

REPORT OF THE COMMISSIONER.

1.—INTRODUCTORY NOTE.

During the period of time covered by this report the work of the United States Fish Commission was under the direction of Prof. Spencer F. Baird. In consequence of his declining health and the pressure of administrative duties as Secretary of the Smithsonian Institution, as well as Commissioner of Fisheries, the preparation of a report proper to accompany the various reports and papers constituting the appendix was prevented.

The following digest of the operations of the year, which has been prepared from data compiled mainly by Mr. C. W. Smiley, editor, for the convenience of the Commissioner in the preparation of his annual report, aims to present briefly, from an impersonal standpoint, the principal features of interest in connection with the work accomplished.

The personality of the distinguished naturalist who founded the United States Fish Commission, and under whose wise and broad administration it has grown to be the custodian and conservator of one of our most important food resources is, however, fitly represented by his important posthumous paper on the sea fisheries of eastern North America, which appears in the appendix. This monograph, after some introductory account of the fisheries, follows with a list of the food and bait fishes and invertebrates, together with biographical notices of the most important species. The food and the reproduction of the sea fishes, their migrations and movements, numbers and abundance, and the dangers and fatalities to which they are subject from enemies in the sea, from man, and through physical causes or changes are discussed at length. The important fishing grounds are described in detail, as well as the apparatus of capture, from the primitive bow and arrow to the elaborate nets and pounds of the present time. The various kinds of bait, the methods of preserving fish and bait, and the disposition of offal are considered. The statistics of the value of the American fisheries are given, and followed by a review of the economical applications of the products of the fisheries as food for man and animals, and for use in the arts and industries in the form of oils, fertilizers, medicines, etc. The maintenance and improvement of the fisheries by legislation, artificial propagation, and the transfer of species from one region to another are subjects which receive the attention warranted by their importance.

2.—INQUIRY RESPECTING FOOD-FISHES AND THE FISHING GROUNDS.

A.—FIELD-WORK.

In this branch of inquiry field-work was carried on in a thorough manner along the Eastern coast of North America from the Straits of Florida to Newfoundland. From February 20 to May 10 the steamer *Albatross*, Lieut. Commander Z. L. Tanner, U. S. Navy, commanding, was engaged in a survey of the region about the Bahama Islands, in the joint interests of the Fish Commission and the Navy Department, the expenses of the cruise being shared by the two. The purpose of the voyage, on the part of the Fish Commission, was to ascertain, if possible, the winter range and habits of certain important food-fishes, which resort to the Eastern coast of North America during the warmer months, but whose first appearance in the spring and whose abundance during the fishing season vary from year to year. The principal species concerning which information of this character was desired were the mackerel, menhaden, and bluefish; but attention was also to be paid to other economic forms, such as the Spanish mackerel, sheepshead, and drum, if found to occur abundantly in those waters. On behalf of the Navy Department several lines of soundings were to be made to the northward and eastward of the islands and in the deeper channels which separate them, the hydrography of this important region being but little known. Mr. James E. Benedict was in charge of the civilian scientific staff, and was assisted by Mr. Thomas Lee, Mr. Charles H. Townsend, Mr. Willard Nye, jr., and Mr. F. L. Washburn, the two last mentioned being volunteers.

The work of sounding was begun to the north of Great Abaco Island, and was carried thence southeastward along the Atlantic side of the islands as far as San Salvador or Watling's Island, and offshore in some places to a distance of over 100 miles. The greatest depth of water discovered was 3,196 fathoms, in latitude $28^{\circ} 34' 42''$ north, longitude $76^{\circ} 10' 25''$ west, or about 110 miles northeast of Great Abaco. Several lines were run between the five islands lying at the mouth of Exuma Sound, namely, Cat Island, Long Island, Watling's Island, Concepcion Island, and Rum Cay, showing that the intervening channels are of great depth, the depth in one place exceeding 2,400 fathoms. From this point the soundings were carried through Exuma Sound to its upper end, and thence by way of the open sea on the eastern side of Eleuthera Island to the town of Nassau, New Providence Island. Subsequently the work was continued through the Northeast and Northwest Providence channels and the Tongue of Ocean. On the homeward journey soundings were also made to the east and north of Great Abaco Island and Little Bahama Bank, and off the coast of the Southern Atlantic States as far as Cape Hatteras. During these explorations one trip was made to Key West and Havana for the purpose of

obtaining coal and other supplies, giving opportunity for a limited amount of work in the Straits of Florida. The customary physical observations were made at all of the sounding stations, in order to determine the currents, temperatures, and densities of the water and the character of the bottom. The dredge, beam trawl, and tangles were also occasionally employed to ascertain the abundance of bottom life, but generally with poor results, the white coral ooze which predominates in the deeper waters about the Bahama Islands being comparatively barren and the shallower spots generally too rough for the successful working of the dredging appliances. Surface collecting in the same region with the towing nets was equally unproductive, but by allowing the naturalists to land upon the islands and work along the shore very important results were obtained. The shore work was vigorously pushed at every place where the steamer made a harbor, and parties of two were occasionally left upon the islands while the steamer continued its sounding operations in the neighboring region. The fisheries which center at Nassau, including the important sponge fishery, were carefully studied, but no traces were found of the pelagic fishes, whose winter abode, it was thought, might be in this region. In the Straits of Florida and along the line of the Gulf Stream farther north the results of dredging were exceedingly rich.

From July 8 to October 28 the steamer *Albatross* was at work upon the offshore fishing grounds of Eastern North America, between New York and Newfoundland, with headquarters at Wood's Holl, Mass. Mr. Benedict having resigned his position, Mr. Thomas Lee acted as chief naturalist during these explorations, and was assisted by Mr. Sanderson Smith. From July 15 to 18 a short trip was made to the outer edge of the submerged continental plateau south of Martha's Vineyard, where the tilefish was formerly abundant. On August 2 the *Albatross* started east on a second cruise to the great cod and halibut banks lying off the coasts of the British Provinces, the purpose of which was to study the character and resources of the banks in general, and of those areas specially which are but little known; to search for new or reported banks, the existence or location of which was uncertain; and, partly in the interests of the Navy Department, to investigate certain reported dangers lying in the track of ocean steamers and fishing vessels. Diligent search was made for the mythical Hope Bank, supposed to be located south of Halifax, some distance off Le Have Bank; but although numerous soundings were made over a wide area inclosing its reported position, and thence to Sable Island Bank, no unusual inequalities in the bottom were discovered. A line of soundings was run between Banquereau and the Grand Bank to develop the contour of the intervening gulley in which halibut abound. Trials were made for codfish on the eastern part of Grand Bank, the eastern edge of which was found to be incorrectly represented on the published charts. Fruitless search was made for a reported bank of great promise

to the fishermen, which was supposed to be located about 200 miles east of the Grand Bank in about 45° north latitude. Soundings were made from this point to the Flemish Cap, which was partly explored, and thence to the northeastern edge of the Grand Bank. St. John's, Newfoundland, was then visited for supplies, giving the naturalists an opportunity to study some important salmon streams, the steamer starting homeward from this place on August 21. During the trip to the westward the explorations were continued off the southern end of Green and St. Pierre Banks, between the latter bank and Banquereau, across Banquereau and Sable Island Bank, past the reported position of Hope Bank, and thence along the edge of George's Bank to Vineyard Sound, the steamer arriving at Wood's Holl August 29. Subsequently two trips were made to the deep-water area lying between latitude $36^{\circ} 30'$ and 39° north, and longitude 70° and $74^{\circ} 33'$ west.

The steamer *Fish Hawk* was engaged but little in this branch of inquiry during 1886. In August a few of the light-ships at which temperature observations are taken for the Commission were visited, and the keepers instructed as to the proper methods of immersing and reading the thermometers, especially during extremes of temperature. In October a few casts of the beam trawl were made in the region off Sandy Hook, N. J., where specimens of the English sole had been planted several years before, but without finding any trace of them.

The schooner *Grampus*, Capt. J. W. Collins commanding, made many important investigations respecting the fishing grounds and food-fishes off the New England and adjacent coasts, but these were mostly undertaken in the interest of fish culture. In August, a cruise was made to the tilefish grounds south of Martha's Vineyard, and six days were spent in fishing with cod trawls and hand lines in depths of from 60 to 160 fathoms, over an area about 120 miles in length. Only a few fish, mostly hake, were captured. From September 22 to October 9 the *Grampus* was engaged in an attempt to carry living specimens of halibut from the fishing grounds to Wood's Holl, for the purpose of securing their spawn in suitable condition for hatching. Fishing for this species was mainly carried on off Le Have Bank, in depths of 200 to 300 fathoms. A number of halibut were taken and transferred to the schooner's well, apparently without receiving serious injury from the hooks or subsequent handling. None of them lived, however, more than thirty-six hours, and the conclusion was reached that the fish could not survive the great change of temperature and pressure incident to their transfer from deep water to the surface. As it was probable, however, that halibut taken in shallow water could be successfully transported, a search was made for them in other localities, but none were found. With other species less difficulty was encountered. On this and the previous cruise, Mr. Raymond L. Newcomb acted as naturalist, and Mr. James Carswell accompanied the *Grampus* as fish culturist, in the search for halibut. During most of the remainder of the

year the *Grampus* continued her fishing trips in Massachusetts Bay and off Cape Ann, carrying several cargoes of live fish, principally cod, in good condition, to the Wood's Holl station.

In December, Mr. Charles H. Townsend, an assistant of the Commission, was sent to the western part of the Caribbean Sea for the purpose of studying the fisheries of that region in the interests of the American fishermen. One of the objects of his trip was to ascertain if that region was to any extent the winter home of pelagic fishes which resort to the eastern coast of the United States in summer. His work extended into 1887. Free transportation as far as Swan Island was furnished by Mr. J. M. Glidden, president of the Pacific Guano Company.

The Wood's Holl station was occupied in the interests of scientific inquiry from early in July until the middle of October, becoming during this period the headquarters for the steamer *Albatross*. The Commissioner, Professor Baird, was in attendance during the entire season, and personally directed the work as in previous years. Prof. A. E. Verrill was in charge of the laboratory, assisted by Mr. Richard Rathbun. The regular force of workers in the biological laboratory was constituted as follows: Prof. S. I. Smith, of Yale College; Prof. John A. Ryder, of Washington; Mr. Sanderson Smith, of New York; Prof. Leslie A. Lee, of Bowdoin College; Prof. Edwin Linton, of Washington and Jefferson College; Prof. B. F. Koons, of the Storr's Agricultural School; Mr. J. H. Blake, of Cambridge, as artist; Mr. Peter Parker, jr., of Washington; Miss K. J. Bush, and Miss. C. E. Bush, assistants of Professor Verrill; and Mr. A. H. Baldwin and Miss M. J. Rathbun, assistants in the National Museum. The chemical and physical laboratory was in charge of Dr. J. H. Kidder, and the aquaria were managed by Mr. William P. Seal, of Philadelphia. Tables in the biological laboratory were also occupied by the following college representatives: Prof. S. F. Clarke, of Williams College; Prof. E. B. Wilson, of Bryn Mawr College, and Dr. A. T. Bruce, of Johns Hopkins University. Mr. Vinal N. Edwards, a permanent observer and collector for the Fish Commission in the Vineyard Sound region, worked in conjunction with the summer party, and assisted it in various ways.

