 p.m.	38 38 00	72 15 00	18.3	13.9	
	7.00 p.m.	38 34 00	72 24 00	17.8	13.9	
	8.00 p.m.	38 30 00	72 34 00	16.7	12.5	
	9.00 p.m.	38 26 00	72 44 00	15.6	11.7	
	10.00 p.m.	38 22 00	72 54 00	15.0	11.7	
	11.00 p.m.	38 19 00	73 00 00	15.0	11.7	
	12.00 m.	38 15 00	73 09 00	15.0	12.2	
May 19	1.00 a.m.	38 11 00	73 18 00	15.6	12.2	
	2.00 a.m.	38 08 00	73 26 00	15.0	12.0	
	3.00 a.m.	38 04 00	73 26 00	15.0	12.0	

SURFACE TEMPERATURES TAKEN WHILE UNDER WAY DURING ATLANTIC CRUISES, SOUTH FROM NORFOLK, 1919, AND NORTH FROM NORFOLK, 1920—Continued.

Date.	Hour.	Latitude.	Longitude.	Temperature (°C.). Air.	Temperature (°C.). Surface.	Stations between which taken.
1920.		° ′ ″	° ′ ″			
May 19	4.00 a. m.	38 00 00	74 45 00	15.0	11.7	
	5.00 a. m.	37 56 00	74 53 00	15.0	11.7	
	6.00 a. m.	37 52 00	74 02 00	15.0	11.7	
						C20130.
	8.00 a. m.	37 48 00	74 11 00	16.1	12.2	
	9.00 a. m.	37 43 00	74 20 00	17.2	12.2	
	10.00 a. m.	37 37 00	74 29 00	17.8	12.2	
	11.00 a. m.	37 32 00	74 39 00	18.3	12.2	
	12.00 m.	37 27 00	74 48 00	17.8	12.2	
	1.00 p. m.	37 22 00	74 57 00	18.3	12.2	
	2.00 p. m.	37 16 00	75 06 00	18.3	12.2	
	3.00 p. m.	37 11 00	75 15 00	17.8	12.5	
	4.00 p. m.	37 06 00	75 25 00	18.3	13.3	
	5.00 p. m.	37 01 00	75 34 00	18.3	13.3	
	6.00 p. m.	37 04 00	75 42 00	18.3	13.9	
	7.00 p. m.	37 01 00	75 52 00	18.3	13.3	
						[Cape Charles.]

PRESERVATION OF FISH NETS

By HARDEN F. TAYLOR
Assistant for Developing Fisheries and for Saving and Use of Fishery Products
U. S. Bureau of Fisheries

Appendix IV to the Report of the U. S. Commissioner of Fisheries for 1920

51700°—21——20

CONTENTS.

PRESERVATION OF FISH NETS.

By Harden F. Taylor, *Assistant for Developing Fisheries and for Saving and Use of Fishery Products, U. S. Bureau of Fisheries.*

Contribution from the Fishery Products Laboratory, Washington, D. C.

INTRODUCTION.

The art of net preservation grew up long ago, as it might be expected inevitably to do, where it was necessary to make fishing gear of nonliving plant fibers that are exposed to the destructive effects of water, air, and sunlight. The word "art" of net preservation as distinguished from "science" of net preservation is used advisedly; one needs to see only the multiplicity of recipes for curing or preserving nets to be convinced that the processes belong to the same class as cookery or home treatment of diseases, where each locality and often each family has its own recipes or formulas, which are tenaciously adhered to and believed in. The many recipes found in the literature represent the fisherman's efforts to make his expense and labor count for more by prolonging the life of the net and reducing his overhead expenses.

The purpose of this paper is not to collect all these old recipes for preserving nets, but rather to review the literature of the subject and to present the fundamental principles in the light of chemistry so far as they are known, and to give for use those recipes which, from a chemical standpoint, seem best calculated to serve their purpose. It will be seen that while many methods as practiced are empirical and crude, they nevertheless contain the germ of correct chemistry, and not a little progress has been made in improvement of technique by chemists, notably Thv. Lindeman and Henrik Bull in Norway and J. T. Cunningham in England. Most of the work has been done by the Norwegians; as a matter of fact, only one important paper, that of Cunningham, has been found, in any language other than Norwegian, as shown by the list of references at the end of this paper.

NATURE OF DISINTEGRATION OF NETS.

MECHANICAL WEAR AND TEAR.

Before considering the various treatments that are given nets to prolong their usefulness, it may be profitable to consider the nature of the wear and tear that ruins nets. Obviously mechanical wear is one of the great enemies of nets. The threads rub against one another, against the gunwales of the boat, and against the floats and leads; this rubbing slowly abrades the threads and wears them out. Actual breakage by being caught on snags or by the struggles of large fish and the like must be reckoned with; such breakings, of course, become more numerous when the net becomes weaker by rotting. A factor in the destruction of nets that is sometimes overlooked may also be mentioned here: That when the threads are coated with thick tars and the like the total weight of the net is greatly increased and the preservative action of the tar is thus in part neutralized, the pull of the extra weight being added to other strains that may break the threads.

BACTERIAL DECOMPOSITION.

But of more importance than mechanical wear and tear in shortening the life of nets is the action—chemical in nature—of water and air, aided by other agencies, particularly bacteria, in causing a weakening and rotting of the fibers. This rotting deserves very careful study, for it destroys nets long before they would otherwise be destroyed by mechanical wear and tear, and its nature, while exceedingly complex, must be understood, at least in part, before remedial measures can be taken intelligently.

Up to this point chemistry has made some progress, and some valuable work has been done on the chemistry of preserving materials, but as a whole the fishing industry has never taken very kindly to chemistry, and most of the work that bears useful fruit for the net preserver has been incidental to work in other important fields—the tanning of leather, bacteriology, and textile science. We must admit frankly that we know very little directly about the intimate nature of the rotting of nets.

In the discussion of bacterial decomposition let it be assumed that cotton nets are being considered, because it is chiefly nets of this material that need preserving. They consist of fine fibers of almost pure cellulose, a substance very close to starch in composition, differing from it chiefly in being insoluble in water under all ordinary conditions, while starch, by simple treatment, may be made to dissolve. Cellulose can be made soluble in different liquids by severe chemical treatments. As bacteria are also capable of dissolving or rotting the fibers some detailed consideration will be given to their mode of action.

Bacteria are plants, so very small that they can be seen only by the aid of a microscope; they are not provided with many parts, as are the large plants of our acquaintance, as they have no roots, leaves, bark, or flowers; they are simple little rods or spheres, movable, reproducing under favorable conditions with the greatest rapidity. They have no claws, mouth, jaws, teeth, or any other offensive weapons. How, then, do they do the great damages that they are accused of? In a most interesting and important way. We know that land plants take nourishment from the ground and air by imbibing it and that they have no mouths or offensive weapons. So do bacteria, by absorbing or soaking up the food on which they live. But anything to be absorbed must first be made liquid; solids can not be soaked up, and it happens that very few natural foods are liquid. So the bacterium must secrete a digestive juice that causes the solid food surrounding it to liquefy, whereupon the liquid food is absorbed. This digestive juice acts in a way similar to that of the human digestive juice, and for the same purpose; the principal difference between our own digestion and that of bacteria is that ours takes place inside our bodies after the food is taken in, while the bacteria digest it before. So after all there is nothing incredible about it. Most bacteria are equipped for using a particular class of foods—they are meat eaters, sugar eaters, starch eaters, fat eaters—and they do not mix foods. They are able to secrete a digestive juice capable of liquefying that particular food on which they live.

Now, from what has been said, it is easy to see that the damage done to nets by bacteria must be done in either one of two ways, viz, the digestive juice itself or some of the changed products of digestion must attack the nets or else the waste products thrown off from the bacteria themselves (and some of these are active or virulent chemicals) must do so. If the digestive juices attack the cellulose fibers of the net, of course the fibers are dissolved, and this dissolution would be a very effective rotting. At any rate, what has already been said constitutes about all that can confidently be said about the intimate nature of bacterial decomposition of nets. If any more is to be known about it, a study must be undertaken.

For preserving nets against bacteria a number of possibilities suggest themselves. Since bacteria require water for activity, it is plain that if we keep the nets dry as much as possible we lessen the decomposition. But since the use of fish nets requires them to be wet, another step may be taken against the bacteria. It is possible to impregnate the fibers with substances that are poisonous to bacteria, or, quite as effective, which spoil the activity of the digestive juices produced by bacteria. Creosote and substances containing copper have been used for this purpose. Another method of preventing the destructive action of bacteria is to make the fibers insoluble and proof against the digestive action of bacteria. For hardening the fibers and making them harmful and indigestible to bacteria, tanning barks and extracts, such as birch bark, catechu, quebracho, quercitron, etc., have been used. These will be considered in detail later. Meanwhile other methods of resisting the action of bacteria are to cover the fibers with a protective coating, such as tar, linseed oil, etc.

OXIDATION.

Another enemy to nets is oxidation. The air consists of one-fifth oxygen, a colorless gas, which supports all fire and also is the active constituent of our breath. When one "sets fire to" a combustible material one so heats a small part of the material that the oxygen of the air combines directly with it. This combining releases more heat, which in turn hastens the combining of more oxygen with still more of the material, and so on, until the material is burning. While most combustible substances either burn rapidly or not at all, some things may oxidize slowly. For example, when nets are stored wet, covered with herring oil, blood, and slime, all of which are easily oxidizable, the oxygen of the air combines with these fish residues and probably also with the net. A heating thus begins, and the nets may even take fire; if not, the heat generated may be sufficient to weaken or destroy them.

To prevent this oxidation it may be sufficient to coat the nets with a covering like tar or linseed oil; it is, however, probable that tanning the fibers makes the fibers less likely to heat. The simple precaution of washing the nets clean and drying them while spread out is usually sufficient to prevent damage from overheating.

It is further possible that the products formed by the decomposition of fish slime and oil are injurious to nets.

Scarcely any treatment will confine itself to preventing any one of the attacks on nets mentioned above, but should be directed toward prevention of all causes of disintegration. The successful process must (*a*) destroy bacteria or prevent their action, (*b*) make the threads insoluble and proof against the digestive action of bacteria, and (*c*) prevent oxidation by coating the fibers or making them proof against oxidation.

COLORING OF NETS.

Before consideration is given to net-preserving materials, another purpose of curing nets should be mentioned. When nets are treated or cured, their color is usually changed, and it is argued that a less conspicuous net is less likely to frighten away fish. This is a disputed point (see Jessen, 1910),[a] though it might seem perfectly natural that an invisible or poorly visible net would be less likely to frighten fish. It must be remembered, however, that a fish does not see through human eyes but through fish eyes and that a color that is conspicuous to our eyes might not be readily discerned by a fish. The French sardine fishermen use (at least they did several years ago) a combination of soap and bluestone that imparted a bright green color to the nets; it was claimed that these caught more fish than nets not dyed. The Norwegians have a word, "*fiskelig*," that they apply to nets that are good catchers of fish. Bluestone is applied to nets (by methods to be mentioned later) to make them *fiskelig* by making them bluish green. This is done, of course, on the assumption that if the net is in color similar to sea water the fish can not see it well and so do not avoid it.

Many scientific investigations have been conducted to determine whether fishes can distinguish colors or not. Most of the evidence goes to show that they can; but perhaps they can see fewer colors than humans can. Some investigators have secured evidence that fishes do not distinguish color but that they get different amounts of light from different colors. Thus, a bright green would give more light, or appear lighter in shade, than a dark red, though a fish could get no effect of greenness or of redness. It is also possible, even probable, that different kinds of fish have different abilities to see colors. Thus, it is argued, light does not penetrate very deep into water, and so fishes living at some depth could not see colored objects, even if they had eyes equipped for color vision; and, since nature does not commonly provide useless organs or powers, color vision is not among the accomplishments of bottom-living fishes.