Although acting as superintendent of the station during the summer, Professor Ryder was able to devote much time to the problems of lobster and oyster culture, which were then being carried on, especially with reference to the care and rearing of the young. During the spring hatching season for cod and lobsters he also made elaborate studies of the development of those two species from their earliest stages. The other naturalists were mostly engaged in preserving, assorting, and studying the large collections brought in by the steamer *Albatross* from its several cruises to the fishing grounds. Much field work was also done in the neighboring region, in continuance of the investigations of former years, for the purpose of obtaining informa-

tion respecting the times of occurrence, the abundance, life histories, habits, diseases, parasites, etc., of the useful fishes and marine invertebrates. The Roosen process of preserving fresh fish, which has attracted much attention in Europe, was given several trials, with the expectation of finding it adapted to the preservation of bait for the offshore fishing vessels, a problem of unusual importance at the present time. It proved to be entirely unsuited to this purpose, however, the fish placed in it becoming too soft either for bait or for food, though generally free from the offensive odors of decomposition. Many large aquaria were added to the equipment of the lower floor of the laboratory and fish-hatching building, and under Mr. Seal's arrangements gave excellent opportunities to observe the habits of even large-sized fishes, of which an abundant supply for that purpose was always kept on hand. During the hatching season it was intended that these aquaria should be used for the temporary storage of the fry.

B.—SPECIAL INVESTIGATIONS.

Temperatures and densities.—One of the most important scientific problems before the Fish Commission has been the determination of the temperature and density of the water along the sea-coasts and in all inland lakes and rivers which afford valuable fisheries, or might be suited to that purpose. The object in studying these physical characteristics is at least twofold: First, to ascertain the influence of temperature and density on the movements of those migratory fishes which form so large a proportion of the fishery production of the country, and the appearance and abundance of which during any fishing season may possibly, in a measure, be predicted by a thorough knowledge of the physical conditions essential to their well-being; second, to furnish a guide in the transplanting of fishes and the stocking of any region with the species most likely to survive and propagate. General results are not so important or so applicable to this study as special series of observations continued from year to year. In the furtherance of this object, observations of temperature, and where expedient determinations of density, were made at all of the stations of the Commission during the entire year, or while operations were in progress. The same observations were made with great care by the vessels of the Commission, whether in port or cruising, and generally at intervals of one hour. The bottom and serial temperatures, and other physical data obtained by the steamer *Albatross*, on the fishing banks and in deep water, are of special value in the same connection. The most important continuous series of surface temperatures, however, are those taken for the Commission by employes of the Light-House Board and Signal Service along both sea-boards of the United States, at several stations on the Great Lakes, and upon some of the most important shad and salmon rivers on both sides of the continent. This co-operation between the two bureaus just mentioned and the Fish Commission

has continued for many years, and has resulted in the accumulation of a large amount of valuable information. During 1886, these observations were carried on at thirty-six light-ships and light-houses, and at forty-eight stations of the Signal Service.

Rusty mackerel.—The rusting of mackerel, which sometimes occurs when, through the leaking out of the brine in which they are preserved in barrels, they are left more or less exposed to the air, has been a source of frequent loss to the fish dealers. The character and precise cause of this peculiar change being unknown, specimens of rusty mackerel were obtained during the year and submitted to Prof. W. O. Atwater, of Middletown, Conn., for examination. His report upon the subject has not yet been received.

Disease among trout.—The investigations by Prof. S. A. Forbes, of Illinois, of specimens of trout from Baird Station, Cal., affected by a disease hitherto unknown in that region, proves that the disease is identical with that found among the herring in Madison Lakes, Wisconsin, where it was very wide spread and destructive in 1884. Mr. Forbes's report will be found in the account of McCloud River station, by Livingston Stone.

C.—PREPARATION OF REPORTS, ETC.

The study of materials and the reduction and compilation of observations made by the field parties, including the preparation of reports upon the same, was continued during the year at the Washington and Wood's Holl stations of the Commission and at many college laboratories. As heretofore this class of work was done mostly by volunteers, among whom are some of the most accomplished naturalists of the country. Prof. A. E. Verrill has had general charge of the collections of marine invertebrates obtained along the Eastern coast, north of Cape Hatteras, which he is studying in their relations to the fishing grounds. The fishes were being treated in a similar manner by Prof. G. Brown Goode and Dr. T. H. Bean. Other special subjects were intrusted to the following persons: The crustacea to Prof. S. I. Smith; the bottom deposits to Prof. L. A. Lee; the internal parasites of fishes to Prof. Edwin Linton and Prof. B. F. Koons; the crustacean parasites of fishes and the temperature results to Mr. R. Rathbun; special groups of the mollusca and the preparation of charts to illustrate the marine investigations of the Commission to Mr. Sanderson Smith; embryological work respecting the cod, lobster, and oyster and other economic species to Prof. John A. Ryder; the preservation of bait to Dr. J. H. Kidder and Mr. Rathbun.

D.—PROPOSED EXTENSION OF THE INQUIRY TO THE PACIFIC COAST.

The first extensive fishery investigations made upon the Pacific coast of the United States were undertaken by the U. S. Fish Commission in connection with the Tenth Census, beginning in 1879 and extending

through two or three years. Although these were mainly limited to a study of the history of the fisheries and of their condition at that time, large collections of fishes, containing many new and interesting species, were also obtained and described. An important result of these researches was to furnish conclusive proof of the value and extent of the fishery resources of the Western coast, which were then developed and utilized only to a very limited extent in the vicinity of the large settlements, and especially about San Francisco. A few fishing vessels, however, were in the habit of visiting, each season, certain rich cod and halibut banks off the central and southern Alaskan coasts, but the extent and character of these banks was unknown. The advantages which the Eastern fisheries have derived from the investigations of the steamer *Albatross* seemed to warrant the extension of the survey to the Pacific coast, and upon the solicitation of many persons interested in the matter the Commissioner decided to detail the *Albatross* for that purpose as soon as Congress could make provision for her voyage around and for the necessary alterations in her machinery. Appropriations for this purpose were passed in August, 1886, and before the close of the calendar year new boilers for the steamer were under construction. The plans for the Pacific work contemplated a thorough survey of the entire coast from southern California to the upper limit of the extensive cod and halibut banks in Alaska, upon the basis of the East coast explorations; but considering how little has been done to make known the contour and character of the bottom in that region, except near the shore, it was expected that hydrographic work in laying out and defining the fishing banks would demand a larger share of attention than hitherto. The study of the fishery resources will, however, be kept up at the same time, with the view of completing results as the explorations continue.

3.—INQUIRY RESPECTING THE FISHERIES.

Considerable progress was made during the year in the study of several of the more important fisheries, with respect both to their methods and their statistics. An event of more than usual interest was the completion of the fishing schooner *Grampus*, which has been constructed upon an entirely new plan proposed by Capt. J. W. Collins. While intended to serve as the model of a type of off-shore fishing smack, which it is thought will insure greater speed and safety to this class of vessels, she has also been specially adapted to certain branches of marine work for the prosecution of which no adequate means have hitherto been provided.

A.—OFFICE AND FIELD WORK.

The office and field work in charge of Mr. R. E. Earll had reference mainly to the following subjects:

(1) *The mackerel fishery.*—The extent of the southern spring fishery and the condition of the fish, both fresh and salt, when placed upon the

market. The effect of the spring fishery upon the demand for and the average price of salted mackerel caught later in the season. As to whether the continuance of the spring fishery is tending seriously to affect the abundance of mackerel, or, as is often claimed, has any influence in breaking up or scattering the schools of fish.

(2) *The menhaden fishery.*—The present extent and location of this fishery. As to whether the methods of the fishery are in any way connected with the continued absence or scarcity of menhaden on the New England coast.

(3) *The sardine industry.*—The statistics of the industry, and the changes which have taken place in the methods of capture and of preparation of the fish since the investigations of 1880. The influence of the abrogation of the Treaty of Washington and of the proposed duties upon the supply of fish and upon the cost of producing the canned goods.

(4) The fisheries of the Great Lakes, respecting which a report, based upon the investigations of 1885, has nearly been completed.

(5) A general and statistical review of the vessel fisheries of the United States, material for which is being collected by means of circulars filled out at the custom-houses located at fishing ports.

(6) The compilation of national and State laws relating to the fisheries.

Mr. W. A. Wilcox was employed at Gloucester, Mass., during the entire year, as an agent of the Commission in collecting data relative to the statistics and methods of the New England fisheries. He was assisted by Capt. S. J. Martin, and rendered monthly reports which have been published in the Fish Commission Bulletin for 1886. During September and October the Senate Committee on Fisheries visited Gloucester for the purpose of giving personal consideration to the different phases of the industry, and also took testimony of the fishermen. The facilities of the station were placed at its disposal.

The sturgeon fisheries of Delaware Bay and River were made the subject of an investigation by Mr. S. G. Worth, who reported over two hundred and fifty boats, carrying from 200 to 500 fathoms of net each, engaged in the industry. Mr. Worth's inquiries also had reference to the expediency of propagating sturgeon by artificial methods. The statistics of the salmon canning establishments of the Pacific coast, from 1883 to 1886, were collected by Mr. Loren W. Green, an assistant at the California stations of the Fish Commission. Mr. Green, in the course of this work, visited all of the canneries of fish on the Sacramento River. His report on the subject is contained in the Fish Commission Bulletin for 1886.

B.—THE MACKEREL FISHERY DURING 1886.

The following summary of the mackerel fishery for 1886 was prepared by Mr. W. A. Wilcox:

The work of the season began early, the first vessels sailing from Gloucester on March 11. A large fleet was soon cruising off the Delaware coast. On March 28, the

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first mackerel were seen and caught in latitude 37° 30', longitude 75° 35'. An immense body of fish, in large schools, was seen extending some 25 miles. The fish remained in this location up to April 20. A small catch was made, 25 miles north of where they were first seen, up to May 15. For a week during the middle of May quite a large body of fish was seen, and some good fares were secured in latitude 38° 30', longitude 74°, off Fenwick's Inlet. The weather was unfavorable for fishing much of the time, the early catch small, and the fishing followed at a loss. May 15, part of the fleet were off Block Island taking some mackerel, but no large body of fish was again seen off the United States coast until fall. The early catch was noticeable as being all large fish, and, as usual in the spring, of poor quality. The body of fish appear to have crossed the southern part of George's Bank, and were next found off the Nova Scotia coast, between Cape Sable and Canso, mackerel having been caught there between May 25 and June 5, passing on into the Gulf of St. Lawrence, being found June 15 off North Cape, Prince Edward's Island. On July 8 they were found 15 miles N. by E. from North Cape, soon disappearing. From July 8 to August 1 was the only time mackerel were found in abundance in the Gulf of St. Lawrence, and not always during that time, yet vessels that were on the grounds of Orphan and Bradley Banks, and off Escumenac Point, had a fair catch. The fish were mostly taken from 10 to 25 miles from shore.

The early catch came to a close abruptly. Only the first arrivals secured fares, later arrivals spent weeks and months, taking very few if any fish. Vessels with a fair catch came home, selling their catch at the extremely low price of \$4.50 a barrel, and at once returned in hopes of securing another fare of better fish and realizing more for them; in most cases they were disappointed, catching only a few barrels of fish.

Returning from the disastrous trips to the Gulf of St. Lawrence, the fleet cruised off the home shore, from the Bay of Fundy to Cape Cod, adding a small amount to the catch which was continued up to the middle of December. Quite a body of fine mackerel were off Block Island, and in Barnstable Bay as late as December; they seldom schooled, yet quite an amount was taken by small boats and net fishermen. The work of the season is remarkable for the scarcity of fish, they having been seen only occasionally in any amount either in American or provincial waters. The amount taken is the smallest since 1843, and with three exceptions, since 1818. The catch often shows great fluctuations, years of small production being followed by abundance. As late as 1883, the catch of Massachusetts was only 154,140 barrels, followed the next year by 304,938. The rapid and great advance in prices is noticeable, yet under the circumstances not remarkable.

The American catch of mackerel for 1886.