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[a] Author's name, with year mentioned in parenthesis, refers to the "Citation of Literature" at the end of this paper. For example: Jessen (1910) refers to the paper by Peter Jessen, published in 1910, a reference to which will be found at the end of this paper.

But it is not necessary to go further into this disputed subject. It stands to reason that fish perceive differences of brightness, and probably of color, and that if we make a net similar to sea water in both shade and color it will not be so readily visible. Those who might wish to go into this subject are referred to the article by Reeves (1919).

PRESERVATION OF NETS BY TANNING MATERIALS.

The materials most widely used for curing nets are tanning materials—barks of birch, oak, spruce, hemlock; extracts of bark or wood, such as catechu, quercitron, quebracho, and the like. For preserving, the original process consisted of immersing or soaking the net in a decoction of bark, or in a solution of the extract. One of the earliest methods was the so-called "cold-tanning," a slow process described by Aase (1912). This writer says that the old Norse fishermen used the same nets over and over for from 30 to 50 years. He also says that while much of this superiority of their nets might be explained by the fact that their thread was selected and spun by hand, and therefore better than modern machine-spun threads, the difference between those times and the present, when one is lucky to use a net for from 3 to 10 years, is too great to be explained by the homespun theory. He accounts for the difference by the cold-tanning process, described as follows:

COLD TANNING.

'Every net owner had his own large tanning vessel, which provided a place for both bark and net. In this vat was placed as much water as there was use for, and to every barrel of water was added 1½ vog (1 vog=36 pounds) of birch bark, well broken up. This was allowed to stand four or five weeks, but was daily stirred around with a stick so that it could not become thick and slimy. The nets were put into this mixture. In the bottom of the vat a hole was provided so that the finished liquor could be tapped into a tub and poured back over the net to cover thoroughly the upper part of the net which otherwise might not come under the bark. The net remained in this vat two or three days, and every day the liquor was poured over it several times.

Such a barking gives little color, but makes the net hard. To produce the desired color it must not go into the bark a single time only. Nay, it must be dried and again laid in the tan vessel if there is any bark left, as many as four or five times. After it is dried it is dipped into the sea, and it now takes on its right color for the first time—a color it will hold for years. If the barking is repeated every year the net becomes harder and harder as it grows older.

The method takes a long time, and demands much labor; when more and greater nets began to be used, and prices of birch bark also rose, other methods of barking began to be tried.

HOT TANNING.

The next step in the development of processes of net curing was the employment of a warm barking. The bark is boiled, and the nets are treated in the hot decoction. Aase is authority for the statement that "with this method of tanning the net acquires color and hardness with one treatment, and much time can by this method be saved. But experience has shown that warm tanning does not endure, by a great deal, so long as cold tanning."

Then the extract, catechu, came into use. This extract is not so bulky, is readily soluble in water, and has been used successfully. The methods as practiced varied greatly, the variations being apparently not based on any particular reason. In general, the extract is dissolved in water—1 pound of catechu to from 1 to 3 gallons of hot water—and applied to the nets.

Nets preserved with tanning extracts are brown or tan in color and are more resistant to decay than untreated nets, as will be seen in figures to be given later. The tan, however, washes out, and it is necessary to repeat the treatment often.

CHEMISTRY OF TANNING MATERIALS.

Before going further with the methods of curing nets with tanning materials, it will be necessary to consider the chemistry of the latter.

It is not improbable that the treatment of nets by tanning was induced by the success of the treatment of animal skins by such materials to make leather. Tanning materials are bark or other parts of various trees which produce a reddish or brownish solution when steeped in cold water. There is scarcely a tree or shrub in some part of which tanning substances are not found.

The action of those materials may be illustrated by their effect on leather. Untanned hide when boiled for some time is nearly all dissolved; after it has been treated with tan liquor it is scarcely affected by boiling. When untanned hide is left in a moist condition for some time it putrefies; tanned hide does not. Thus a hide that is soluble in boiling water and putrefies in cold water is converted by tanning into a hide which is neither dissolved in hot water nor putrescible in cold. Just how these great differences are brought about can be illustrated by the effect of tanning materials on gelatin or glue. If a tanning extract be added to a solution of gelatin, the latter is coagulated and precipitated and is made permanently insoluble. Pure untreated gelatin readily swells in cold and dissolves in warm water and easily decomposes if left wet. But this tanned precipitate is resistant to the action of water and does not decompose. How is this important change brought about? The answer is given by a pair of balances. If we weigh a dry piece of gelatin, dissolve it, precipitate or curdle it with tan liquor, collect the precipitate or curd, wash, dry, and weigh it, we find that it has increased in weight. It can also be shown that the tan liquor has lost as much weight as the gelatin has gained—something from the tan liquor combined permanently with the gelatin to make the latter insoluble and resistant to change. This something is called tannin. It would be more correct to say these somethings, for there are several tannins, all closely akin, all affecting gelatin in the same way. It is they that, acting on hides, convert the soluble, putrescible gelatins in hides into insoluble substance, causing the hides to become leather.

The earlier method of analyzing tanning materials was to treat the solution with gelatin. This was done by taking first a definite volume of the solution and evaporating it to dryness and weighing the dry residue; then a like volume was taken from a sample that had been treated with gelatin, evaporated to dryness, and weighed. The sample that had been treated with gelatin had lost weight. The loss represents, of course, the substance taken up by the gelatin or tannin.

Since to the leather tanner the chief item of interest is the amount of substance actually taken up by hides, gelatin, as a measure of the tanning power of materials, has been supplanted by hide powder, which is clean oxhide dried and ground in a suitable mill. The liquor is drawn through this, and the difference in the weight of dried residue is noted and recorded as tannin. Account is also taken of the difference between weights of the liquor and dried residue, this difference representing water. There is also given the percentage of matter that does not dissolve in cold water, but which was filtered off of the liquor. Thus an analysis of a tanning material intended to represent its value for leather tanning gives four figures, of which the following is a typical example (Cunningham, 1902) of Burmah cutch or catechu:

	Per cent.
Tannins	46.6
Nontannins	20.0
Insoluble	11.5
Water	21.9
Total	100.0

There are some very significant differences between the treatment given to hides in making leather and that given to nets to preserve them and in the behavior of the treated materials. Hides, once they have taken up tannins, never let go, even though they are boiled or soaked in water; nets, however, lose their tanning materials rapidly in water, so that they must be tanned repeatedly if the method used for treating them is the same as that used for treating leather. It is thus obvious that the tannin does not combine in nets with any gelatin or other similar substance, but rather is merely deposited in the fibers. There is another important difference: Hides are tanned in a cold decoction of tan bark or extract, while nets are usually treated in hot liquors.

When catechu, for example, is dissolved in cold water, there always remains a residue, which appears in the analysis given above, as "insoluble." If the solution is heated to boiling, nearly all of this apparently insoluble material dissolves, only some pieces of leaves, sticks, and sand remaining. If the liquor is cooled off, the insoluble material again separates from solution. There is thus a comparatively large amount of substance insoluble in cold water but soluble in hot water. Upon examination, this substance, catechin, is found to be an active tanning material, and for the purpose of net preserving is better than that which is soluble in cold water, because it will not dissolve out in use. Cunningham tried to fix the tannin in nets by first impregnating them with glue (which is crude gelatin) and then treating them with catechu. The effort resulted in failure, apparently because the glue did not penetrate the fibers.

The coloring matters in barks and extracts are independent of the tannins and have no tanning power. Pure tannin (gallotannic acid from nut galls) is a light grayish yellow flaky powder, easily soluble in water.

Since the value of tanning material for net preservation depends upon the abundance of tannins, analyses should support important purchases. The following are analyses made of different samples of catechu, or cutch, by Cunningham, using the hide-powder method:

	Burmah.	Tuan.	Mudah.	Caller Herrin.
Tannins......per cent..	46.6	46.0	45.2	60.8
Nontannins......do....	20.0	9.8	15.6	14.9
Insoluble......do....	11.5	17.1	4.8	2.2
Water......do....	21.9	27.1	34.4	32.1
Total......do....	100.0	100.0	100.0	100.0
Strength after exposure......pounds; ounces..	5;6	8;0	2;4	2;9
Strength after exposure......kilograms..	2.437	3.629	.964	1.161

It is seen from the above table that there is a considerable difference between the values of the various samples of catechu, a fact equally true of other tanning extracts. The last two figures under each sample (which the writer has given also in kilograms for convenience in comparing with the Norwegian figures that are to follow later) represent breaking strength. Cunningham explains as follows how these figures were obtained:

In order to test the actual preserving power of different samples of cutch, I adopted, in my investigations in Cornwall, the following method: I procured a machine for testing the strength of a net before and after the experiments. The principal part of such a machine, which is called a dynamometer, is of the nature of a spring balance. One mesh of the net is attached to the balance, the other at a certain distance to a hook or knob which can be pulled away gradually by turning a handle. As the strain increases the hand on the dial of the balance indicates in pounds and ounces the weight which is equal to the strain until one of the meshes breaks, when the hand shows the number of pounds equal to the breaking strain.

In comparing the value of the different materials or processes of curing, I took pieces cut from the same net, and, therefore, when new, of the same strength, cured them, then fastened them by mooring at the bottom of Newlyn Harbor. After they had been under water a certain time the pieces were taken up and tested on the dynamometer and found to be of very different strengths, which showed the differences in the preserving properties of the various materials or processes.

One of the earliest experiments carried out on this method proves the preserving power of that part of cutch which is insoluble in cold water. So far as I know, there is no natural cutch or tanning extract which is completely soluble in cold water for the very good reason that the cutch or extract is generally made by boiling. But some of the red cutches put upon the market by the Borneo companies are almost entirely soluble in the cold, either because they have been chemically treated or because the insoluble part has been removed from them.

In this experiment I tested four kinds of cutch [as above]. The last three were red or mangrove cutches from Borneo. In every case the strength of the solution used was 1 pound to 1 gallon of water, the net was dipped twice, being left half an hour in the liquor each time and dried between the two dips. The pieces of cured net were left under water, uncovered only at low water in spring tides, for five weeks, and then tested.

Further reference to the table above will show that the Caller-Herrin catechu which contained the highest percentage of tannin was one of the poorest in preserving power where the nets were actually exposed for a long time to water and tested for strength. The Tuan catechu was best, though it contained the greatest percentage of insoluble matter, which would ordinarily be considered objectionable. This fact shows that the insoluble matter may add greatly to the value of the catechu. The reason for this superiority has already been mentioned. The analysis is made by dissolving samples of material in cold water. That which does not dissolve in cold water is recorded as insoluble and is useless to the leather tanner. But a great part of this insoluble matter is readily soluble in hot water, and, inasmuch as the nets are treated in the hot solution, this matter is deposited in the fibers and stays in the nets while the cold-water-soluble tannins wash out when the nets are put to use.

It will thus appear that analysis of tanning extracts made for the leather tanner's purpose is not all that could be wished from the fisherman's point of view. Cunningham recommends that for the use of net preservers there be included in the usual analysis a figure representing the amount of tannins insoluble in cold but soluble in hot water.

It might prove to be profitable for chemical manufacturers to go a step further than this by separating commercial catechu into two parts, the cold-water-soluble part suitable for the leather industry, and the hot-water-soluble part, not suitable for leather tanning, but preferable for the preservation of fishing gear.