State.	Apparatus.	Vessels.	Tonnage.	Crows.
Massachusetts.....	Vessels.....	220	10,350.69	3,313
Do.....	Weirs and traps.....			243
Maine.....	Vessels.....	99	5,944.36	1,377
Do.....	Weirs and traps.....			
New Hampshire.....	Vessels.....	4	180.01	60
Rhode Island.....	Weirs and traps.....			
Connecticut.....	Vessels.....	2	88.13	10
New York.....	do.....	1	77.00	17
Pennsylvania.....	do.....	1	79.15	17
Total.....		327	22,726.24	5,046

The American catch of mackerel for 1886—Continued.

State.	Apparatus.	Southern.		New England shore.		Nova Scotia shore and Gulf of St. Lawrence.		1886. Total barrels.	
		Cured.	Fresh.	Cured.	Fresh.	Cured.	Fresh.	Cured.	Fresh.
Massachusetts	Vessels	2,612	9,928	8,126	10,632	51,633	.....	65,401	19,960
Do	Weirs and traps	.....	.....	1,299	5,091	.....	.....	1,299	5,091
Maine	Vessels	95	2,590	6,604	2,528	10,727	780	17,426	5,898
Do	Weirs and traps	.....	.....	80	950	.....	.....	80	950
New Hampshire.	Vessels	.....	.....	125	1,500	.....	.....	125	1,500
Rhode Island.	Weirs and traps	.....	.....	650	1,100	.....	.....	650	1,100
Connecticut	Vessels	.....	.....	275	.....	.....	.....	275	.....
New York	do	.....	.....	50	.....	100	.....	150	.....
Pennsylvania	do	.....	88	200	.....	148	.....	348	68
Total	.....	2,737	12,586	17,409	22,101	65,608	780	85,754	35,467

C.—THE SCHOONER GRAMPUS.

In previous reports allusion has been made to the building of a sailing vessel for the work of the Commission, which was to be named the *Grampus*. The vessel was completed and went into commission on June 5th of the present year. Her operations are fully discussed in a report published in the appendix.

The purposes for which this vessel was constructed are varied and important. For some time the Commission has felt the necessity of having a suitable sailing vessel, provided with a well, in which marine fishes can be kept alive and transported from the fishing grounds to the hatching stations on the coast where the eggs may be obtained for the purpose of artificial propagation.

Such a vessel can also serve a useful purpose by bringing in alive marine species, not perhaps in a gravid condition, which can be put into large aquaria and thus afford to biologists an opportunity to study the habits of our ocean fauna under conditions that can not possibly be otherwise afforded.

Another important duty which it is believed may be performed by a well equipped vessel, that is seaworthy and swift, is to visit European waters and bring therefrom alive certain species of marine fishes which are held in high repute for food and do not occur in American waters. Among these may be mentioned the sole, turbot, plaice, and brill. The introduction and propagation of these species in our waters must be of great advantage to the United States, not only in giving to our people additional species of delicate food fishes, but in introducing for their capture the method of fishing with a beam trawl, which is not now in vogue here and might, perhaps, profitably employ many vessels and men.

The *Grampus* has been fitted for using a beam trawl to test its utility in American waters in a commercial way. Although we have not the species of flat fishes which constitute the principal objects of the beam trawl fishery in Europe, there are several kinds in our waters

that are nearly as good, and it is possible that on the sandy and muddy bottoms frequented by these off our coast the beam trawl may be very effectively used.

It is also of the highest importance that the movements of the migratory fishes should be followed in the spring and autumn, when they are approaching and leaving the feeding grounds which they frequent in summer.

Hitherto less has been done in this direction than is desirable, and a sailing vessel which is able to remain at sea in all weathers is especially well adapted to carrying on such investigation, since she is not dependent upon a supply of coal, and may, if necessary, cruise for weeks or months in succession. The *Grampus* being especially fitted for carrying on fishing operations can use all the appliances and methods for the capture of fish much better than they can be used on larger and more expensive steam vessels. In connection with these researches to ascertain the movements and habits of the migratory species, various forms of apparatus will be used to ascertain their presence, as well as the occurrence of crustacea or other forms of minute life that may constitute the food of fishes. Observations of the temperature, density of water, and the influence of winds and currents upon the movements of fish can also be studied.

She is especially adapted to making researches at sea for the discovery and investigation of fishing grounds, as well as for collecting the fauna of the localities visited, and thus determining the value of certain regions for the purposes of commercial fishing.

The *Grampus* is a two-masted, schooner-rigged vessel, 90 feet long, over all; 81 feet 6 inches on load-water line; 22 feet 2 inches beam, and 10 feet depth of hold; her registered tonnage is 83.30 tons. In model and rig she is a radical departure from the vessels commonly in use in the New England fisheries; and an additional important object sought in building her was to produce a type of fishing vessel which will be safer and better adapted in various ways to the exigencies required of a schooner employed in the ocean fisheries.

In the cruises made the present year she has shown remarkable sea-going qualities, and has demonstrated the fact that in safety, speed, and "handiness" she is far superior to the clipper fishing schooners of New England. Her influence is already being felt, and the principal features in her model and rig, which have been alluded to in a previous report, are being copied by the New England builders.

It is reasonable, therefore, to suppose that marked innovations may be caused by her advent, and that a few years will witness a change for the better in the form and rig of our fishing vessels. Such a change will result in the obtainment of greater safety and other scarcely less desirable qualities that must prove very beneficial to the fishing interests, and especially in preventing the sacrifice of life and property which has heretofore seriously handicapped these industries.

4.—FISHERY RELATIONS OF THE UNITED STATES WITH CANADA.

The treaty of Washington, defining the fishery relations between Canada and the United States, terminated July 1, 1886, but, by courtesy of the British Government, the privileges which it had granted to American fishermen were extended to the 1st of January following. In connection with the correspondence which ensued between the representatives of the two Governments relative to this subject, the U. S. Fish Commissioner was occasionally called upon for information. In December, 1886, he made the following report to the honorable Secretary of the Treasury, in reply to several questions which the latter had presented for his consideration. This report is of special interest as giving in concise form a comprehensive view of the fishery question based upon the evidence in the possession of the Fish Commission. The questions and replies are as follows:

Question 1. "What do you estimate to have been the value of the products of the British North American fisheries for 1885?"

The Canadian fisheries in 1885, as shown by tables compiled by the Canadian government, furnished occasional or continuous employment to 59,493 persons, with 1,177 vessels and 28,472 boats. The value of these, together with that of the other apparatus and capital, including shore property, gives a total of \$6,697,459 employed in the fisheries industries, with a total value of products amounting to \$17,722,973.18. The tables from which the summary is obtained have been compiled from the annual report of the Department of Fisheries, Dominion of Canada, for the year 1885.

In using the figures, it should be remembered that the tables include not only the commercial fisheries, but also the persons, apparatus, and capital employed in fishing for local supply, and probably a large number who fish only to furnish food for their own families. This class, owing to the lack of manufacturing interests and the character of the soil, composes in many localities a large part of the population.

Question 2. "What are the descriptions of the fish—in consequence of the present habits of the fish, the present methods of catching, drying, curing, and preserving—American fishermen desire to take either in the jurisdictional waters of British North America, or in the open sea or open bays near the British colonial possessions?"

Prior to, and during the first half of the present century, many of the New England vessels engaged in the offshore cod fisheries, being of small size, found it desirable to fish in the vicinity of the shore, where they could make a harbor in case of severe storms. Owing to their small tonnage, they found it difficult to carry sufficient quantities of codfish to make a trip to the more distant fishing grounds profitable, and many of them found it desirable to land and dry their fish upon the shores, thus enabling them to bring home a much larger quantity as a result of the voyage. At that time the majority of the fish were exported to Spain and the West Indies, and the methods which our fishermen found it necessary to adopt in drying their fish on the provincial shores made them especially adapted for these markets.

Since 1850 the small vessels engaged in the offshore fisheries have been gradually replaced by larger ones, and thus the privilege of fishing for cod in the vicinity of the shore has become less important, and as the codfish are more abundant on the offshore banks, 20 to 200 miles from land, vessels engaged in this fishery now prefer to visit these localities; and they have been doing so, with comparatively few exceptions, for the past fifteen or twenty years. The catch of these vessels, instead of being exported, is now to a great extent consumed in this country, and our market at present calls for fish cured in a different way, so that the privilege of drying and curing fish

on Canadian soil, now that the vessels are large enough to readily carry the undried fish, is no longer of any advantage whatever to our fishermen.

Formerly vessels employed in the mackerel fisheries were provided only with band-lines, and the crews caught the fish from the vessel's deck. When fishing in this way they found it desirable to grind up fish and clams, which they threw in large quantities into the water to attract the mackerel and keep them in the vicinity of the vessel. The best results were then obtained by fishing in shoal water, as the bait thrown overboard could not sink to any great depth, and the entire body of fish were thus kept near the surface, where they were within reach of the hook and line. About 1,865 purse-seines were introduced for the capture of mackerel, and in a few years they came to be generally adopted by vessels employed in the mackerel fishery. These are fished to best advantage at some distance from the shore, and the fishermen usually avoid shoal water, as the seines are liable to be ruined when set in depths where the lead lines may chance to come in contact with the bottom.

During earlier years the halibut fishery in the vicinity of Provincial shores was of some slight importance to the American fishermen, but this has been confined wholly to deep water, many miles from land, since 1875.

The shore herring fisheries, and the occasional capture of certain species for bait, were also at one time of value to fishermen from the United States; but such a decided opposition on the part of the resident Provincial fishermen was manifested to the exercise of the privilege of taking fish, accorded by the Treaty of Washington, that the practice of catching their own supply was practically abandoned, and the fishermen have almost without exception, since the well-known difficulty at Fortune Bay, Newfoundland, about ten years ago, purchased their cargoes of herring from the local fishermen, and, where these had no suitable apparatus for obtaining the same, have carried their own apparatus and hired the provincial fishermen to manipulate it.

The mackerel is, then, the only species of any importance visiting Provincial waters which American fishermen at present desire to catch within 3 miles of the shore, or indeed within a much greater distance. This is practically the only Provincial shore fishery in which our fishermen have had any considerable interest since the ratification of the Treaty of Washington, as the great majority of our vessels employed in other fisheries on the banks off the Provincial coast seldom fish nearer than 25 or 30 miles from land, and a majority of them secure their cargoes from 100 to 200 miles from shore.

At the present time the advantage to be derived from any privilege of fishing within 3 miles of the Canadian coasts, even for mackerel, is comparatively insignificant, as the results of the season which has just closed show conclusively that our vessels which have fished wholly outside of the 3-mile limit have done fully as well as the Canadian vessels which have had the opportunity of fishing everywhere, without restriction as to distance from shore.

Question 3. In the method of fishing on that open sea, or in those open bays, of preserving the catch and sending it to our ports for a market now desirable for our American fishermen, of what importance is the right to enter, in a commercial way, British colonial ports in the neighborhood?

The nature of the occupation of fishing, when the size of the vessel is considered, renders it impossible for a fishing vessel to provide against all contingencies. On leaving the home ports the vessels are ordinarily provided with what is supposed to be a full outfit of provisions and apparatus, but a scarcity of fish may render it desirable that it should remain on the fishing grounds longer than was expected, or it may be delayed by head-winds, storms, or floating ice, until the supply of provisions or water is exhausted. It then becomes convenient, in order to prevent actual suffering, that the vessel should make a harbor and obtain additional quantities. Instances have occurred during the present year when vessels short of provisions have attempted to reach one of our own ports to obtain a supply rather than incur the risk of seizure by entering those of Canada for that purpose.