With the provision that the hot-water-soluble tannins be considered in making calculations, Henrik Bull's (1912) point may be regarded as important; that is, that when tanning extracts are bought by the pound without reference to their content of active tannins, very unprofitable purchases may be made. Thus, if a sample of catechu sells for $0.10 per pound, and contains 40 per cent tannins, the actual price we pay for tannin is 10/40, or $0.25 per pound. Further, as will be seen from the following table, the cheaper grades of catechu may (but do not necessarily) furnish tannin at a price considerably higher than would be paid for actual tannin in more expensive grades of extract.[a]

Sample.	Price per pound.	Percentage tannin present.	Price tannin per pound.
A	$0.09	35	$0.26
B	.10	45	.22
C	.11	55	.20
D	.12	65	.185

To calculate the actual cost of tannin where an analysis is available, use the formula:

$$\text{Cost of tannin per pound} = \frac{\text{cost of extract per pound}}{\text{percentage of tannin in extract}}$$

that is, divide the cost of extract per pound by the percentage of tannin in the extract, and the quotient represents the cost per pound of the tannin.

[a] The original table is in Norwegian øre per kilogram of extract. Since, however, the table is only intended to represent a comparison, the writer has assumed suitable figures for American readers.

TANNING MATERIALS USED FOR FISH NETS.

Up to this point attention has been given to catechu. There are numerous other tanning materials put upon the market as bark or wood or as extract. The extract may be liquid, solid, in lumps, or in a fine powder prepared by a recently developed process. The principal tanning materials, as given by Cunningham, are:

Oak bark, the bark of the common English oak, is largely used for tanning leather. The barks of another species in Turkey, and of the chestnut oak (*Quercus castanea*) of America are also used. The bark is stripped from the trees when they are about 15 years old.

Hemlock bark is really the bark of a kind of pine abundant in America, called Canadian pine (*Abies canadensis*). It is the principal tanning material of the United States. The extract of this material in liquid form has been recommended for net curing under the name of Canada cutch, and is sold in tins containing about 3 pounds weight.

Mimosa, or wattle bark, is obtained from various Mimosæ or acacia trees growing in Australia, where this is the staple tanning material.

Quebracho is obtained from several kinds of South American trees. It is imported largely in the form of both dry and liquid extracts.

Valonia consists, not of the bark, but of the cups of the acorns of a certain oak (*Quercus ægylops*) growing in the Levant.

Sumach consists of the leaves of a plant dried and ground. The plant grows in the south of Europe.

Gambier, or terra japonica, is a dry extract prepared from the leaves and twigs of a tree called *Uncaria gambier* in the Malay Peninsula. It is imported from Singapore. There are two forms, block gambier, in large masses, and cube gambier, in small, light-yellow cubes. It is not much used for net curing, but I believe has been used in former times at some places, such as Clovelly, under the name of catechu.

True cutch, or catechu, is a dry extract made from the wood of a tree called *Acacia catechu*, which grows in India and Burmah. It may be distinguished as Burmah cutch, as its manufacture is carried on chiefly by natives, according to their own traditional methods, in Burmah. It is imported from Rangoon. Until recently it was used everywhere around the British coasts for net curing, and was used in far larger quantities than any other tanning material.

Red cutch or mangrove cutch is made from the bark of mangrove trees, which grow in swamps at the mouths of rivers in tropical countries. This cutch is now manufactured extensively by two British companies in Borneo, and is largely used for net curing, having replaced Burmah cutch to a considerable extent.

Myrobalans, divi-divi, and algarobilla are raw materials consisting of the dried fruits or seed pods of different trees. They are imported for use in the leather industry, but are not used for net curing. Canaigre is also a raw material, consisting of the root of a plant growing in New Mexico and Arizona, not used for the fishing industry.

To this list should be added quercitron, a large timber oak (*Quercus velutina*) of the eastern United States, having foliage resembling that of the red oak, but with yellow inner bark. It is on the market as rough bark, rossed bark, ground bark, and solid and liquid extracts. As will be seen later, Bull found this to be one of the best materials for curing nets.

It is thus seen that there are a great many tanning materials, that in common they have tannin, and that this tannin in some way prevents rotting of nets, probably by destroying the digestives with which the bacteria seek to rot the net, or by making the thread indigestible. At any rate, actual measurements of strength show that tannins do preserve nets, and that the principal objections to them as ideal preservatives are that if used unaided they wash out of the nets, and that if the preservation is to last the application must be often repeated.

FIXING OR MORDANTING OF TANNED NETS.

The next step, therefore, is to cause the preserving tannin to stay in the net, and to do this it is necessary to know something of the chemistry of the tannins. It has already been shown that tannins combine with gelatin to form a permanently insoluble substance, this combination being the essential principle in converting hides into leather. Gelatin exists naturally in hides, but there is nothing naturally occurring in cotton corresponding to gelatin with which the tannin can form an insoluble compound.

Tannin is readily oxidized; that is to say, it readily takes up and combines with the oxygen of the air, and when so combined is insoluble and much darker in color. Why, then, does not the tannin oxidize and stay in nets? In fact it does, to a certain extent, as any fisherman who has used "barked" nets knows the nets never regain their original whiteness. But the oxidation takes time, and in practice the net is put into the water before much of the tannin is oxidized, whereupon the unoxidized tannin promptly washes out. To store the net for a time after barking would do little good, for in a dry condition the oxidation proceeds very slowly or not at all. Repeated wetting and drying was credited by Bull in his comments on the paper by Aase referred to above, with the eventual thorough impregnation of nets by the old-time, cold-barking method. It is probable that by holding the nets wet for a long time after barking and allowing free access of air the tan might be fixed permanently in the fibers.

There is, however, no need to do this, for once the chemistry of the process is understood the same end may be achieved by quicker chemical means. There are a number of chemicals which contain oxygen in large quantities, and which yield up this oxygen easily. One such chemical is potassium bichromate. If a solution of potassium bichromate be added to a solution of catechu, a dark-colored, insoluble compound is formed—the combination of tannin with oxygen, the oxygen coming from the potassium bichromate. Advantage is taken of this principle in dyeing; catechu or some other natural wood dye is applied to the fibers and then darkened and fixed by a solution of potassium bichromate. This process is used primarily in the leather and textile industries for the coloring it gives, but no modification is needed to use the method for preserving nets.

The bichromate acts not only on the tannins that are soluble in cold water, but upon the catechin that is soluble in hot water.

The oxidation of tannins is greatly accelerated by alkalis—lye, soda, potash, etc.—but these all have a very objectionable characteristic in that they cause to dissolve in cold water the tanning substance which in its natural state is soluble only in hot water. These alkalis are therefore not used.

CUNNINGHAM'S EXPERIMENTS.

The very thorough work done by Bull in Norway and Cunningham in England has made it possible to preserve nets at much less labor and expense by use of potassium bichromate. To quote Cunningham:

Accordingly I made at Newlyn a large number of experiments * * * to test whether by the use of bichromate the net could be preserved more successfully or more cheaply, and the results were very favorable. One of the most striking of these experiments was made entirely with Burmah cutch, of the Double Eagle brand. The pieces of net used were cut from the net made at Bridport, 25 rows to the yard, 12-ply cotton. The strength of the net when tested new and uncured, or "white," was 15¾ pounds * * *. Four pieces of net, cured with and without bichromate, as shown below, were put down in Newlyn Harbor on January 31, 1900, and taken up and tested on March 3, so that they were in the water between four and five weeks. The strengths given are the averages of five trials on the testing machine:

	Pounds.	Ounces.
1. Dipped once in Burmah cutch, 1 pound to 1 gallon of water	4	2
2. Dipped *twice* in Burmah cutch of same strength, dried after first dip	6	5
3. Dipped once in Burmah cutch, same strength, with 1 ounce bichromate potash added to 1 gallon cutch liquor	5	3
4. Dipped once in Burmah cutch, same strength, then dipped separately in hot solution of bichromate, one-half pound to 1 gallon water	14	5

It will be seen that of these four pieces of net, which were placed in the harbor at the same time, fastened to the same piece of rope, three were practically rotten, while the fourth was nearly as strong as when new, and this fourth piece was the one that had been cured with bichromate of potash.

Dipping twice in cutch alone (No. 2) seems to improve the net very little. Experiment No. 3 shows that the bichromate does no good if added to the cutch solution, but must be applied *separately* to be effective. The reason for this, as will be seen above, is that the bichromate makes the tannins insoluble, so that they do not get into the fibers at all.

The bichromate solution used above was strong.

The following series of tests shows the results with weaker bichromate solution, and different combinations, nets submerged January 31, taken up March 30, put down again May 14, finally taken up and tested May 28:

	Pounds.	Ounces.
1. Burmah cutch, 1 pound to gallon, net put in hot liquid and left to soak 24 hours	4	14
2. Mangrove cutch A, a somewhat insoluble kind; same treatment	5	12
3. Mangrove cutch B, another brand; same treatment	7	6
4. Burmah cutch, same treatment; net then dipped in hot bichromate, 1 ounce to 1 gallon water	13	5
5. Mangrove cutch A, same treatment, following by hot bichromate, same strength	14	9
6. Mangrove cutch B, same treatment, followed by hot bichromate, same strength	13	5
7. Mangrove cutch B, 1 pound, with 1 ounce bichromate, boiled together in 1 gallon water, net left to soak 24 hours	1	13
8. Burmah cutch, 1 pound, with 1 ounce washing soda, boiled together in 1 gallon water, net left to soak 24 hours	6	12
9. Mangrove cutch A and soda; same treatment	4	2
10. Burmah cutch, 1 pound to 1 gallon sea water instead of fresh	5	13
11. Mangrove cutch A, in sea water; same strength	6	5

Here, again, it is shown that no treatment appears to do much good without the after treatment with bichromate. The use of bichromate *with* the cutch destroys any preserving power the cutch alone may have. The small differences between the different varieties of cutch and the different modes of handling, exclusive of the bichromate after treatment, are not significant.

The following is another series of experiments made by Cunningham in which quebracho and cube gambier were tried:

The pieces in this case were left in the harbor from May 28 to July 15, a period of seven weeks. The pieces of net were cut from another new net, which seems to have been of better quality than that previously used, as the pieces cured with cutch alone were not so weak after exposure as in previous experiments:

	Pounds.	Ounces.
1. Mangrove B, alone, 1 pound to 1 gallon water, dipped once, soaked 10 minutes	12	5
2. Quebracho alone, same strength, same treatment	9	5
3. Cube gambier alone, same strength, same treatment	5	
4. Mangrove B, as before, then dipped in hot bichromate, 1 ounce to 1 gallon water	13	8
5. Quebracho as before, followed by bichromate, 1 ounce to 1 gallon	12	8 14
6. Gambier as before, followed by bicromate, 1 ounce to 1 gallon	11	5
7. Mangrove B, 1 pound, soda 1 ounce to 1 gallon water, net dipped in mixture then dipped in bichromate, 1 ounce to 1 gallon water	7	8
8. Gambier with soda, then bichromate in above proportions	7	12
9. Mangrove B, one-half pound to one-half gallon water, mixed with one-half pint bichromate solution, 1 ounce to 1 gallon	7	8
10. Quebracho mixed with bichromate, same proportions	10	10
11. Quebracho, one-half pound, bichromate one-half ounce to 1 gallon water, together	5	10

Again, it is shown that bichromate, if used as a separate after-treatment, greatly increases the preserving effect of the tanning materials; it also further confirms the conclusion that bichromate mixed with the tanning material does harm rather than good. Soda added to the tanning extract previous to use is rather harmful than otherwise, as shown by trials Nos. 7 and 8.

LINDEMAN'S EXPERIMENTS.