Again, portions of the vessel's equipment, such as anchors, cables, fishing-boats, and apparatus of capture, are liable to be lost during stormy weather, and it is a great convenience to be able to purchase new material in the nearest Provincial port rather than to incur the loss which must be sustained, provided the vessel is obliged to return to American markets to purchase them. This is true both in the fisheries carried on near the land and also in those on the more distant fishing grounds. This season much inconvenience was experienced by many of the vessels engaged in the mackerel fishery from the tearing of their seines and the loss of their seine-boats in heavy weather, owing to the refusal of certain Canadian officials to allow them to land their seines for purposes of repair or to buy new boats for continuing their fishing operations. Many of them were provided with two boats, and some carried two seines to guard against such contingencies, but in a number of cases vessels so equipped were equally inconvenienced with the others.

The only occasion that vessels would have for entering the harbor, due to the methods of preserving fish, would be for the purpose of obtaining either salt, barrels, or ice. It sometimes happens that the salt is damaged by a leak in the vessel, or that a detention beyond the expected time causes the melting of the ice, and it is important that our fishermen should be permitted to purchase additional quantities in Canadian ports, rather than run the risk of losing the entire cargo of fish or of returning with only a partial trip. The present interpretation given to the treaty of 1818 by the Canadian authorities, while it might allow a leaking vessel to enter a port for repairs, would not allow it to replace the salt that might have been rendered worthless by the leak.

The privilege of landing cargoes of fish at Provincial ports for shipment to the United States is of considerable importance to vessels engaged in the mackerel fishery, but of little value to those employed in the capture of other species. Vessels are thus enabled to land trips for shipment and to immediately resume their fishing operations, thus saving the two to four weeks necessary for making the homeward and return passage; but with the privilege of transshipping cargoes should be coupled that of refitting at the port where the fish are landed, otherwise the vessel might be short of provisions or apparatus, which would render it impossible for it to continue its fishing operations.

Most of the vessels from Gloucester, Mass., engaged in the off-shore cod fisheries have made a practice of obtaining fresh bait in Provincial ports; but a majority of vessels similarly employed from other places carry salt bait, thus being entirely independent of the Canadian supply. The chief difference between the two classes is that the Gloucester vessels fish with trawls, while the crews of most of the other vessels catch their fish with hand-lines. It is claimed by certain of the Gloucester fleet that they get more and larger fish by the use of fresh bait, but the fishermen from other ports have found their own methods profitable and have not felt disposed to follow Gloucester's example even when they had free access to Canadian ports for the purpose of obtaining bait.

A few of the vessel-owners in Gloucester have long maintained that the time lost in going to and from Provincial ports to secure bait, and the temporary demoralization of the crews resulting from a visit to these ports more than offset any advantages that are to be derived by the use of fresh bait, and urge that salt bait would be found, on the whole, more profitable; but as a considerable percentage of the men employed on the vessels have families or relatives in the Provinces, they have continued to urge upon the owners the necessity of obtaining bait in these localities, and it has been difficult to dissuade them. After the experience of the present year quite a number of other Gloucester owners and fishermen as well are convinced that it is on the whole better to substitute salt bait than to continue the old practice of leaving the Banks in the midst of the fishing season to obtain other kinds in the Provinces. That this opinion is shared by the Nova Scotia fishermen is proven by the fact that for some years they have been in the habit of purchasing large quantities of salt

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clams from dealers at Portland and other towns in the State of Maine, to be used by them in the cod fisheries.

Since the introduction of the purse-seine the mackerel fishermen have required no bait.

In the halibut fishery it is only necessary to take a sufficient quantity to last one or two days, as the remainder of the catch can be obtained on refuse fish taken on the trawls with the halibut, or, if necessary, small halibut can be cut up and used for baiting the hooks.

In the past the cod-fishermen frequenting George's Banks have at certain seasons of the year obtained their bait from Canadian ports, but the experience of the present year has proven that they are not dependent upon them, as most of the vessels have obtained their supply on our own coast with comparatively little difficulty, and frequently with less loss of time than was customary when visiting localities in New Brunswick and Nova Scotia.

It will thus be seen that though the privilege of obtaining bait and the ice necessary for preserving it in British North American ports has been in the past and may even still be considered a convenience to certain classes of vessels, it is not of vital importance.

The agitation of the question of bait supply has had a very beneficial influence upon our own fishermen, and has resulted in the development of extensive shore-bait fisheries along the coasts of Maine and Massachusetts, which give promise of being able to supply in large part, if not wholly, the demands of our entire fleet. During the past summer the experiment of shipping bait to Boston from the more remote localities on the coast of Maine has been made with success, and the cost of transportation is not high enough to be a barrier to the continuance of the business. If this practice increases, as at present seems probable, it will doubtless result in a great saving of time to our fleet, which has often in the past been seriously inconvenienced in its fishing operations, owing to the time consumed in sailing from port to port in search of a supply. The U. S. Fish Commission has recently begun a series of experiments with a view to determining the practicability of preserving fresh bait long enough to admit of its shipment from New England ports to the fleet fishing on the more distant banks, but the work is not yet sufficiently advanced to warrant an opinion as to the probable result.

Question 4. "The same question in regard to the fishing on the permitted coasts and the commercial entry in the prohibited bays and harbors, but not for fishing."

There is at present comparatively little fishing by American vessels on that portion of the coast to which free access is given by the treaty of 1818; but vessels fishing in that vicinity should have the same privileges in other ports as are accorded to other vessels, as it would seem unwise to discriminate, and it would, perhaps, owing to the few settlements of any importance on the permitted coast, be more convenient for the vessel to enter ports in the prohibited districts to purchase the necessary articles than to go out of their way in an opposite direction, where there might be any uncertainty of securing them.

Question 5. "What is your estimate of the total tonnage of the American vessels, the number of fishermen thereon, engaged in the Canadian and North Atlantic fisheries in 1886, and the total value of their catch?"

A careful estimate of the extent and importance of our New England vessel fisheries indicates that during the present year there have been 1,956 vessels, aggregating 115,130 tons, with crews numbering 17,996 men, employed in the various sea fisheries. The fleet is estimated to have been divided as follows: 1,530 vessels in the food-fish fisheries, 215 in the shell-fish and lobster fisheries, 177 in the capture of whales and seals, and 34 in the menhaden fishery.

The 1,530 food-fish vessels aggregated 71,200 tons and furnished employment to 14,240 men. The vessels, with their equipment, were valued at nearly \$5,000,000, and their catch is estimated to have sold at prices to fishermen for \$4,590,000. Of this

fleet 350 sail were engaged in the off-shore mackerel fisheries, 200 in the cod fisheries on Quereau, Grand, and Western Banks, 165 others in the cod fisheries of George's and Brown's Banks, 65 in the off-shore halibut fisheries, and the remaining 750 in the miscellaneous shore and off-shore fisheries.

The off-shore mackerel vessels are the only ones that have engaged to any extent in catching fish in the vicinity of waters under British jurisdiction. Of this fleet about one-half, or possibly a slightly larger percentage, have fished in the Gulf of St. Lawrence during a portion of the mackerel season, the remainder of these vessels having remained off our own coast.

Below are given two tables, showing in detail the extent and character of our New England vessel fisheries in 1885. The figures as there explained are estimated from partial statistics furnished by collectors of customs on Treasury circular No. 63, Bureau of Navigation, and from special, but as yet unfinished, investigations by the U. S. Fish Commission. The statements in both tables are therefore subject to revision; but, as due allowance has been made for the statistics not yet received, it is believed the totals will not be materially changed by the final compilations.

Table estimating by fisheries the total number, tonnage, and value of New England vessels employed in the North Atlantic food-fish fisheries in 1885, with the number of men and value of apparatus and outfit on same, and the total value of their catch.

[These estimates are based upon partial returns from collectors of customs on Treasury Circular No. 63, current series, and upon special investigations by the U. S. Fish Commission.]

Fisheries.	Number.	Tonnage.	Value.	Value of apparatus and outfit.	Number of men.	Value of catch.
Off-shore mackerel fisheries.....	350	30,000	\$1,325,000	\$520,000	5,500	\$875,000
Cod-fisheries on Quereau, Grand, and Western Banks.....	200	16,500	765,000	330,000	2,800	990,000
Cod-fisheries on George's and Brown's Banks.....	165	10,000	640,000	200,000	2,000	850,000
Off-shore halibut fisheries.....	65	5,000	400,000	110,000	900	750,000
Miscellaneous shore and off-shore fisheries.....	750	9,700	430,000	260,000	3,040	1,125,000
Total.....	1,530	71,200	3,560,000	1,420,000	14,240	4,590,000

Table estimating by fisheries the total number, tonnage, and value of New England vessels, with the number of men thereon, employed in the various fisheries in 1885.

[Based upon partial returns from collectors of customs on Treasury Circular No. 63, current series, and information obtained from other sources.]

State.	No.	Tons.	Value.	No. of men.	State.	No.	Tons.	Value.	No. of men.
<i>Food-fish.</i>					<i>Lobster and shell-fish.</i>				
Maine.....	525	18,000	\$900,000	3,600	Maine.....	40	750	\$30,000	100
New Hampshire.....	20	600	30,000	120	New Hampshire.....	15	850	8,000	40
Massachusetts.....	850	50,000	2,500,000	10,000	Massachusetts.....	10	100	7,000	25
Rhode Island.....	35	400	20,000	80	Rhode Island.....	150	2,600	200,000	400
Connecticut.....	100	2,200	110,000	440	Connecticut.....				
Total.....	1,530	71,200	3,560,000	14,240	Total.....	215	4,300	245,000	565
<i>Whale and seal.</i>					<i>Menhaden.</i>				
Maine.....	2	100	\$10,000	20	Maine.....				
New Hampshire.....					New Hampshire.....				
Massachusetts.....	180	36,000	1,500,000	2,500	Massachusetts.....	19	960	\$161,000	291
Rhode Island.....					Rhode Island.....	15	570	66,550	140
Connecticut.....	15	2,000	100,000	240	Connecticut.....				
Total.....	177	38,100	1,610,000	2,760	Total.....	34	1,530	227,550	431

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Table estimating by fisheries the total number, tonnage, and value of New England vessels, with the number of men thereon, etc.—Continued.

SUMMARY.

State.	No.	Tons.	Value.	No. of men.
Maine	567	18, 850	\$940, 000	3, 720
New Hampshire	20	600	30, 000	120
Massachusetts	1, 025	86, 850	4, 008, 000	12, 540
Rhode Island	64	1, 460	188, 000	396
Connecticut	280	7, 370	476, 550	1, 220
Total	1, 956	115, 130	5, 642, 550	17, 996

Question 6. "What change has, in your view, come to American fisheries since the last full year of the Washington treaty in regard to the character, quantity, and general features of that industry?"

There has been little change in the fisheries other than the mackerel fishery during the past year. In this fishery the scarcity of mackerel has been very marked and the catch has been much below that of the average year. The decrease, however, can be in no way attributed to the abrogation of the Treaty of Washington, but must rather be accounted for by natural causes which have affected the abundance, movements, and locality of the species.

For several years prior to 1886 mackerel appeared in more than average quantities, and for eight or ten years, ending with 1885, they have been much more plentiful on our own coast than on any portion of that of British North America. For this reason the fleet of American mackerel vessels visiting waters in the vicinity of British territory has of late been very small. In 1885, out of a total of about 380,000 barrels caught by our fleet, only 26,000 barrels, or less than 7 per cent., were taken in the vicinity of Canada, the quantity obtained within the 3-mile limit being only 3,564 barrels. The fact that, during a season when permission had been given to allow American vessels to fish anywhere in the waters of British North America without restriction as to distance from shore, less than 1 per cent. of the catch of our mackerel fleet was secured within 3 miles of British territory, and that more than 93 per cent. of the total catch of mackerel was obtained in the vicinity of our own coast, is certainly significant.