Thv. Lindeman (1897), in the prize-winning paper submitted in competition before the Trondhjem Fishery Society in 1896 for the best paper on preservation of nets, seems to have been first to use the dynamometer, or breaking-test, method of studying the preservation of nets. On two kinds of thread, hemp and cotton, he tried 12 preserving materials in comparison with untreated thread, as follows:

I. Thread, without treatment.

II. Bluestone.—1½ kilos (3.3 pounds) bluestone, 1 barrel water. Net lies in this 1 day, washed out without drying, and then put directly into the sea.

III. Catechu with mordant.—To 7½ kilos (16.2 pounds) net, take 1 to 1¼ kilos (2.2 to 2.75 pounds) catechu, which is boiled until dissolved; add 60 grams (2 ounces) bluestone. The net is put in this bath while it is warm (60° C. or 140° F.) and allowed to stand over night. The next day it is well drained and brought into a bath (80° C. or 176° F.) in which is dissolved 180 grams (6.4 ounces) potassium bichromate.

IV. Catechu with linseed oil.—The net is prepared according to III, dried by artificial drying, and brought into warmed raw linseed oil, in which it lies until next day; it is then taken out, freed as much as possible from the oil, and dried in air.

V. Birch bark, cold.—20 kilos (44 pounds) birch bark is added to 1 barrel water; to this is added 1 to 2 kilos (2.2 to 4.4 pounds) of soda. This stands cold about 8 days to extract. The net lies in this 1 to 2 days.

VI. Linseed oil, raw.—The net is first artificially warmed; it is then laid in raw linseed oil for 1 day. It is then taken out, freed of oil, and dried as in IV.

VII. Spruce cones.—To one-half barrel of water a quarter of cones is taken. This is boiled vigorously about 3 hours. After it is cooled off the net lies in it about 2 days.

VIII. Wood tar, Norwegian.—The net is artificially dried as in VI, laid under warm wood tar for a sufficient time to assure that it is thoroughly penetrated, after which it is taken out and freed of excess.

IX. Quebracho wood.—10 kilos (22 pounds) to about 150 liters (40 gallons) water, boiled for 1 hour, after which the net is laid in it while it is still warm and allowed to lie in it a couple of days.

X. Zinc chloride.—1 kilo (2.2 pounds) zinc chloride to 100 liters (30 gallons) water; net is allowed to lie in this 1 day.

Before treatment a series of trials was made on different places in the skein of thread used. The results of these stretching tests were as follows:

	A. Hemp.	B. Cotton.
Average breaking load	14.9 kilos (av. of 13 tests).	8.5 kilos (av. of 10 tests).
Weight per meter	0.623 gram.	0.494 gram.
Breaking length	23.9 kilometers.	17.1 kilometers.

It will be observed that in addition to the breaking load, Lindeman also gives the weight per meter of the thread and "breaking length." This latter figure denotes the length of thread that will hold itself up, or the length of thread in a ball whose weight is the breaking load. The strength of thread as ordinarily understood means strength for a given size or weight, for of course a thread can be made of any strength if it is only large enough. The smaller and lighter a thread of given strength, the better. This figure, breaking length, probably furnishes a better basis, if proper precautions are taken, than breaking load, of the quality of a net. Since the weight of a meter of thread is given and the breaking load is given, the breaking load divided by the weight of a meter will give the breaking length in meters (1 kilometer=1,000 meters, or 0.6 mile).

This breaking-length figure is particularly valuable in judging such preservatives as tar and linseed oil, preservatives that add considerable weight to the net. This figure may go to show that where a net must support its own weight, one that appears to be well preserved may be, in fact, poorly preserved because of the greatly increased weight.

After testing the original thread, Lindeman treated different samples by the methods described above, and put them, along with untreated samples, in the sea, and after varying lengths of time measured strength and weight.

The nets were put in the sea October 6 (1895).
First test, 8 days afterward.
Second test, February 1 (1896), after about 14 weeks.
Third test, May 3, about 13 weeks after second test. After the third test the samples were destroyed by a passing boat. A new series was prepared and hung out in the sea July 7.
Fourth test, October 1 (1897), after 12½ weeks.
Fifth test, January 1 (1897), after 13 weeks.

The test pieces taken up October 1 were covered with mussel spat, and were greatly reduced in strength. By the time the fifth test was made the nets had so far disintegrated that they could not be tested on the dynamometer; the investigator therefore made notes with the letters, *a*, *b*, and *c* to indicate how far gone they were, meaning something like poor, poorer, poorest.

It is apparent that the pieces of net used for the fourth and fifth tests underwent decomposition much more rapidly than the earlier ones. While Lindeman offers no explanation of this difference, it may be readily explained by the warm weather, since it is common experience that nets rot more rapidly in warm weather than in cold.

The results of these tests are summarized in the accompanying table. Each figure represents an average of from 5 to 13 trials, so that differences in particular places on the thread are ironed out to some extent.

Strength and weight of thread.	I. Without preparation.	II. Bluestone.	III. Catechu with mordant.	IV. Catechu with linseed oil.	V. Birch bark.
A. HEMP.					
Test 1:					
Breaking load........kilogram..	13.3	12.6	13.7	10.9	11.5
Weight per meter........gram..	.600	.675	.696	.910	.628
Breaking length........kilometer..	22.2	18.7	19.7	12.0	18.3
Test 2:					
Breaking load........kilogram..	8.6	11.2	12.2	14.0	9.1
Weight per meter........gram..	.554	.593	.723	1.000	.660
Breaking length........kilometer..	15.7	18.9	16.8	14.0	13.8
Test 3:					
Breaking load........kilogram..	6.4	11.8	12.1	13.2	9.7
Weight per meter........gram..	.509	.646	.687	.837	.652
Breaking length........kilometer..	12.5	18.3	17.6	15.8	14.9
Test 4:					
Breaking load........kilogram..	...	9.0	7.7	7.9	4.6
Weight per meter........gram..	...	.804	.688	1.200	.732
Breaking length........kilometer..	....	11.2	11.2	6.6	6.3
Test 5:					
Breaking load........kilogram..	...	...	9.1	7.5	...
Weight per meter........gram..	...	(*b*)	.765	1.045	(*c*)
Breaking length........kilometer..	....	....	11.9	7.1	....
B. COTTON.					
Test 1:					
Breaking load........kilogram..	7.8	8.2	7.9	5.6	7.8
Weight per meter........gram..	.558	.507	.566	.961	.538
Breaking length........kilometer..	13.9	16.1	13.9	5.8	14.5
Test 2:					
Breaking load........kilogram..	3.7	7.7	8.5	7.5	6.1
Weight per meter........gram..	.497	.493	.610	.894	.530
Breaking length........kilometer..	7.6	15.6	13.9	8.4	11.5
Test 3:					
Breaking load........kilogram..	2.3	7.0	9.3	7.4	3.8
Weight per meter........gram..	.530	.564	.610	.865	.577
Breaking length........kilometer..	4.4	12.8	15.2	8.5	6.6
Test 4:					
Breaking load........kilogram..	...	2.7	6.7	7.1	2.8
Weight per meter........gram..	...	.489	.580	.822	.536
Breaking length........kilometer..	....	5.5	11.5	8.6	5.2
Test 5:					
Breaking load........kilogram..	...	...	5.8	6.3	...
Weight per meter........gram..	...	(*c*)	.570	.764	(*c*)
Breaking length........kilometer..	....	....	10.2	8.2	....

NOTE.—*a*, *b*, and *c*, meaning something like poor, poorer, poorest, indicate that nets had disintegrated too far to be tested on the dynamometer.

Strength and weight of thread.	VI. Linseed oil.	VII. Spruce cones.	VIII. Tar.	IX. Quebracho.	X. Zinc chloride.
A. HEMP.					
Test 1:					
Breaking load.......kilogram..	12.6	13.4	10.8	12.5	11.4
Weight per meter.......gram..	.821	.852	.987	.720	.679
Breaking length.......kilometer..	15.3	15.7	10.9	17.4	16.8
Test 2:					
Breaking load.......kilogram..	11.5	12.4	13.1	11.9	8.1
Weight per meter.......gram..	.704	.678	.958	.686	.588
Breaking length.......kilometer..	16.3	18.3	13.7	17.3	13.8
Test 3:					
Breaking load.......kilogram..	12.9	12.6	11.9	12.7	6.6
Weight per meter.......gram..	.642	.712	.792	.803	.622
Breaking length.......kilometer..	20.1	17.8	15.0	15.8	10.6
Test 4:					
Breaking load.......kilogram..	7.8	3.5	9.3	5.0	...
Weight per meter.......gram..	.840	.700	1.030	.738	...
Breaking length.......kilometer..	9.3	5.0	9.0	6.8	....
Test 5:					
Breaking load.......kilogram..	...	...	...	...	...
Weight per meter.......gram..	(c)	(b)	(a)	(b)	...
Breaking length.......kilometer..	....	....	....	....	...
B. COTTON.					
Test 1:					
Breaking load.......kilogram..	7.0	8.5	7.8	8.1	7.2
Weight per meter.......gram..	.727	.585	.974	.559	.647
Breaking length.......kilometer..	9.6	14.5	8.0	14.5	14.0
Test 2:					
Breaking load.......kilogram..	8.4	8.6	7.6	8.2	3.0
Weight per meter.......gram..	.734	.571	.848	.564	.487
Breaking length.......kilometer..	11.4	15.1	8.8	14.6	6.2
Test 3:					
Breaking load.......kilogram..	8.5	8.5	8.4	8.1	2.9
Weight per meter.......gram..	.710	.600	.830	.590	.523
Breaking length.......kilometer..	12.0	14.1	10.1	13.7	5.5
Test 4:					
Breaking load.......kilogram..	6.0	3.7	6.8	2.9	...
Weight per meter.......gram..	.660	.510	.856	.495	...
Breaking length.......kilometer..	9.1	7.3	7.9	5.9	...
Test 5:					
Breaking load.......kilogram..	...	...	...	...	...
Weight per meter.......gram..	(c)	(b)	(a)	(b)	...
Breaking length.......kilometer..	....	....	....	....	....

Of the methods that depend on tannins for their activity, Nos. III, IV, V, VII, and IX, only two may be considered at all successful; they are Nos. III and IV. These two received identical treatment—i. e., catechu with copper sulphate and potassium bichromate—but No. IV received a subsequent treatment with linseed oil. If judged by the breaking strength alone, the linseed oil adds a very little; but if judged by breaking length, it is not so good as the previous one. Of methods of tanning nets this is additional evidence that the use of a fixer or mordant, potassium bichromate, greatly increases the preserving quality of tanning materials.

The use of zinc chloride suggested itself to Lindeman because it converts cellulose into so-called hydrocellulose and is used as a preservative for railroad crossties. It is a failure for preserving nets.

The nontannin preserving materials will be considered later.

Another point about the table worthy of notice is that tannins have an effect on hemp nets similar to that on cotton, but not so great.

It should also be noted that Lindeman's paper appeared five years earlier than Cunningham's paper, or that of Bull, next to be considered.

BULL'S EXPERIMENTS.

Bull (1901), in Norway, carried on a similar series of experiments, using a greater number of combinations, including oak bark, quercitron extract, and coal tar. He also carried out more elaborate processes of preparation, including such manipulations as three or four baths and combinations of second treatments. The table following gives Bull's results and carries brief descriptions of the methods used. In the text Bull says he barked the nets in "the customary way."

Lindeman used the bluestone (or copper sulphate, copper vitriol, blue vitriol, as it is variously called) in the same bath with the tanning material. On this point Bull (1901) says:

> When I began this investigation, since I used quercitron extract in as pure a condition as was obtainable, in lieu of catechu, I observed that in solution in water it has, with copper-vitriol solution, a reaction that produces a precipitate which dissolves with difficulty in water, for which reason the coloring method must be regarded as disadvantageous, because the precipitate is formed rather on the thread and is not in the solution. In addition, I found that the second bath may be also harmful in the use of very warm (80° C. or 176° F.) solution of potassium bichromate, since this strong agent, with the high temperature used, may very well cause a weakening of the thread.

Bull also says:

> As a barking material quercitron extract has shown itself to be the best. * * * A noteworthy result is shown in experiment 17, in which the net is barked twice with quercitron extract and afterwards treated with the oxidation mixture. It is shown that the net, after 11 weeks, is of the same strength as before it was immersed in the sea, namely, 23 kilograms.

Quercitron, as well as other tanning extracts and barks, can be secured from American dealers in tanners' supplies.

The copper may have some preserving action; Cunningham thinks it is injurious. It appears to the writer that, while it may strengthen the defense against certain organisms, its chief use on nets is to impart a dark, durable color.

Experiment No.	Method of preparing the thread. After treatment, No. — I.	II.	III.	IV.	Breaking load, after— Preparing.	Sunlight 14 days.	Stored moist 14 days.	Moistened with herring offal 14 days.	1 week in sea water.	5 weeks in sea water.	7 weeks in sea water.	9 weeks in sea water.	11 weeks in sea water.	Weight of 10 meters.	Thread takes up water.	Breaking length.a
					Kilograms.	*Kilograms.*	*Kilograms.*	*Kilograms.*	*Kilograms.*	*Kilograms.*	*Kilograms.*	*Kilograms.*	*Kilograms.*	*Grams.*	*Per cent.*	*Kilometers.*
0	Untreated				1.95	1.75	1.85	1.65	1.98	0.0	0.0	0.0	0.0	1.45	227	13.5
1	Catechu				2.13	1.90	2.02	2.09	1.88	.48	.12	.0	.0	1.514	282	14.1
2	do	Bluestone and potassium bichromate.			2.00	1.77	1.84	1.88	2.00	1.88	1.7	1.87	1.58	1.656	254	12.0
3	Spruce bark				2.02	1.95	2.00	1.35	2.04	.20	.0	.0	.0	1.576	250	12.8
4	do	Bluestone and potassium bichromate.			2.00	2.07	1.84	2.00	2.09	1.82	1.97	1.79	1.42	1.514	232	13.1
5	Birch bark				2.03	2.15	2.59	2.24	2.19	.39	.0	.0	.0	1.53	248	13.2
6	do	Bluestone and potassium bichromate.			2.19	2.01	2.24	2.03	2.17	2.21	2.20	1.67	1.97	1.61	123	13.6
7	Oak bark				2.13	2.02	2.45	2.17	1.88	.19	.0	.0	.0	1.45	228	14.7
8	do	Bluestone and potassium bichromate.			2.11	1.95	1.99	2.17	2.10	2.15	1.71	1.97	1.95	1.50	145	14.0
9	Quebracho				2.15	2.03	2.32	2.03	2.19	2.13	.0	1.83	.0	1.65	206	13.0
10	do	Bluestone and potassium bichromate.			1.97	2.06	2.06	2.04	2.10	.41	.0	.0	.0	1.65	203	11.9
11	Quercitron				1.77	1.84	1.98	1.79	2.00	.42	.0	.0	.0	1.52	179	11.7
12	do	Bluestone and potassium bichromate.			2.00	1.96	1.95	2.16	2.07	2.18	2.11	2.15	2.03	1.58	134	12.6
13	do	Bluestone			2.09	1.97	2.00	1.55	1.82	.48	.0	.0	.0	1.472	237	14.2
14	do	Manganese chloride and potassium bichromate.			2.15	2.04	2.15	1.97	2.15	2.08	1.1	.46	.28	1.57	170	13.6
15		Zinc vitriol potassium bichromate.			2.16	2.02	2.14	1.93	2.10	2.03	1.34	.50	.0	1.57	188	13.7

16	Quercitron	Quercitron			2.04	1.99	2.20	2.21	2.08	.34	.45	.0	.0	1.55	216	13.1
17	do	do	Bluestone and potassium bichromate.		2.34	2.11	2.19	2.37	2.55	2.48	2.45	2.36	2.32	1.79	137	13.0
18	do	Bluestone and potassium bichromate.	Quercitron		2.15	2.15	2.19	5.15	2.19	2.27	2.36	2.15	2.06	1.65	191	13.1
19	do	do	do	Bluestone and potassium bichromate.	2.06	2.06	2.11	2.14	2.06	2.02	2.37	2.15	2.02	1.72	144	11.9
20	Catechu	do	Catechu		1.83	1.88	1.95	1.69	1.85	1.90	1.86	1.81	1.88	1.82	164	10.0
21	Coal tar and carbolineum.				2.09	1.88	2.13	2.02	2.16	1.32	.94	1.04	.44	2.697	85	7.8
22	Quercitron	Coal tar and carbolineum.			2.25	2.16	2.25	2.25	2.04	2.34	2.11	2.17	2.09	3.214	70	7.0
23	do	Wood tar			1.99	2.16	2.22	2.26	2.24	2.37	2.48	2.20	2.39	3.15	54	6.3
24	do	Bluestone and potassium bichromate.	Wood tar		1.99	2.01	1.53	1.95	1.95	1.95	1.9	2.0	1.99	3.5	49	5.7
25	do	do	Coal tar and carbolineum.		2.08	2.01	1.90	1.99	2.06	2.06	2.2	1.88	2.06	3.45	45	6.0

[a] By "breaking length" is to be understood the length of thread, expressed in kilometers, required to cause the thread to break of its own weight.

Lime may also be used as a mordant or fixer for the tanning material. The lime is applied in the form of a solution as follows: Add slacked lime to water in a large container, and let stand with occasional stirring for several days. The clear liquor that remains after the excess lime has settled is to be applied to the nets in lieu of the potassium-bichromate-and-bluestone solution in the method to be given below, after they have been barked. No measurements of the strength of nets so preserved have been found.

A rather elaborate process of tanning employing lime fixation is described in an article in Norsk Fiskeritidende (1886). A translation of this article by Herman Jacobson was published in the Bulletin of the United States Fish Commission (Vol. VI, No. 7, June 12, 1886, pp. 97–104). The method consists of three applications of catechu, one of lime water, and a final treatment of a mixture of Stockholm (pine) tar and coal tar. That method appears to be too elaborate for use in the fisheries of to-day. A point of value in this paper, however, is that where more than one bath of the tanning extract is used the first one should be much weaker than the others.

IMPROVED RECIPE FOR TANNING NETS.

This section of the paper, treating preservation by tanning materials, is to be concluded with a recipe regarded as the best, and a summary. The recipe, given by Bull (1902), is:

To 220 pounds of net (cotton or hemp, the method is best suited to cotton) take 33 pounds of solid extract of quercitron, or 143 pounds of oak bark. (Catechu does not give such good results, but if used, take 53 pounds.)

The extract is boiled[a] until dissolved in 130 gallons of water. Stir continuously in the vessel to prevent the extract from burning to the bottom; the warm solution is poured over the net, which is laid in the vessel. With a flat board, if necessary, push the net down under the liquor. Cover the vessel well with a tarpaulin or sail canvas so that it can cool off only very slowly. After the vessel is completely cooled off the net is taken out and as much of the water as possible is wrung out before beginning the after treatment. If this is done at once, without preliminary drying, some of the tannin will dissolve out and the net will lose.

The after treatment is carried out as follows: To 220 pounds of net take $2\frac{1}{5}$ pounds bluestone and $3\frac{1}{3}$ pounds potassium bichromate, and dissolve them in 150 gallons of cold water.[b] After the substances are entirely dissolved and the whole stirred well, the net is put into the bath. It is best to move the net about in the liquid from time to time so that it works evenly on the entire net. In this bath the color of the net is much darkened; if quercitron is used a uniform brown color is produced, like that of a barked net that has been used a long time. After two hours the net is taken out.

It is the safest plan now to wash the net in water—for example, by putting it in a tub—but perhaps this is not necessary, so it can be spread out at once to dry, or be taken aboard. The water from the after treatment is quite worthless, for the salts added have been completely used up.

By way of comment it may be remarked that the best way to dissolve the extract is to put it in a coarse bag and to suspend the bag in hot water. This prevents débris from going into the solution. In heating the large amount of water the exhaust steam from an engine, or any other steam of a pound or two pressure may be used.

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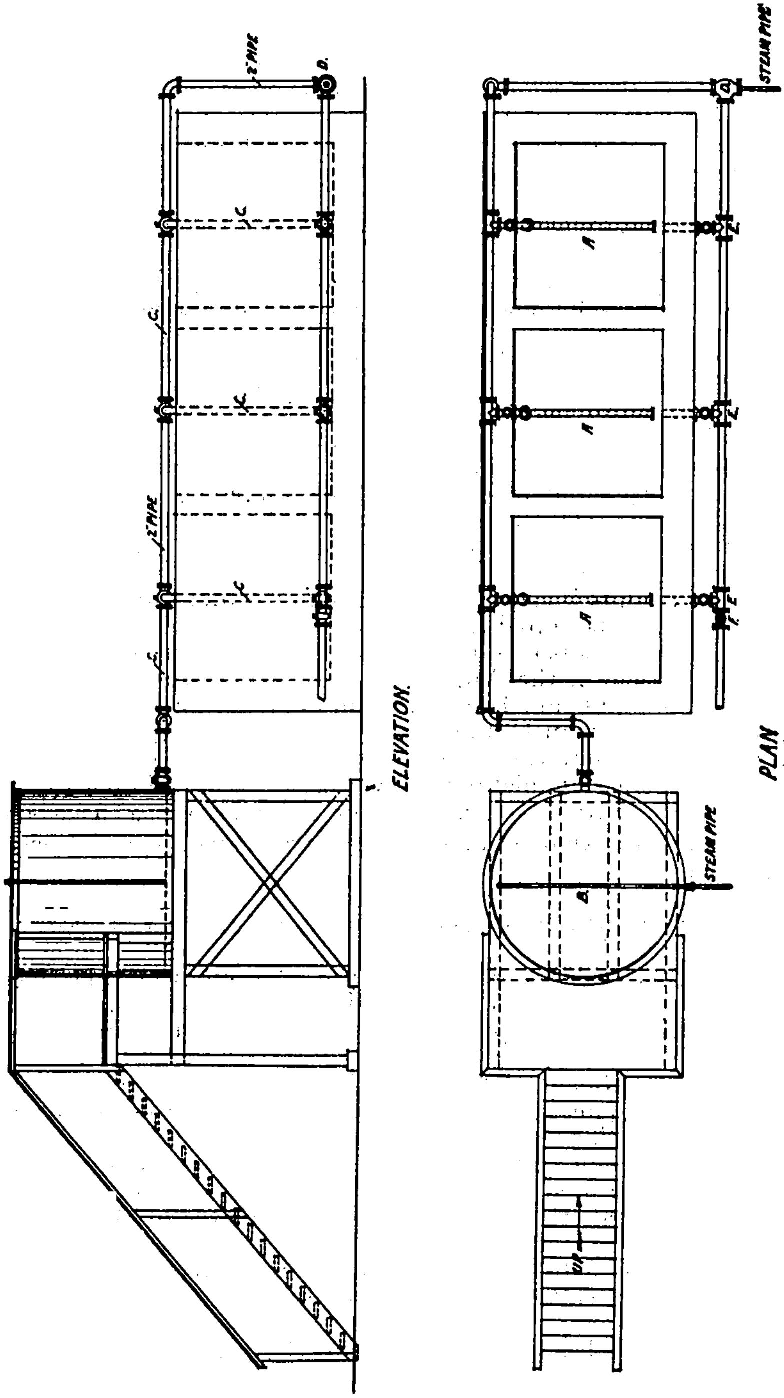
[a] The advisability of boiling the tan liquor is disputed. It appears the safer procedure to heat the water during the process of dissolution of the extract to about 175° F. (80° C.).