During the present year mackerel have been peculiarly scarce in all localities, though for the first time in eight or ten years they have been more abundant in the Gulf of St. Lawrence than off the New England coast, and a large percentage of the American vessels employed in the fishery have visited that locality. The catch has, as a rule, been unusually small, but the price has increased in proportion, so that the season for some of the vessels has not been wholly unprofitable. The limited catch can not in any way be accounted for by the restrictions placed upon our vessels within the 3-mile limit, for their catch, as previously stated, has been equal to that of the Canadian vessels that fished without restriction as to distance from the shore.

The vessels engaged in the cod-fishery have met with more than average success. This is partially attributed to the fact that the squid, used for bait, have been very plenty during the summer and fall months on the fishing-grounds. It has not infrequently occurred that vessels have sailed without any bait, depending upon the supply that they could catch on the Banks upwards of a hundred miles from shore.

Question 7. "Your Commission has, in its annual reports, alluded to the diminished necessity on the part of American fishermen to go to British North American ports or waters for bait. What are the new features of that necessity?"

A few years ago the United States Fish Commission obtained from Norway a number of gill-nets suitable for catching codfish, and used them with success in the cod-fisheries about Gloucester, Mass. Similar nets are now made in this country, and are extensively employed by the shore cod-fishermen of that vicinity, who obtain large

catches by their use. These fishermen formerly depended in large part for their bait upon frozen herring, brought from New Brunswick and Newfoundland, but where gill-nets are used bait is no longer required. Thus far, however, gill-nets have not been extensively employed in the capture of codfish on the more distant fishing-banks.

The development of our shore bait fisheries, referred to in answer to a previous question, also renders our people less dependent upon the Provincial supply, and the growing sentiment upon the part of certain Gloucester owners in favor of substituting salt clams purchased in American markets for fresh bait obtained in the Provinces, seems destined to decrease still further our dependence upon the Canadian supply. It can not be denied, however, that there are still a large number of vessels that would consider it a convenience to obtain bait in the Provinces, provided commercial privileges, under proper restrictions, are accorded to our vessels.

Question 8. "Your Commission has also alluded to inquiries presented by it in respect to the general value of the inshore Canadian waters to American fishermen, and the yearly value of the liberties given to American fishermen by the Washington treaty. Have you ascertained new facts of public interest in that regard which you can conveniently communicate to me?"

The decreased importance to American vessels of the inshore Canadian fisheries has resulted—

(1) From the increased size of our vessels, which did away with the necessity of fishing close to land, where harbor could be made in case of storms, and of landing in the vicinity of the fishing grounds to dry their fish before sailing for home;

(2) From the substitution of the purse-seine for the hand-lines in the capture of mackerel, which has necessitated the fishing in deeper water and at a greater distance from shore; and

(3) From the change in the location of the mackerel fisheries, which has for the past few years enabled our vessels to obtain full cargoes in the vicinity of our own coast, instead of going to the Gulf of St. Lawrence, where they formerly met with better success, but where of late years—prior to the present season—they have found fishing unsatisfactory.

This recent return of the mackerel to the more northern waters should, however, not be considered as indicating a permanent change in the location of the fishery, for within a short time, and possibly next season, they may again appear in greater abundance on our own coast; and, indeed, the study of the movements of other fishes renders it not wholly improbable that mackerel may at no distant day disappear entirely from the Gulf of St. Lawrence and from other portions of the Provincial shores, where they are now abundant.

5.—PROPAGATION OF FOOD-FISHES.

DISTRIBUTION OF FISH AND EGGS.

The cars of the Commission have been extensively used in transportation. Some changes have been made in methods of distribution. Carp and other fishes of the same family are shipped during the fall and early winter, and not in the spring, which is the season of their greatest emaciation. Eggs intended for shipment to foreign countries were packed at the stations for the entire trip, and not repacked in New York. The boxes containing them were transferred from the non-conducting material surrounding them in the outer shipping cases to the refrigerating-rooms of ocean steamers.

Trout have been shipped by express, without a messenger, from Washington to New York and back, with no loss. A shipment to

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Natural Bridge, Va., under less favorable conditions, was not so satisfactory; but these experiments indicate that it is possible to send trout moderate distances without attendants.

Below is a summary of the distribution for eighteen months, including 1886 and one-half of 1887; it covers, also, the distribution of 1885-'86 from the McCloud River and Cold Spring Harbor Stations not previously reported. The total number is somewhat too large, since the eggs of the Salmonidæ, after being counted as distributed from the station where they were obtained, were hatched at other stations, and the fry produced were sometimes again reported. The distribution of whitefish (94,670,000) is the largest that has been made up to this time.

Summary of distribution from January 1, 1886, to June 30, 1887.

Kind of fish.	Eggs.	Fry.	Large fish.	Miscellaneous.
Whitefish.....	22,600,000	62,070,000		
Grayling.....			2	
Smelt.....		2,100,000		
Salbling.....	18,000			
Brook trout.....	82,000	7,488	1,711	
Lake trout.....		155,809	6,923	
Atlantic salmon.....	754,000	416,588		
Land-locked salmon.....	377,500	44,017		
Rainbow trout.....	420,000	49,930	16,482	
Brown trout.....	84,800	26,500		
Eels.....				200
Shad.....	10,718,000	99,752,000		
Carp.....		136,163		
Tench.....				1,202
Gold fish.....		2,805		
Brook pickerel.....				14
Rock fish.....		75,000		
White perch.....				68
Black bass.....		48		
Sunfish.....				125
Redeye.....		2,328		
Codfish.....		662,000		
Sole.....				19
Lobsters.....		5,000		

The grand total of the distribution is 210,628,413.

NOTES ON THE SPECIES PROPAGATED AND DISTRIBUTED.

a. **The Sole** (*Solea solea*).

During 1886 several consignments of soles were brought across from Liverpool in the White Star steamer *Britannic*. Early in the year 24 were brought in one shipment without loss. From two later consignments 37 fish out of 49 sent were safely received at Wood's Holl, where they were kept with the hope of using them for breeding purposes.

The hanging fish-globes now employed for carrying soles across the Atlantic give better results than any other form of apparatus as yet devised for the purpose.

b. **The Halibut** (*Hippoglossus hippoglossus*).

As the fishing for this important species in moderate depths has become unprofitable because of the scarcity of the fish it was earnestly desired to begin its artificial propagation during the present year. The

Grampus was accordingly sent to the fishing-banks in the latter part of September in search of halibut. It was found that the spawning season was near at hand. The fish were caught in deep water, from 200 to 350 fathoms, and placed in the vessel's well apparently in good condition; but all of them died within twenty-four hours, probably on account of the difference in pressure and temperature. Attempts will be made to get halibut from shallow water in the Gulf of St. Lawrence or on the west coast of Newfoundland for future experiments, when it is expected that they will better endure transportation in the vessel.

c. **The Codfish** (*Gadus morrhua*).

The apparatus which proved most satisfactory for hatching the floating eggs of the cod was the tidal box devised by Colonel McDonald in 1881, modified by Capt. H. C. Chester's addition of inverted glass cylinders, having the mouth closed by cheese cloth and the bottom perforated for ventilation.

During January and February eggs were hatched easily in the apparatus above mentioned, but owing to the severe weather it was very difficult to obtain spawning fish.

On the 25th of January two acid carboys, each containing 40,000 codfish just hatched, were forwarded by express from Wood's Holl to Washington. After being forty-four hours in transit, about 7 per cent. of them reached Washington alive. On the next day 50,000 fish were sent in a carboy. After a journey of forty-four hours fully 50 per cent. of them reached the station in good condition. On January 28 a shipment of 500,000 fish in ten carboys was taken from Wood's Holl by messengers. They reached Washington on the 29th with a loss of less than 10 per cent., and were sent forward the same day to Pensacola, Fla., where they arrived shortly after midnight, February 1, with an additional loss of about 10 per cent. At Pensacola they were transferred to the revenue steamer *Forward*, which had been placed at the service of the Commission by order of the Secretary of the Treasury, and carried to the place selected by Mr. Silas Stearns for their final destination in the Gulf of Mexico, southeast by east from Pensacola Bar, in 100 fathoms of water. This experiment was made to determine whether or not the cod can be successfully transferred to Southern waters and become the object of a profitable fishery there.

In February a shipment of 500,000 young cod was forwarded from Wood's Holl through Washington to Old Point, to be deposited in Hampton Roads, with the hope of forming a colony in Chesapeake Bay.

Work of the Grampus.—During the winter of 1886-'87 the *Grampus* was engaged in obtaining eggs of the codfish for hatching at the Wood's Holl Station. In many cases the fish were taken with the gear of the *Grampus* and carried alive in the well to the station. Between 600 and 700 live fish were thus secured. Over 43,000,000 eggs were obtained; 20,000,000 were hatched and planted in the immediate vicinity of the station. Frequently eggs were obtained by sending men to collect

them on board fishing vessels on the grounds. Owing to the cold and inclement weather during much of the winter cod were unusually scarce and fishing, even under the most favorable circumstances, was poorly remunerated. The work of collecting, however, was continued whenever opportunity offered until the middle of March.

Work of the Fish Hawk.—Early in January, 1887, the crew and some of the hatching apparatus of the vessel were utilized in the work at Wood's Holl. Late in February and till near the end of March the *Fish Hawk* was engaged in making short trips off Portsmouth and in Ipswich Bay, boarding fishing vessels to collect codfish spawn for shipment to Wood's Holl.

d. The Mackerel (Scomber scombrus).

In the month of May Captain Chester secured three gravid mackerel at Wood's Holl, and from them eggs were taken and placed in the apparatus which had been used for eggs of the cod. The fish commenced hatching in ninety-four hours after the eggs had been placed in the jars. This adds another very important species to the list of fishes that may be propagated at the Wood's Holl Station.

e. The Black Bass (Micropterus dolomieu).

11 breeders and 100 yearlings were collected during the summer at the Wytheville Station. 48 yearlings were sent away during the year.

f. The Red-eye (Amblplites rupestris).

At the Wytheville Station, during the fiscal year 1886-'87, 77 breeders and 2,125 yearlings were obtained. 18 breeders were sent to the Central Station and 2,085 yearlings were distributed, including 586 in Cacapon River and 600 in Cowpasture River. On March 1, 1887, 25 red-eyes, about an inch in length, were sent to Max von dem Borne, Berneuchen, Germany, 20 of which reached their destination in safety.

The red-eye is a good pan fish, gamey, and weighs a half pound on the average; it is likely to do well in ponds.

g. The Sunfish (Lepomis gibbosus).

During the summer of 1886, 125 sunfish, about 1 inch in length, were taken at Cold Spring Harbor and forwarded, through Mr. E. G. Blackford, to Max von dem Borne, Berneuchen, Germany, who was fully advised of their predatory character.

h. The White Perch (Roccus americanus).

Three shipments of the young of this fish were sent from the Cold Spring Harbor Station to Max von dem Borne, in October and December, 1886, and March, 1887, of which only three, from the last shipment, reached Germany alive.

i. The Rockfish or Striped Bass (Roccus lineatus).

600,000 eggs were obtained at the Battery Station, near Havre de Grace, Md., but owing to pressure with the shad work, few of them were

hatched. 75,000 fry were successfully planted in Lake Ontario, near Oswego, N. Y.

j. The Smelt (Osmerus mordax).

Large numbers of smelts were hatched at the Cold Spring Harbor Station, the parent fish having been obtained on the south side of Long Island. The hatching was rendered difficult by the glutinous nature of the eggs, but about one-half were developed. Over 2,000,000 young were planted in Cold Spring Harbor and 50,000 were deposited in Saranac Lake, in northeastern New York.

About the first of April a lot of eggs were sent to Northville Station, where they arrived in bad condition and apparently dead, but upon digging into the mass about 15 or 20 per cent. were found to be good.

k. The Whitefish (Coregonus clupeiformis).