[b] Bluestone attacks metal vessels, and it should, therefore, be dissolved in barrels or other wooden vessels.



Plant for tanning nets. (From Barclay, 1905b.)

The accompanying drawing (Barclay, 1905*b*) represents a plant as used in Scotland for barking nets. Catechu or other extract is dissolved in tank *B*, which is heated by steam from a steam pipe. A system of pipes, the arrangement of which is obvious in the drawing, provides for drawing off the liquor into tanks where the nets are treated. *D* is a steam injector or siphon used for convenience in transferring the liquor from one vat to another, or returning it to the dissolving tank.

It is assumed in these recipes that the nets are perfectly clean and free from oil before tanning. Preferably, nets should be tanned before they are ever used. If they are dirty or greasy they should be washed in warm water and soap, well rinsed in warm water, and dried before tanning.

It will be noticed from Bull's figures that a double treatment of quercitron extract before mordanting (experiment No. 17) gave best results. If it is desired to do this—and this procedure is recommended—the first tan should be much weaker than the second; that is, use half the total amount of quercitron for first bath, add the remaining half to the same liquor for second bath, following with mordant, or after treatment. The net should be dried between first two baths of quercitron. This procedure is in keeping with the practice in the leather-tanning industry.

While this method is usually referred to in the literature as "Bull's method," it should be stated that an after treatment with a chromate (sodium chromate) was used before; for example, mention was made of it in the article in the Allgemeine Fischerei-Zeitung (1896) referred to, and potassium bichromate in combination with catechu was tested by Lindeman (1897). Olaus Tyskø, in a paper submitted in the Trondhjem contest, states that the method using catechu, copper sulphate, and potassium bichromate had been "used in Fosen for the last 20 years." (Konserveringsmidlers indflydelse paa fiskegarnstraad. Tillæg til Årsberetning for 1898 fra Trondhjems fiskeriselskab, pp. 4–7.)

SUMMARY OF METHODS OF PRESERVATION OF NETS BY TANNING.

1. Tanning methods are suitable for preservation of nets, leave the nets soft and pliable, and afford a high degree of protection.
2. Very little increased protection is afforded by treating tanned nets with lineseed oil or tar.
3. An after treatment of potassium bichromate following the application of tan liquor greatly increases the preserving power of tanning materials, such as quercitron, catechu, gambier, etc.
4. Copper sulphate (bluestone, copper vitriol) contributes to the color of nets when used as an adjunct to tanning methods, but does not add much, if anything, to the protecting power of the tanning material.
5. So far as the data go, hemp threads are protected by tanning materials just as is cotton, but not such a great degree of protection is afforded.
6. No data have been found regarding the preservation of linen thread.

7. All the methods of tanning impart a dark color to the nets, which color may be advantageous in making the nets less conspicuous in the water.

PRESERVATION OF NETS BY METHODS NOT DEPENDENT ON TANNING MATERIALS.

The methods of prolonging the life of nets which make no use of tanning materials, or make use of them only as adjuncts, employ linseed oil, pine tar, coal tar, bluestone, soap and bluestone, salt, smoke, and creosote.

Of these, linseed oil and tars are physical protections to the net; they fill up the spaces between the fibers and to a large extent keep the water from coming into contact with the materials of which the threads are composed. Naturally these materials are very efficacious, but that there are many and serious objections to the general use of linseed oil and tar will appear later. Linseed oil will be considered first.

LINSEED OIL.

For practical purposes the animal and vegetable oils are looked upon as being divided into two principal groups, the nondrying oils and the drying oils. The nondrying oils, of which coconut, peanut, cottonseed, and olive oils are examples, are used for soaps, foods, lubricants, and the like; they do not "dry"; that is, they do not form a skin upon being exposed to air, but under storage conditions may become rancid. The drying oils, such as linseed and menhaden oil, when exposed to air "dry"; that is, they form tough, somewhat elastic skins, which, when a pigment is incorporated with them, constitute paints. The conspicuous properties of these oils, that is, the turning rancid of the first class, and the drying to a skin of the second, are both traceable to the same cause—oxidation, or absorption of oxygen from the air. Both classes possess a keen appetite for oxygen, and the process of absorption is attended with the generation of heat; if the oil is distributed in such a way that great surface is offered for oxidation and at the same time little opportunity is afforded for the heat to escape, so much heat will be generated as to start a fire, as it is well known that oily rags will do, and also nets. Another peculiarity about this heating is that the hotter the rags or nets become, the faster the oxidation.

Linseed oil is the great drying oil, used the world over as the body for paints. It has been used in Holland (Barclay, 1904) for many years for preserving nets and to a considerable extent in the same way in England, particularly at Lowestoft and Yarmouth. This method, according to Cunningham, is simple: The nets are given one bath of catechu, thoroughly dried; and then one bath of linseed oil, drained, and dried. After drying, which takes two or three weeks or more, they are again bathed in catechu, which removes any undried oil. In use they are occasionally given a treatment of catechu, like any other net. The method, as used by the Dutch, according to Jessen (1903), is as follows:

Any grease on the net is first removed in water, to which a little more than 2 quarts of slacked lime is added, per barrel of water. The net is then thoroughly dried, and introduced into a bath of 18 pounds catechu to 35 gallons of water; the water is boiled and stirred till the catechu is dissolved. The liquor is kept hot while the net is put into it. It is left in until the knots have had time to be thoroughly penetrated; then taken out, drained, and the moist net packed in a vessel till next morning, when it is taken out and dried very thoroughly. As soon as completely dry it is ready to receive the same treatment again, and so on until it has had 6 to 8 treatments, between each two of which it is thoroughly dried out, care being taken that the interior of knots is soaked at each treatment and dried with each drying.

The net, perfectly dried, is now brought under raw linseed oil—1 pound of oil for each pound of net. The oil is kept as cold as possible. The excess of oil is drained off in a vessel with a false bottom. This done, the net is laid out in a field to dry, which drying takes two or three weeks or more. Much rain will injure the net, but under no circumstances should the net ever be heaped up until absolutely dry, even if it does rain. If it is heaped up it is certain to heat, and, aside from the danger of fire, it may be ruined by the heat generated.

There is no doubt that this is an excellent preserving method for nets and deserves all the esteem in which it has been held for so many years. But, because of its laboriousness and the present cost of linseed oil, it is not at all likely to receive consideration under present conditions in the United States. Neither is it every fisherman that has idle land on which he can lay out nets for three weeks or more to dry. Nor is the method necessary in many cases, for if the figures by Lindeman and Bull, given above, are reliable, the threads may be as well preserved by catechu or other tan, followed by a mordant, at much less cost and labor. The threads of hemp, preserved with catechu and mordant, were reduced in strength from 13.7 to 12.1 between first and third tests (28 weeks); preserved with catechu, mordanted, and then oiled, the figures are 10.9 and 13.2, or an apparent increase in strength. With cotton the results were similar, only both appeared to become stronger. But it will be noticed that the oiled nets are 50 per cent or more heavier than the other and the breaking length is correspondingly shorter.

Nets oiled with linseed oil are stiffer and harder than nets not oiled; in some cases, such as the gill nets for shad, this would be a serious objection; but for nets that stay constantly in the water, such as trammel or moored nets, oiling might be well justified. Cunningham said he left oiled nets in the water two months and found no diminution in strength in that time. Barclay (1905) concludes that improved tanning methods are good where there is opportunity for occasional drying of nets, but where there is no opportunity for drying it may be desirable to oil the nets after they are tanned or "barked."

TAR.

Preservation of nets by tar is the principal method used in the United States. The nets are simply passed through hot tar, freed from excess, and partially dried. On use the drying continues until the tar is hard and tough. Of this method Cunningham says:

This method of treating a net is very cheap and tested by the method above described—breaking tests—on pieces of net exposed in a harbor, the preservation is very perfect. A piece of net lost scarcely any strength after two months in the water, and, moreover, a tarred net is distinctly stronger than a cutched net, because the dry tar increases the strength of the cotton fibers by gluing them together. As an antidote to putrefaction coal tar is perfect, no septic organisms being able to live in it. The fibers of the cotton, being covered by the tar, do not come actually into contact with water. For these reasons tar is an excellent preservative for coarse nets for rough use, such as trawl nets.

But for drift nets there are many objections to its use in the manner considered. The net is too rigid and stiff, and, therefore, does not usually mesh the fish well although to some extent the net is made more flexible by occasional dips in hot cutch, which softens the tar and removes a portion of it. The rigidity of the net causes it to wear out mechanically; after two or three years it is apt to give way at the knots, owing to the breaking of the stiffened fibers under the constant bending.

Another method sometimes used employs cutch and tar together, the tar being stirred into the hot cutch and the net bathed in the mixture. Cunningham found this to be very little better than the cutch or catechu alone, for the reason that the tar does not mix uniformly with the cutch, but breaks up into little droplets which attach themselves to the threads. The threads are therefore not uniformly protected by the tar.

Tar consists of two parts, a liquid part which is separately known as creosote, and a black, solid part which is left behind when the creosote evaporates. When the tar is first applied both are present, but as time passes the liquid creosote gradually evaporates, while the solid part remains. Both assist in protecting the nets, the solid by gluing the fibers together, the liquid by killing bacteria; one protects, the other preserves.

If in the table given by Bull (p. 20) the samples prepared with tar are compared with samples prepared in other ways, it is seen that tar holds its own against all rivals, if we consider preservation of breaking strength only. But it is noticed that weight is increased from around 1.6 grams per 10 meters to around 3.5, or about 2¼ times; the breaking length is correspondingly reduced, while the absorption of water is reduced from about 250 per cent to about 50 per cent; that is, the amount of water the threads will absorb is reduced by the application of tar from about 2½ times its own weight to one-half its own weight.

The added weight of tar is a very material disadvantage in large nets, for it increases the labor of handling nets and prolongs the time of every move of the net. On the other hand, Bull's table shows that the tarred net soaks up much less water than the barked net and that, since absorbed water adds to the weight of the net just as tar does, the weight added by water must also be considered.

In the case of drift nets, where the poise of the net in the water is of greatest importance, the balance of the net has a bearing on the method of barking (Jessen, 1906). Jessen argues thus: A quantity of sea water of the same air and salt content and at the same temperature as that of the sea, will neither sink nor float, but will stay at whatever depth it is put, and when water thus soaks into a net it will tend neither to sink nor float the net, but is a dead weight. This dead weight, however, must be counterbalanced by a greater weight on the lead line than would be needed without it; that is, the weights on a water-logged net must be greater by an amount equal to the weight of the water in the net in order to keep the net vertical. Thus, if the untreated net in Bull's table took up 227 per cent water (No. 1) and required 24 kilograms stone sinkers, the barked net which took up 179 per cent water (No. 11) would require 21.6 kilograms sinkers, and with the barked and tarred net (No. 23) that took up 54 per cent of water, only 10.5 kilograms sinkers would be needed, and that with lead sinkers these figures are 14.6, 13.2, and 6.4 kilograms, respectively. Then, to show the practical force of his argument, he points out that with the untreated net (No. 1) with stone sinkers one must work with the weight of the net, 8.6 kilograms plus the water soaked up, 19.5 kilograms plus the stone sinkers, 24 kilograms, or 52.1 kilograms all together. While with the barked and tarred net and lead sinkers these weights are, net, tanning material and tar, 15.7 kilograms; absorbed water, 8.5 plus the necessary lead, 0.4 kilogram; a total of 30.6 kilograms. He also shows that the first net, requiring 17 men to handle it, can, if its weight is reduced by barking and tarring, be handled by only 10 men. No argument is required to show, also, that of two nets made of material exactly the same size and quality, but one weighted down to nearly twice the weight of the other, the heavier will wear faster than the lighter. While space does not permit of an extended review of the discussion of these matters,[a] it should be pointed out that Jessen appears to have overlooked the fact that if a tarred net of a weight of 3.15 increases in weight by 54 per cent, it will weigh 4.85 in all, while the untreated net of 1.45 will, when increased by 227 per cent, weigh 4.95, or more than the tarred one. Bull, in the article referred to in the footnote, gives the correct mathematics for making the calculations.

CUNNINGHAM'S FURTHER EXPERIMENTS.

At this point it is appropriate to introduce the remaining experiments conducted by Cunningham, using all the ordinary net preservatives in various ways.

PREPARATION OF SAMPLES.

1. Cutch alone (one-half pound cutch boiled in one-half gallon of water).—The pieces of net put in this until well soaked, then dried. Then put into cutch of same strength, steeped for two days, then dried.
2. Cutch and glue (one-half pound glue dissolved in 1 gallon of water).—The net dipped into this, then squeezed and put into hot cutch—one-half pound cutch to one-half gallon of water—then dried. Afterwards dipped a second time into cutch of same strength and dried again.
3. Cutch, glue, and bichromate of potash.—The net was dipped into glue, 1 pound to one-half gallon of water, with a little bichromate of potash added; then put into cold cutch and left to steep two days.
4. Cutch and copper sulphate.—The net was steeped two days in cutch, one-half pound to one-half gallon of water, then, while wet, put into copper sulphate, 1 pound to one-half gallon of water, and after a short soak rinsed in fresh water and dried.
5. Cutch and coal tar.—The net was first saturated with coal tar, then squeezed and wrung out several times with hot water, then dried for a week, and afterwards dipped in hot cutch, one-half pound to one-half gallon of water.
6. Cutch and coal tar mixed.—One-half pound cutch boiled in one-half gallon of water and then about a pint of coal tar stirred into the hot solution. The net was dipped into the hot mixture, then dried.
7. Cutch, tar, and green oil [a creosote distilled from coal tar].—The net was first steeped three days in cutch, one-half pound to one-half gallon of water. Then the same cutch was heated and the net passed hot from this through a mixture of coal tar, Stockholm [pine] tar, and green oil as thick as paint. The net was then passed through a wringing machine and dried.

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[a] See further, Bull (1906). Reference is made by Bull to a discussion of the matter between Dr. Johan Hjort and Peter Jessen in the Bergens Tidende, presumably in 1906.

8. Coal tar and green oil mixed.—The net was steeped in the mixture, then passed through a wringing machine, and hung up to dry.

9. Cutch and green oil.—The net was steeped several days in cutch, one-half pound to one-half gallon of water, then dried and put into green oil, then passed through a wringing machine and hung up to dry.

10. Green oil alone.—The net was simply saturated with green oil, passed through a wringer, and hung up to dry.

11. Cutch and Stockholm tar, mixed (one-half pound cutch boiled in one-half gallon of water, and one-half pint Stockholm tar stirred into the hot solution).—The net dipped into the mixture, squeezed out, and dried.

12. Cutch, Stockholm tar, and green oil.—The net was steeped three days in cutch, one-half pound to one-half gallon of water, then dried and soaked in Stockholm tar warmed, with a little turpentine added. As the net was very hard and sticky, it was soaked with green oil and passed through the wringing machine.

13. Cutch and linseed oil.—The net was steeped in cutch (one-half pound to one-half gallon of water) for three days, dried, and then dipped in boiled oil, with driers added. After some weeks it was dipped again in cutch and dried.

14. Soap and copper sulphate (one-half pound soap boiled in one-half gallon of water).—The net soaked in this and then put into a solution of copper sulphate, one-half pound to one-half gallon of water.

15. Soap, copper sulphate and linseed oil.—The net, prepared as in 14, was saturated with boiled oil, with driers added, and hung up to dry.

The pieces were all cut from the same mackerel net, 24½ rows to the yard. 12-ply, and the following table shows the results of testing:

Mode of cure.	Strength when dry.		Strength after 4 weeks in water.		Strength after 2 months in water.	
	Lbs.	*ozs.*	*Lbs.*	*ozs.*	*Lbs.*	*ozs.*
1. Cutch only, two dips and steeped	15	9	16	8	6	6
2. Glue and cutch, one dip in glue, two in cutch	17	2	9	6	.....	.....
3. Cutch, glue, and bichromate of potash	16	11	14	4	.....	.....
4. Cutch and copper sulphate	13	8	10	9	.....	.....
5. Cutch and coal tar, tarred first	18	4	21	0	18	0
6. Cutch and coal tar, mixed	17	12	18	6	8	1
7. Cutch, tar, and green oil, passed direct from the cutch into the tar	17	3	18	0	14	3
8. Coal tar and green oil, mixed	16	0	16	1	14	12
9. Cutch and green oil	15	14	18	4	17	0
10. Green oil alone	16	5	16	0	15	8
11. Cutch and Stockholm tar mixed	17	13	17	6	6	12
12. Cutch, Stockholm tar, and green oil	14	4	18	0	16	6
13. Cutch and linseed oil	15	1	16	12	15	8
14. Soap and copper sulphate	15	1	15	8	.....	.....
15. Soap, copper sulphate, and linseed oil	15	1	15	4	14	8

It is evident that Cunningham did not carry his tests far enough to give decisive indications. In spite of this insufficiency, it is plain that those methods are good which depend on tar or oil as a protective covering, where these substances really cover, but when they are broken up into tiny particles or applied to a wet net, as in Nos. 6, 7, and 11, little protection is given.

SHRINKAGE CAUSED BY PRESERVING.

Cunningham also kept a record of the shrinkage caused by the various methods of curing nets. As stated above, the nets were 24½ rows per yard before treatment. After treatment they varied according to the following list. (Of course, the greater the number of rows there are the more the shrinkage that has taken place.)

No.		Rows per yard.
1.	Cutch only	26¼
2.	Glue and cutch	25½
3.	Cutch, glue, and bichromate	25½
4.	Cutch and copper sulphate	25½
5.	Coal tar and cutch	28½
6.	Cutch and coal tar mixed	27
7.	Cutch, tar, and green oil	25½
8.	Coal tar and green oil	25½
9.	Cutch and green oil	26¼
10.	Green oil alone	25½
11.	Cutch and Stockholm tar	27
12.	Cutch, Stockholm tar, and green oil	25½
13.	Cutch and linseed oil	27
14.	Soap and copper sulphate	27
15.	Soap, copper sulphate, and linseed oil	27

All the methods caused shrinkage, the greatest being caused by coal tar and cutch, but the other combinations of cutch and tar caused marked shrinkage. All the tanning methods cause shrinkage, and the shrinkage increases with each application of the preservative.

To conclude the discussion of tar as a preservative, it can be said that tar effects excellent preservation, is comparatively inexpensive, and requires much less labor and time than, for example, the combination of catechu and linseed oil. For the heavier and coarser kinds of nets that are anchored or moored in the water, such as trammel or pound nets or nets that are handled by machinery, the method is well suited. But for gill nets, the method is not at all suited, and for even the heavier seines that are hauled by hand, consideration should be given to the extra weight added by tar and the consequently increased number of men necessary to handle nets so preserved. In such cases, especially for nets that can be dried occasionally, the more improved barking methods, such as quercitron and potassium bichromate, are likely to prove to be better and to be little more expensive or laborious than methods employing tar.

Tar should never be mixed with catechu solution or anything else containing water before application to the net and should never be applied to a wet net. It may be thinned with creosote, "green oil," turpentine, etc., without injury. If a net be cutched or barked before being tarred, it should be thoroughly dried before the tar is applied. While tar may be applied profitably to new, white nets, it seems likely that it will always yield a good return on the investment to tan the nets with quercitron and bichromate and to follow with a thorough drying before application of the tar.

CREOSOTE, SMOKE, ETC.

As stated above, tar consists of a solid and a liquid part. The liquid part really consists of a number of different liquids and volatile solids, such as carbolic acid, benzol (or benzene), napthalene, etc., mixed, which, when separated, have different important commercial uses. They are distilled off from coal tar. One portion (the third main portion distilling over at from 230 or 240 to 270° C.) is known as "green oil" or creosote oil, a greenish-yellow, oily liquid, heavier than water, and containing various antiseptic substances. It is used for the preservation of crossties, fence posts, telegraph and telephone poles, and has been used for the treatment of nets. Reference to Cunningham's table above shows that creosote oil alone is a good preservative for nets and causes little shrinkage; it also possesses this advantage, that it does not make nets stiff. The principal objection to its general use is that it washes out or evaporates rather rapidly from the net, and no method of fixing it is known. The net is oily or greasy for some time after it is treated and is therefore objectionable to handle.

Concerning the mode of application of creosote, Cunningham says:

> There are many different ways of applying the green oil or creosote to the nets; the net may be well cutched first, then dried, soaked in the green oil when dry, then passed through a wringing machine, and spread out to dry; or the net may be passed straight from hot cutch, without drying, through the green oil, and then dried, or, instead of the oil alone, a mixture of tar and green oil may be used. In whatever way it was applied I found pieces of net treated with green oil had lost but very little strength after two months' exposure in Newlyn Harbor.

The principal preserving matters in creosote that comes from wood go over in the smoke when the wood burns in a smoldering fire. Upon this fact is based a method using smoke.[a]

It is stated in the articles referred to that this method had been used on the Gulf of Courland for many years in houses that had no chimneys by allowing the smoke to go through passages into a loft where the nets were hung. A direct method of applying the smoke is to fasten the net to the underside of boards which are supported above a smoking wood fire.

While this method appears to be primitive, there is nothing chemically unreasonable about it, and it may be that under certain circumstances the method would be applicable to-day. It would certainly be much better than nothing, provided the nets were not allowed to be overheated during the smoking process. It would be necessary to repeat the treatment, perhaps several times a year. The method has the advantage of depositing upon the fibers the volatile antiseptic substances of tar, without the heavy thick parts, and it would appear less likely to shrink the nets.

COPPER SULPHATE.

It was noticed in the figures of Lindeman, given above, that hemp threads were improved by every method that improved cotton threads; only one preserving material had a more marked effect on hemp than on cotton—that is, copper sulphate (or copper vitriol, bluestone, blue vitriol, etc., as it is variously known). This substance has long been used for nets, alone or in combination with other substances. According to a quotation in the Norsk Fiskeritidende (1906) this is used in Norway for the treatment of salmon nets. One kilogram (2⅕ pounds) of copper sulphate is dissolved in a barrel of water. The nets are treated with this by allowing them to lie in it overnight. They are put into the sea as soon as they are taken from the bath, without preliminary drying. Lindeman's figures show that the method does not deserve serious consideration.