Notwithstanding the stormy and very cold weather 129,400,000 whitefish eggs were obtained during November and December for the hatching stations at Northville and Alpena, Mich. The first eggs were received from Lake Erie November 7; the last from Lake Michigan December 13. On November 28 about 30,000 eggs were taken from two whitefish which had been hatched and reared at the Northville Station; this is believed to be the first record of their breeding in captivity. The hatching season at Northville lasted from March 11 to April 12; at Alpena, from April 22 to May 8.

32,600,000 eggs were distributed, mostly to neighboring state fish commissions; 62,070,000 fry were planted in waters of Michigan, Ohio, Indiana, and New York; 2,500,000 eggs were sent to England, 1,000,000 to Germany, and 1,500,000 to New Zealand; 5,000,000 were forwarded to the Central Station at Washington; 10,000,000 each to the State hatcheries of Pennsylvania and Minnesota; 1,000,000 to New York, and 1,600,000 to Delaware. From the 1,000,000 eggs sent to the Cold Spring Harbor Station nearly 950,000 young were obtained, and these were deposited in deep, cold lakes on Long Island.

l. The Dwarf White fish (Coregonus albula).

In January, 1886, Max von dem Borne sent 80,000 eggs of this species as a gift from the Deutsche Fischerei-Verein, by Herr von Behr, to the United States Fish Commission. These were received at the Cold Spring Harbor Station, and Mr. Mather was directed by the Commissioner to forward 70,000 eggs to Bucksport and 10,000 to Northville. Mr. Atkins received his allotment February 1. The first fish hatched out March 24, and about 51,000 young were obtained; these were planted April 21, 1886, in Heart Pond, a small lake near Bucksport which empties into the Eastern River, a small tributary of the Penobscot. Some of the eggs sent to Northville were hatched March 7, but no healthy young were secured from them.

m. The Brook Trout (Salvelinus fontinalis).

The Northville Station.—At the Northville ponds 186,750 eggs were taken. From December 28, 1886, to February 9, 1887, 82,000 eggs were shipped away, 10,000 to England, the remainder to Minnesota, Delaware, and Pennsylvania, and to the Central and Wytheville Stations. 527 young fish were sent away and 4,000 fry were retained for breeding purposes.

The Wytheville Station.—In December, 1886, 193 breeders were received from the Northville Station. In April 5,000 fry came from the Central Station. In January, 1887, 26,508 eggs were received from Northville and 75,000 from Mr. R. E. Follett, of Windham, Conn. During May and June, 1887, 750 yearlings and 2,488 fry were planted in suitable streams in Maryland and Virginia.

n. The Saibling (Salvelinus alpinus).

The Cold Spring Harbor Station.—In February and March, 1887, three shipments, each containing about 20,000 eggs of the saibling, were received from Berneuchen, Germany. 3,000 eggs from the first lot were repacked and sent to the State hatchery at Plymouth, N. H., where they arrived in good condition. The sound eggs of the second shipment were mixed by mistake with eggs of the brown trout received from Germany at the same time, and were distributed in this state to the hatcheries at Corry, Pa., Wytheville, Northville, and Cold Spring Harbor. 15,000 good eggs from the last shipment were sent safely to the Northville Station March 17, and hatched soon after; but the fry refused to eat, and most of them died of "blue sac" and starvation.

o. The Lake Trout (Salvelinus namaycush).

The Northville Station.—6,150 lake trout, hatched in January and February, 1886, were sent to Ohio, Indiana, Kentucky, and Tennessee. Owing to a lack of available funds no eggs were taken.

The Wytheville Station.—During the fiscal year 1886-'87, 800 yearlings were sent to the Central Station, 50 to the Gasconade River, Missouri, and 350 were planted in streams near the station.

The Cold Spring Harbor Station.—150,000 eggs were received from Northville December 19, 1885. 80,000 fry were distributed to waters in and near the Adirondacks; 5,000 to Monroe, N. Y.; 5,000 to Gloucester, Mass.; and 20,000 to Long Island waters. An attempt to rear some of the fry at the hatchery was unsuccessful, on account of the high temperature of the water. In June, when it reached 60° Fahrenheit, the young began to die, and none lived until September.

The Bucksport Station.—100,000 fry were obtained from eggs received from Northville. Of this number 35,000 were kept for rearing; 1,439 were placed in Craig's Pond June 17; and 2,113 in Pond B June 22. Upward of 31,000 were kept in the troughs and fed on liver, refuse meats, salt codfish, insects, and entomostraca.

p. The Rainbow Trout (*Salmo irideus*).

The McCloud River Station.—The first eggs for the season of 1885-'86 were taken on December 26, 1885, which was somewhat earlier than usual. The species seem to spawn sooner than formerly. The spawning season closed May 10. 221,425 eggs were taken from 226 fish. 30,000 eggs were lost because of high and muddy water; 15,000 were hatched for the trout ponds and the river, and 131,000 were distributed, chiefly to State fish commissions and to Central Station. During the spawning season of 1886-'87, which lasted from December 26 to April 11, 268,400 eggs were taken from 299 fish. 84,100 of these were lost from various causes; 39,300 were hatched and the fry planted in the McCloud River; the remaining 145,000 were sent to State commissions and to Central Station.

The Northville Station.—The spawning season in the ponds lasted from January 9 to April 25. 196,350 eggs were obtained from 375 fish; 25,000 were sent to the Michigan Fish Commission; 25,000 to Mr. Blackford, for shipment to France; while 25,000 fry were hatched out and nearly all of them kept at the station. 4,920 young fish were shipped away from the station.

The Wytheville Station.—During April and May, 1887, 8,000 fry were received from the Central Station, and 220,500 eggs were collected at Wytheville. During the fiscal year 1886-'87, 12,095 yearlings, 271 two years old or older, and 98,000 eggs were shipped away. 40,000 eggs were sent to Germany, 10,000 to England, and 5,000 to France. The remaining eggs and fry were distributed to private applicants, to suitable streams for stocking, and to various hatcheries. Mr. Max von dem Borne, writing from Berneuchen, Germany, on April 11, 1887, stated that the fry hatched from the eggs received were in excellent condition.

q. The Brown Trout (*Salmo fario*).

The Cold Spring Harbor Station.—64,000 eggs were received in very bad condition from the Deutsche Fischerei-Verein March 1, 1886, and 40,000 came from the same source, in good condition, March 20. On April 16, 50,000 eggs arrived in good order from Max von dem Borne. 13,000 eggs were repacked and sent to the Northville Station, and 1,000 to the Wisconsin Fish Commission. During April and May, 23,500 young trout were planted in suitable waters in New York.

In July a brown trout was caught in Allen's Creek, a tributary of the Genesee River, New York, which weighed 3 pounds. This must have been hatched from the first lot of eggs received in America. One of this first shipment, which was hatched and reared at Cold Spring Harbor, weighed 3½ pounds in October, 1886, at the age of three and one-half years.

During March, 1887, 108,000 brown trout eggs were received from Germany, but 60,000 of them were unfit to be developed. The last shipment of 50,000 eggs contained 13,000 dead ones. The good eggs of this

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lot were mixed by mistake with 14,500 saibling eggs, which arrived the same day, and 50,000 mixed eggs were sent to several State and National fish commission hatcheries. 10,000 eggs were received, also, on account of the New York Fish Commission, from Herr von Behr.

The Northville Station.—20,000 eggs were received March 17 from the Cold Spring Harbor Station, having come originally from Germany. 2,500 of these were sent to the Michigan Fish Commission and 5,000 to the Wisconsin Commission. The remaining eggs yielded nearly 9,000 fry, which were kept at the station. During November and December 9,400 eggs were taken from stock-fish in the Northville ponds, but only 1,500 fry were obtained from them.

The Wytheville Station.—2,165 brown trout eggs were received in March, 1886. They were hatched at a very unfavorable time, the water being muddy during incubation and remaining so until the surviving fish were several weeks old. 286 were reared, and in November they were between 2½ and 3 inches long. In March, 1887, 9,100 eggs were received from Cold Spring Harbor, and in May, 3,000 fry arrived from the Central Station.

r. The Loch Leven Trout (*Salmo levenensis*).

On January 14, 1887, the Cold Spring Harbor Station received 48,000 eggs of the Loch Leven trout from the Howietoun fishery in Scotland, but nearly one-half of them were dead. Strong and healthy fry were hatched from the remainder.

s. The Atlantic Salmon (*Salmo salar*).

The Bucksport Station.—205 salmon were purchased from the Penobscot River fishermen, from May 29 to June 8, and placed in the inclosure at Dead Brook. Only 147 of these lived through the summer. 1,158,776 eggs were taken from 101 females, an average of 11,473 each. Of these eggs, 1,099,000 were distributed, 320,000 being awarded to Massachusetts and 779,000 to the U. S. Fish Commission, the work having been conducted by these two commissions conjointly. 25,000 eggs were reserved for experiments at the station, and the fry were afterwards liberated in Craig's Pond. The remaining eggs were sent during February, 1887, to the following places:

Cold Spring Harbor, 300,000; F. A. Walters, Bloomingdale, N. Y., 250,000; E. B. Hodge, Plymouth, N. H., 100,000; Grand Lake Stream, 104,000.

The Grand Lake Stream Station.—About the 1st of March, 1887, 104,000 eggs were received from Bucksport. These were hatched with a loss of only 255 eggs and young, and the fry were planted in tributaries of the St. Croix River about the middle of June.

The Cold Spring Harbor Station.—240,000 eggs were received from Bucksport January 7, 1886, and 260,000 on the 7th. 446,573 fry were planted in tributaries of the Hudson and St. Lawrence Rivers and Lake Ontario. During 1886 small numbers of young salmon were taken

in the streams in which they were planted in May, 1885. From information furnished by Mr. A. N. Cheney of Glens Falls, N. Y., and from other sources, it appears that more than 24 salmon were taken in the Hudson during 1886.

t. **The Landlocked Salmon** (*Salmo salar*, var. *sebago*).

The Grand Lake Stream Station.—The spawning season lasted from October 29 to November 18. 752 fish were taken, the females yielding 942,500 eggs, or an average of 1,935 each. 641,500 eggs were distributed and 214,000 were reserved for Grand Lake Stream. The distribution, according to the contributions for the expenses of the year, was as follows:

Contributor.	Money contributed.	Eggs distributed.
The U. S. Fish Commission	\$860.00	377,500
The Massachusetts fish commission	300.00	132,000
The New Hampshire fish commission	300.00	132,000
Total	1,460.00	641,500

The eggs allotted to the U. S. Fish Commission were distributed in March, 1887, to various State commissions, to England, France, and Germany, and to the Wytheville and Cold Spring Harbor Stations. The 214,000 reserved for Grand Lake Stream were hatched and planted with a very small loss.

On March 8, 1886, 19,000 eggs were sent from the Grand Lake Stream Station to the Pennsylvania commission at Corry, Pa. Near the end of June about 12,000 fry developed from these eggs were planted in streams flowing into the lake of the South Fork Fishing and Hunting Club, in Cambria County, Pa.

The Wytheville Station.—50,000 eggs were received on March 13, 1887, from Grand Lake Stream; 12,997 yearlings were liberated in tributaries of the Shenandoah River, in the hope that this would establish a run in the Potomac River.

The Northville Station.—29,000 eggs were received from Grand Lake Stream on March 19, 1886, and on April 14 they hatched, with a loss of only 575. On April 27, 10,000 fry were planted in a lake of Clare County, and 12,000 in Rapid River, in Kalkaska and Antrim Counties, both places of deposit being in the northern central portion of Michigan.

The Cold Spring Harbor Station.—34,000 eggs were received from Grand Lake Stream on March 18, 1886. After a small loss in shipping and hatching, 31,020 fry were placed in two lakes of the Adirondack region. On April 1, 1887, 25,000 eggs received from the Grand Lake Stream Station were repacked and shipped to Leon d'Halloy, vice-president of the fish commission of the Lower Seine, France.