What is perhaps of much more importance is a method of using copper sulphate in combination with soap. A method of this kind is said to have been used in the French sardine industry to give the nets a color. Oils consist of two parts, glycerin combined with fatty acids. When the glycerin is taken out, and soda or potash substituted for it,

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[a] See Mittheilungen des Westpreussischen Fischerei-Vereins (1896), Deutscher Fischerei-Verein (1885), and Norsk Fiskeritidende (1896).

ordinary soaps are produced. If, instead of the alkalis, any other metal—such as copper, mercury, aluminum, etc.—is used, insoluble soaps—such as copper soap, mercury soap, aluminum soap, etc.—are produced. The simplest method of preparing these "heavy metal soaps" is first to make ordinary soap, then treat it in solution with a compound of the metal whose soap is desired. Thus, if to a solution of ordinary soap aluminum chloride is added, an insoluble waxy precipitate falls—aluminum soap; if copper sulphate is employed instead of aluminum chloride, a bright green, insoluble copper soap is formed. The insoluble calcium soap is a very familiar substance formed when soap is dissolved in "hard" water—a tallowy stuff that gets on one's hands, the bathtub, etc. This is calcium or lime soap. A similar soap is used for temporary calking of small leaks in boats; a soap of aluminum is used to waterproof clothing, for it makes clothes difficult to wet, the water rolling off "like water from a duck's back."

Now, if the principal reason for using copper to preserve nets is that it kills bacteria and other injurious living things, and if the principal objection to its use as bluestone is that it washes out so readily, there will be no difficulty in seeing that the object of using it in the form of a soap is to take advantage of its protective property and at the same time to prevent it from escaping into the water. Since copper soap is quite insoluble in water, there would be no way to get it into the fibers if it were made before it is applied; it is therefore necessary to cause the copper soap to be produced inside the fiber by impregnating the threads first with soap solution and then with copper sulphate. In the practice of preserving nets the following process, according to Cunningham, is used:

> To treat a net by this process from one-half to three-fourths pound of ordinary soap, such as mottled soap * * * is used for each gallon of water, and the soap is dissolved by boiling in a copper or in a galvanized bath over a fire. The net is then soaked in the soap solution, taken out, squeezed through the hands, and allowed to drain. The copper sulphate, which is also known as blue vitriol or bluestone, must not be dissolved in an iron vessel, as it will attack and dissolve the iron. It must be put into a wooden or earthenware vessel, and it is not necessary to use heat to dissolved it, as it will dissolve in cold water if stirred up for a short time. The net while still hot from the soap solution is then passed through or put into the solution of bluestone, and the whole net becomes uniformly green. The net is then rinsed in cold water. About three-fourths pound of bluestone to a gallon of water is the proportion required.

This method preserves the net, according to Cunningham's figures, for about four weeks, but he says that after two months the sample treated was quite rotten. The process can, of course, be repeated as often as necessary, and by repeated treatments a net should be kept in condition for years. It causes strong shrinking of the net.

A similar method is recommended for ropes and canvas by the Norsk Fiskeritidende (1887). The procedure there given is as follows:

> Ropes are laid first for four days in a solution of copper vitriol (20 grams to a liter of water—two-thirds ounce to a quart) and then dried. They are then tarred in the usual way or laid in a soap solution (100 grams to a liter of water—3½ ounces to a quart) until they are saturated through. Canvas is treated only with the vitriol and soap.

GENERAL COMMENTS.

Only the more important and widely used or promising processes for the preservation of nets have been considered. To anyone who has searched literature it would be a surprise if a great many other methods and processes were not found to have been tried. The list given by Jessen includes, besides barking, smoking, alum, train oils, tallow, grease, bluestone, potassium bichromate, various compounds of mercury, iron vitriol, pine tar, wood oils, coal tar, aniline dyes, and various other products of gas works, salt, resins, soaps, lime, etc. But all the recorded data found that will have a material value have been included in this paper.

It should be obvious to most people that nets should always receive some preservative treatment. Coarse nets, pound nets, and the like should be both barked with catechu or quercitron, mordanted with potassium bichromate, and then tarred. Where it is not possible or suitable to tar the nets, they should receive the catechu or quercitron treatment and the mordant. It is preferable to use two baths of quercitron, the first containing only one-half the total amount to be used.

Though no actual figures have been brought forth to prove it, there is little doubt that nets are destroyed more rapidly in warm climates and warm weather than in cold. Fishermen should take note of this fact and be accordingly more careful of their nets where the weather is warm. It is also likely that foul, dirty water works more rapid destruction on nets than clean water.

One of the possible ways to avoid the disintegration of nets is, of course, the chance of using some material that is not subject to decay—metals, for example. A person signing the initials C. J. (1912) describes briefly in the Dansk Fiskeritidende some experiments with aluminum, brass, copper, and galvanized-iron wire for bow nets. The aluminum proved to be best.

No important results have come from efforts to substitute metals for plant fibers for nets.

CARE OF NETS.

When nets are piled up wet—especially if they are foul with slime, blood, fat, etc.—the rapid oxidation heats the net. Even if the net does not take fire the heat generated may very well cause a great weakening. This weakening will not be visible, but will tell in a much shorter life of the net. However carefully the net is barked or tarred, a very short life can be looked for if the net has been heated.

For a temporary preservative, where it is not possible to dry the nets, it is customary to salt them. This is a useful treatment, as far as it goes. Salt is not in itself poisonous or injurious to small organisms or bacteria (for they live in the sea which contains much salt) if the concentration is not too great. But it is well known that when any watery organism is exposed to a salt solution stronger than its own juice water will be extracted and usually the organism dies. The salt is injurious to living things not because of its saltiness, but because of its concentration; not because it is poisonous, but because

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it extracts the water necessary for things to live on. The rule is that a stronger salt solution will extract water from a weaker juice whereever it comes in contact with it.

This principle is made use of in many ways. Every fisherman knows that salt draws the water out of fish in the curing process. It is not so apparent, but it is equally true, that it draws the water from and kills the bacteria that would otherwise cause the fish to decay, and thus preserves it. Any equally concentrated substance would do the same. Thus sugar is used in very concentrated sirup to preserve fruits; if the preserves were sufficiently diluted with water, bacteria could live in them and they would spoil.

In this way salt preserves nets. It dissolves in the moisture on the threads to make a very strong solution; this strong solution kills bacteria and other small organisms by extracting the water from them. From this it is hardly necessary to say that the salt should be applied generously, and preferably in the dry condition, to a wet net. If brine is used, it should be very strong.

But salt will not prevent heating in an oily net that has just caught very fat fish, such as herring. The heating is caused by the air working on the fat. The only way to prevent this heating is either to get rid of the fat or to prevent the air from getting to it. Aboard a vessel it is not always convenient to wash the net out immediately, nor is there room to spread the net (if spread, the heat, of course, escapes as fast as produced and no harm is done). Bull (1905) suggests that to prevent this heating of recently used herring nets aboard a vessel, there be provided a wooden tank with a tight-fitting lid, filled with water or salt solution, and that the net be put into this and covered over with the lid until there is opportunity to wash it. The water or salt solution keeps out the air and prevents heating. The cheapest obtainable grade of salt may be used, since there is not likely to be anything in it that is injurious to nets.

Nets, as every fisherman knows, should be washed and dried at every opportunity.

CONCLUSION.

The most important methods of preserving nets are tanning, for which an improved recipe is given on page 22; tarring, found on page 26; and creosote, found on page 30. Other methods are also given.

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AN ANALYTICAL SUBJECT BIBLIOGRAPHY OF THE PUBLICATIONS OF THE BUREAU OF FISHERIES 1871–1920

By ROSE M. E. MACDONALD
Librarian, U. S. Bureau of Fisheries

Appendix V to the Report of the U. S. Commissioner of Fisheries for 1920

LETTER OF TRANSMITTAL.

DEPARTMENT OF COMMERCE,
BUREAU OF FISHERIES,
Washington, June 15, 1920.

HON. HUGH M. SMITH,
Commissioner of Fisheries.

DEAR SIR: I have the honor to submit herewith "An Analytical Subject Bibliography of the Publications of the Bureau of Fisheries, 1871–1920," being an analysis of the reports, appendixes, special papers, bulletins, economic circulars, occasional papers, and of "The Fisheries and Fishery Industries."

Covering the investigations of the Bureau since its incipiency, it shows, in a measure, the work of a number of men of no mean fame in the field of biology. Much of it was pioneer work, which modern investigators can not afford to ignore.

The work here transmitted was started in 1912, as a catalogue of the publications of the Bureau. Later it was decided to assemble these titles under subjects pertinent to the work of the Bureau.

In compiling this subject index it was found that references to many valuable results would be lost unless a meticulous analysis of the publications be made. Each paper was therefore examined searchingly, and when the discussion was found to be of sufficient detail, a title for it was made. For instance, of the 141 titles of *Food of fishes*, 87 were made from the subject contents.

It had long been realized and often stated by those cognizant of the ideals of the Bureau that there was a veritable fund of valuable information in the publications of the Bureau, which was lost because the modern investigator knew not how to find it. It is hoped that this work will prove a valuable key.

The arrangement differs from that usually employed in bibliographies, the object having been to arrange it from the viewpoint of the investigator. In a work of such detail, the preparation of which has necessarily extended over several years, some mistakes will doubtless appear. For these I am quite willing to assume responsibility, knowing that a bibliography of such magnitude can not be perfect.

In its entirety it stands as a slight tribute to the builders of the Bureau of Fisheries and to all who have labored with them. It has been a pleasure and an inspiration to do the work, and I hope it may prove of value. I have the honor to be,

Very respectfully,

ROSE M. E. MACDONALD, *Librarian.*

AN ANALYTICAL SUBJECT BIBLIOGRAPHY OF THE PUBLICATIONS OF THE BUREAU OF FISHERIES, 1871-1920.

By ROSE M. E. MACDONALD, *Librarian.*

GENERAL CONTENTS.[a]

[a] Analytical subject table of contents is given with each part, except in parts 3 and 6, where it is given with each section.

EXPLANATORY NOTE.

The bibliography is composed of two styles of titles, those given just as they appear in the publications and those resulting from the analysis of each article. For the first style, cards have been printed by the Library of Congress from copy prepared in this Bureau. These cards may be purchased from the Library of Congress, the card wanted to be designated by the call number, which appears in the right-hand margin of each page. The second style, or "made titles," are designated by brackets and have no printed cards.

The arrangement under each subject is by authors listed alphabetically. The arrangement under each author is chronological.

Work or investigations covered in the annual report of the Commissioner are combined under the authorship of the United States Commissioner of Fisheries. To give the name of the Commissioner sponsoring the work would frequently destroy the chronological arrangement. For those who may care to cite the Commissioner's name the following list is given:

Baird, Spencer Fullerton, 1871–1887.
Goode, G. Brown, 1887–1888.
McDonald, Marshall, 1888–1895.
Gill, Herbert A. (acting), 1895–1896.
Brice, John J., 1896–1898.
Bowers, George M., 1898–1913.
Smith, Hugh M., 1913–

For the purpose of chronological arrangement, divisional reports are given under the authorship of the United States Bureau of Fisheries.

In anaylzing reports (meaning also appendixes and special papers) and bulletins, the analysis in each case has been of the bound volume, and the date of issue given for each title is therefore that of the volume. In the majority of cases, however, the articles comprising the bound volume are first issued as separates. In all such instances, in addition to the date of issue of the volume, the date of issue of the article as a separate is given in italics. The one exception is in the treatment of the annual reports, page 7, where the date of issue of the separate only is given.

Being an analysis of publications of the Bureau of Fisheries only, which are always printed in Washington and, with few exceptions, by the Government Printing Office, the place of publication is omitted in every case, and the printer given only in the exceptions.

Part 1.—UNITED STATES BUREAU OF FISHERIES.

Part 1.—UNITED STATES BUREAU OF FISHERIES.

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[a] For "Fish-cultural stations" and "Cars" see Part 3, Section 2. For "Vessels" see Part 2.

PART 1.—UNITED STATES BUREAU OF FISHERIES.

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Brice, John J.: The work of the United States Fish commission from December 1, 1896, to November 3, 1897. Bulletin, 1897 (1898), vol. XVII, p. 135–139. *Doc. 354 issued Feb. 4, 1898.* F12–243

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