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u. **The Shad** (*Clupea sapidissima*).

During the season of 1886 over 90,000,000 shad fry were distributed. Now, as the number of shad taken for market was less than 6,000,000 it will be seen that for every adult shad captured 15 young shad, artificially hatched, were placed in the waters. As the cost of this production and distribution was less than \$20,000 the young fish were obtained and distributed all over the United States at the rate of about \$215 for a million, or about 46 fry for a cent. In 1885, which showed a great improvement over previous years, the rate was about 30 fry for a cent. The total number of eggs collected and fry planted have also greatly increased over the results of previous years, as from the beginning up to and including 1882 the total number of young shad obtained was only about 200,000,000, while in 1885 less than 35,000,000 fry were sent out from the stations.

Shad fry for distribution in 1886 were derived from the following sources:

From Battery Station, Susquehanna River.....	43,776,000
From Central Station, Potomac River	28,151,000
From steamer <i>Fish Hawk</i>	21,018,000
From steamer <i>Haleyon</i>	310,000
Total	93,255,000

The following statement shows the general planting summarized by the streams or drainage basins in which the fish were deposited:

To tributaries of Narragansett Bay.....	2,534,000
To tributaries of Long Island Sound	749,000
To Hudson River	2,312,000
To Delaware River.....	21,618,000
To tributaries of Chesapeake Bay	52,835,000
To tributaries of Albemarle Sound	1,990,000
To tributaries of the Atlantic south of Albemarle Sound.....	4,183,000
To Mississippi River and minor tributaries of the Gulf of Mexico	4,758,000
To Colorado River, tributary of the Gulf of California	850,000
To Columbia River basin.....	850,000
Total	92,679,000

The Fort Washington Station.—The first ripe shad was taken April 16. From that time until near the end of May the run of fish was abundant and reasonably steady. The maximum number of eggs taken in one day was 3,503,000, on April 22; the period of greatest activity, was from April 20 to 27, inclusive, when 16,017,000 were procured, being nearly one-half of the entire number obtained during the season. In all, 36,362,000 eggs were collected. The number hatched and planted from the station in waters near by, was 3,154,000. The number forwarded to the Central Station was 33,208,000.

The Central Station.—The number of eggs received alive from Fort Washington was 28,283,000. Of these, 1,586,000 were transferred to other stations, and the number of fry sent out to be planted was

24,997,000. The cost of collecting, developing, and transporting the eggs at this and the Fort Washington stations was \$3,796.45, which is at the rate of \$127.66 per million, or 78 shad for one cent. There has been a marked gradual increase in efficiency of the force in transporting and hatching eggs, the percentage of loss diminishing year by year from 1883, when it was 29 per cent., to 1884, when it was 26 per cent., to 1885, when it was 10 per cent., while in 1886 it was only 7 per cent.

The Battery Station.—The work of the shad season began April 18 and ended June 10. The first run of fish continued for a week. All the runs of the season were very large. The number of eggs collected was 60,766,000. The supply of hatching apparatus was inadequate to meet the requirements. The number of fry hatched was 45,231,000, the percentage of hatching being 74.4; 43,776,000 fry were shipped away and deposited mainly in the Susquehanna River and other tributaries of the northern part of Chesapeake Bay; 1,000,000 fry were sent to Oregon, besides 585,000 eggs, resulting in a deposit of 850,000 fry in the Columbia River.

Work of the Fish Hawk.—From April 26 to May 1 the *Fish Hawk* visited the fishing shores and gilliers in the northern end of Chesapeake Bay, and obtained 2,192,500 eggs for the Battery Station. During most of May the vessel was engaged on the Delaware in transporting spawn-takers, and in collecting, transferring, and depositing eggs. 34,454,500 eggs were obtained, from which 23,196,000 fry were hatched on board and 21,018,000 deposited in the Delaware River.

Work of the Halcyon.—From April 27 to May 23 the steamer *Halcyon* was occupied in Chesapeake Bay and in the Delaware River in gathering, transferring, and hatching eggs, and depositing the young shad. 4,561,000 eggs were taken; most of them were transferred to Battery Station or to the *Fish Hawk*, while some were hatched on board and deposited. 3,000,000 fry were received from Battery Station and deposited in the tributaries of the Upper Chesapeake.

The Cold Spring Harbor Station.—Late in April 1,796,000 shad eggs were received from the Central Station at Washington. Only 100,000 fry were obtained from these, and deposited in the Hudson River, near Albany.

Experiments in planting shad.—Attempts have been continued to acclimatize shad in the Colorado River of the West, and thus to establish fisheries on the Colorado, Gila, and other tributaries of the Gulf of California. This experiment was begun in 1884 by the deposit of 983,000 fish, followed by 998,000 eggs in 1885 and 850,000 eggs in 1886, making a total of 2,831,000, all of which were planted at the Needles. If successful, the fry deposited in 1884 should return as mature fish in 1888.

The effort to transfer shad to the Columbia River basin was repeated also. 1,000,000 fry, 200,000 eggs on trays, and 335,000 eggs in hatching jars were sent out from Havre de Grace on May 9, 1886. The eggs in jars gave the best results, and this may indicate the proper method of

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shipping them across the Atlantic. 850,000 fry were deposited in the river basin.

Plantings have been made during the present season in streams of all the Atlantic coast States from Massachusetts to Florida. Particular localities selected for planting are chosen with a view to the general distribution of shad in all waters of the Atlantic coast.

v. **The Carp** (*Cyprinus carpio*).

The total distribution for the season aggregated 133,769, of which 38,634 were delivered to State commissioners and 95,135 to individual applicants. 589 applications had to be carried over until another year, and the number of fish given to each applicant was reduced from 12 to 15, instead of 20 as in preceding years.

The Washington Station.—The yield of the ponds was small, possibly, in part, on account of the low temperature of the entire season. Inability to drain them in the spring, because of the filling in of the Potomac flats, had an injurious effect on the carp, as it was impossible to kill the eels, sunfish, perch, and other predaceous fish that prey upon them.

The Wytheville Station.—During the fiscal year 1886-'87, 452 scale carp and 3,017 leather carp were received from the Central Station. 450 scale carp were planted in south fork of Reed Creek, in Wythe County, Va., and 1,925 leather carp were distributed to 91 applicants in southwestern Virginia and eastern Tennessee.

w. **The Gold-fish** (*Carassius auratus*).

The Washington Station.—During the season 2,755 gold-fish were sent out, in lots of 4 to 10 each, to applicants in 22 States and 2 Territories. 260 of the Japanese fan-tail variety were issued in small lots in December, 1886.

The Wytheville Station.—During the fiscal year 1886-'87, 50 gold-fish were distributed to 9 applicants in Virginia, North Carolina, Mississippi, and Texas

x. **The Tench** (*Tinca tinca*).

Less than 1,000 tench were reared at the Washington Station, their number being reduced by the ravages of eels. At the Wytheville Station 2 breeders and 450 yearlings were received from the Central Station, and the yearlings were planted in the south fork of Reed Creek, in Wythe County, Va.

y. **The Lobster** (*Homarus americanus*).

The Wood's Holl Station.—During the season the experiments were continued in the artificial propagation of the lobster. Eggs were obtained and placed in hatching jars, the number in the apparatus sometimes reaching nearly 1,000,000, and the young were deposited in Vineyard Sound and adjacent waters. In April and May Capt. H. C. Ches-

ter made some experiments with a view to keeping lobsters alive with the use of a very small quantity of sea water. These experiments seemed to demonstrate the feasibility of transporting the species across the continent. On May 29, 5,000 lobsters, 2 or 3 weeks old, were sent to the Cold Spring Harbor Station. These were planted off Rocky Point, in Cold Spring Harbor, June 5.

z. **The Oyster** (*Ostrea virginica*).

At the Saint Jerome Station experiments were continued in the artificial propagation of the oyster, according to the system devised by Prof. John A. Ryder, and by other methods. The work lasted from April to November 20, and was in charge of Mr. W. de C. Ravenel. On June 23 ripe oysters were found in sufficient numbers to begin spawning regularly. Collectors were put out and afterwards placed in ponds. Spat first appeared July 29. Sand and slime were deposited so rapidly and extensively as to interfere with the success of the undertaking.

6.—THE STATIONS OF THE FISH COMMISSION.

A.—MARINE STATIONS.

Gloucester, Mass.—This station was occupied mainly in the interests of the Gloucester fisheries and for the purpose of obtaining continuous and accurate returns of their statistics. It was in charge of Mr. W. A. Wilcox, a special agent of the Commission, assisted by Capt. S. J. Martin.

Wood's Holl, Mass.—Operations were carried on during the entire year at this important station, which is located on Vineyard Sound, at the southwestern extremity of Cape Cod and opposite the northern end of the Elizabeth Islands. It is now thoroughly equipped both for the propagation of marine fishes and for the purposes of scientific inquiry. The hatching of codfish, begun in November, 1885, was continued through the winter and into the spring of 1886, and was again taken up in November of the same year. The propagation of lobsters was carried on from May until July, and experiments with reference to the planting and breeding of oysters were conducted during the spring and summer. From early in July until the middle of October the station was occupied in the interest of the sea-coast investigations respecting food-fishes and the fishing grounds, under the immediate direction of the Commissioner, and during this period it was also the headquarters for the steamer *Albatross*.

Capt. H. C. Chester, who had served as superintendent of the station since its foundation, was obliged to relinquish his position in June, on account of ill health, and was succeeded by Prof. John A. Ryder, as acting superintendent, until October 1, when the station was placed in charge of Mr. Charles G. Atkins.

A frame store-house and a short section of wharf in front of the coal

shed were finished during the summer, completing the principal structures required at this locality for the purposes of the Fish Commission. The final work upon the stone pier was also completed during this year by the Engineer Corps of the Army, and an appropriation of \$14,000 was made by Congress to enable the Revenue Marine Bureau to construct a coal shed and wharf adjacent to the buildings of the Commission. This work, however, was not begun until the following year.

The system for supplying salt water to the laboratory building was entirely reorganized by the substitution of wooden and hard rubber pipes for the iron ones previously in use, thus obviating the inconveniences resulting from the accumulation of iron rust in the water. In the present arrangement wooden mains, having a 6-inch bore, lead from the harbor to the water tower, and thence to the lower story of the laboratory, the distributing pipes from this point being entirely of hard rubber with brass fittings. A standard Gardner clock, connected by telegraph wire with the Naval Observatory at Washington, was placed in the headquarters building for the convenience of Government vessels touching at the station, and a time ball, working in the same circuit, was arranged on top of the water tower where it could be seen by the many vessels passing through Vineyard Sound. Wood's Holl having been selected as one of the principal stations of the Signal Service, and the shore terminus of the Government cable connecting the main-land with the Elizabeth Islands, Martha's Vineyard, and Nantucket, the necessary accommodations were furnished that Bureau by the Commission. An office room in the laboratory building was assigned to their use, the exposed instruments were placed upon the roof of the storehouse, and permission was given to use the flag-staff for displaying the usual weather signals.

Saint Jerome, Md.—This station is located on the west shore of Chesapeake Bay, about 6 miles above the mouth of the Potomac River. The experiments in oyster culture, described in former reports, were continued here during a large part of the year, under the direction of Mr. W. de C. Ravenel, and upon a much larger scale than in previous years. Careful observations relative to the temperature and density of the water were made in connection with the work.

B.—STATIONS FOR PROPAGATION OF THE SALMONIDÆ.

Maine.—The two stations located in this State, one at Bucksport, the other at Grand Lake Stream, are operated conjointly by the United States, the State of Maine, and one or two other of the New England States. They are both in charge of Mr. Charles G. Atkins as superintendent. At the Grand Lake Stream Station, under the direction of Assistant Superintendent W. O. Buck, 855,500 schoodic or land-locked salmon eggs were obtained in good condition. Of this number 377,500 were allotted to the United States, and were distributed in March, 1887, while 214,000, reserved by the State of Maine, were hatched and

planted in Grand Lake Stream. Of sea salmon or Penobscot salmon eggs a net stock of 1,099,000, resulting from the winter's work, were available for division among the contributors to the fund. Of the assignment made to the United States, 779,000, nearly all were distributed in February, 1887, 25,000, however, being retained at the station for hatching, in order to make experiments in the rearing and feeding of the young during the following spring and summer.

New York.—At the fish-cultural station located at Cold Spring Harbor, Long Island, and owned and operated by the State of New York, certain privileges have been granted to the United States Commission gratuitously from year to year. During 1886 considerable work was done under this agreement by Mr. Fred Mather, superintendent, in hatching the eggs and distributing the fry of the following species to the rivers and lakes of New York, namely: Lake whitefish, lake trout, brown trout, shad, and Penobscot and land-locked salmon. Experiments were also made in the hatching of smelt and tom-cod.

Virginia.—The Wytheville Station, located on the summit of the Alleghany Mountains in southwestern Virginia, is leased from that State, and has been in charge of Col. Marshall McDonald, with Mr. George A. Seagle as superintendent. Many improvements and additions made to the station in 1885 rendered it practically complete in all its appointments for the season of 1886, and more extensive operations were carried on this year than hitherto. The following species were under cultivation: The rainbow, brook, and brown trout, land-locked salmon, red eye, black bass, carp, and tench.

Michigan.—The stations at Northville and Alpena, Mich., are operated mainly in the interests of the whitefish fisheries of the Great Lakes, but at the former station lake, brook, rainbow, and brown trout, and saibling were also propagated during 1886. Both stations are in charge of Mr. Frank N. Clark. Northville Station is the headquarters for the whitefish work and is kept open during the entire year, but the Alpena Station is closed during the summer. During the season of 1886, 129,400,000 eggs of the whitefish were obtained from the fisheries of Lakes Erie, Huron, and Michigan. Of this number 56,800,000 were placed in the hatchery at Alpena, and 72,600,000 were sent directly to Northville; but subsequently 21,000,000 were transferred from Alpena to Northville. The collection of eggs continued from November 4 to December 2. Of the total number, 32,600,000 eggs were distributed mainly to State hatcheries, and 62,070,000 were hatched and the fry planted in Lakes Huron, Michigan, Erie, and Ontario, and two smaller lakes in the State of Michigan.

California.—The salmon station at Baird, Cal., on the McCloud River, was not operated during 1886, but the collection of eggs of the rainbow or California trout was continued as usual at the McCloud River Station, the season lasting from December, 1885, until May, 1886. The total number of eggs taken was 221,425, this having been a smaller

yield than usual, due to the loss of many breeding trout by disease and from the effects of a severe storm. The following season, beginning December, 1886, and ending May, 1887, 268,400 eggs were secured. Mr. Livingston Stone has continued in charge of the California work, with Mr. Loren W. Green as superintendent of the McCloud River Station.

C.—STATIONS FOR PROPAGATION OF SHAD.

Battery Island.—This station, located on Battery Island, near the mouth of the Susquehanna River, a few miles south of Havre de Grace, Md., was in charge of Mr. T. B. Ferguson, with Mr. L. R. Grabill as superintendent during the shad season, which continued from April 19 to June 10. The total number of shad eggs brought into this station was 60,766,000, of which 2,099,000 were received from the steamer *Fish Hawk*, and 2,433,000 from the steamer *Halcyon*, the remainder having been obtained by a temporary force employed for the purpose. About 44,000,000 eggs were hatched and the fry distributed. Experiments in the hatching of rockfish or striped bass met with partial success. Some improvements were made to the station during the year.

Washington.—The shad eggs obtained on the Potomac River were transferred to the Central Station in Washington, where they were hatched and the fry distributed. The total number of eggs thus received was 28,283,000, of which 24,997,000 were hatched and 1,586,000 transferred to other stations. The propagation of other species of fish was also carried on at this station, which is the headquarters for the cars and for the general distribution of young fish. It is in charge of Col. Marshall McDonald.

Fort Washington, Md.—This station, situated on the Government reservation at Fort Washington, on the Potomac River, was occupied during the shad season as a receiving station for the eggs collected from the fishing shores and from the gilliers along the river. A seine is also operated at this point by the Fish Commission. The eggs are retained at Fort Washington until they are sufficiently hardened to permit of their being safely transported, when they are transferred to Central Station, Washington. Over 36,000,000 eggs were received here during the season of 1886, of which one-third were taken from the fish caught in the Fish Commission seine. About 3,000,000 of the eggs were hatched at the station and the fry planted in the vicinity. Operations were in charge of Col. Marshall McDonald.

Delaware River.—Operations were carried on in the Delaware River, with headquarters at Gloucester City, N. J., by the steamer *Fish Hawk*, assisted part of the time by the steamer *Halcyon*, from May 5 to June 3. The total number of shad eggs taken was 34,454,500, of which 23,196,000 were hatched on board the *Fish Hawk*, a part of the remainder having been transferred to Battery Island Station.

D.—STATIONS FOR PROPAGATION OF CARP.

Washington, D. C.—Many improvements were made in the carp ponds on the Monument Lot, in Washington, and a new and more commodious office building was constructed. Congress directed the filling in of Babcock Lake as an additional precaution looking toward the safety of the Washington Monument; but as this work was ordered not to begin before December, it did not interfere with the year's operations. This lake was drained and the fish removed for the last time on November 11. The Monument Lot ponds are chiefly used for the propagation of the several varieties of the German carp, but tench, golden-ide, and gold-fish are also produced in limited numbers. They are in charge of Dr. Rudolph Hessel.

Two or three ponds on the Arsenal grounds in Washington are still used for the rearing of scale carp. They are cared for by an employé of the Arsenal.

E.—NEW HATCHING STATIONS PROPOSED.

Duluth, Minn.—The following petition from the fishermen of Duluth was forwarded, under date of April 18, 1886, to the Hon. Knute Nelson, member of Congress from Minnesota:

The fishermen of Lake Superior, whose market and shipping point is at Duluth, Minn., feel the need of some relief being obtained for them from the U. S. Fish Commission, and a careful consideration of the facts as presented to Prof. Spencer F. Baird, Commissioner, and do hereby petition you to use your influence in securing for them the favors herein set forth.

They have formed themselves into an association to promote their mutual interests; their aims and objects being a better understanding of the fishing laws of States; a uniform action amongst the fishermen concerning the regulation of the sizes of meshes of all nets, and the enforcement of the laws concerning them.

To secure the artificial propagation of the eggs of both whitefish and lake trout by a fish hatchery.

To this end we have pledged ourselves to aid, by manual labor and by the use of our fishing plants and men, to procure eggs in the season for such a fish hatchery.

Realizing that the capital invested in the fishing industry is not proving remunerative under existing circumstances, and realizing from our past experience that the continual diminished catches both of whitefish and lake trout are decreasing one-third of the previous year's catch year by year, we therefore feel the necessity of providing for larger deposits of fry of these fishes, and assure you that a better sentiment is prevailing to-day amongst fishermen concerning the production of such fry.

While gratefully acknowledging the good work done by the Minnesota fish commission for us as fishermen, and the kindly interest evinced by Prof. Spencer F. Baird in the welfare of the fishermen of Lake Superior, yet we pray you to introduce a bill asking for an appropriation to establish a fish hatchery, under the instruction and charge of the U. S. Fish Commission, and have assured Professor Baird that we will, by such manual labor as may seem fitting to the U. S. Fish Commission or the assistants, place our apparatus and fishing plants to aid them in collecting and procuring eggs for this hatchery; and your petitioners will ever pray, etc.

This petition was accompanied by a letter from Mr. C. H. Evans, of Duluth, in which it was stated that if the Government would build a

fish hatchery in that city, at a cost of \$10,000, and maintain it, the people would donate a suitable site with an ample supply of good water. The fishermen of the region, who employ several steamers to collect the fish for marketing at Duluth, also offered to save the spawn and deliver it at the hatchery.

In response to inquiries by Mr. Nelson, the Commissioner replied that the whitefish interest of Duluth had not been wholly neglected, as many millions of the fry of that species had been planted in Lake Superior from the Michigan stations at Northville and Alpena; but that if it was deemed desirable to increase the work, and Congress should provide the means, a hatching station could be built at the proposed location. As a result of this correspondence, the following item was inserted in the sundry civil appropriation bill and became a law August 4, 1886:

Fish hatchery at Duluth, Minn.: For the establishment of a fish hatchery on Lake Superior at or near Duluth, Minn., \$10,000: *Provided*, That the city of Duluth shall furnish, without charge, a suitable site for the said fish hatchery.

A site offered by the Lake-Side Land Company, of Duluth, at the mouth of Lester River, on the northern outskirts of the city, was found, upon examination, to afford the requisite facilities for the purpose, and it was accordingly accepted. Jurisdiction to the land was ceded to the United States by an act of the legislature of Minnesota, approved March 2, 1887.

Clackamas River, Oregon.—In February of the present year the Commissioner received from the Hon. J. H. Reagan, chairman of the Committee on Commerce, House of Representatives, a "Memorial of the Oregon legislature, relative to the establishment of a fish hatchery on the Clackamas River, Oregon," with a request that it be given consideration. The Commissioner, in reply, stated that the "salmon fisheries of that region could not be maintained in the face of the adverse influences exerted by civilization without resorting to artificial propagation on a scale commensurate with the importance of the fisheries, nor without such legislation as will give a reasonable measure of protection to the salmon during their spawning." He also explained that a reconnaissance of the Columbia River basin had been made, under the direction of the U. S. Fish Commissioner, by Mr. Livingston Stone, who reported favorably as to a location on the Clackamas River, as would be seen by reference to his account published in the Report of the U. S. Fish Commission for 1883.

The following amendment to the sundry civil appropriation bill was introduced in the United States Senate December 21, 1886, by Senator Dolph, but was not incorporated in the bill as passed:

For the establishment of a salmon hatchery on the Columbia River, its tributaries or other branches, and for the current expenses of the same for one year, \$20,000.

7.—THE VESSELS OF THE FISH COMMISSION.

A.—THE STEAMER ALBATROSS.

The steamer *Albatross*, Lieut. Commander Z. L. Tanner, U. S. Navy, commanding, continued in active service during the greater part of the year. At the beginning of the year the steamer was at the Washington navy-yard, making preparations for a cruise to the region of the Bahama Islands, for the purpose of investigating the winter range and habits of certain pelagic fishes, which, during the warmer months, are of great economic importance to the American fishermen; and of making a series of deep sea soundings for the benefit of the Navy Department. She was detained in the Potomac River by ice until February 17, but left Norfolk on the 20th of that month and proceeded to sea. The cruise lasted until May 10, when the steamer returned to Washington. March 30, while coaling at Key West, the officers and crew rendered effective service in fighting a disastrous fire which destroyed a large part of the town. From July 15 to October 28 the *Albatross* was surveying on the northern fishing grounds, from the latitude of Virginia to the Grand Bank of Newfoundland and the Flemish Cap, with headquarters at Wood's Holl, Mass.

In preparation for the proposed trip to the Pacific coast extensive repairs to the steamer were necessary, and it was decided that new boilers would be required to insure her safety for so long a cruise. The expenditures for this purpose were provided for by the following act of Congress, contained in the sundry civil appropriation bill, approved August 4, 1886:

Steamer *Albatross*: For the construction and introduction of new boilers for the steamer *Albatross*, and other necessary general repairs, \$20,000; for expenses of voyage from New York to San Francisco, including cost of coal and other necessary supplies, \$7,500; in all, \$27,500.

The plans for the new boilers were prepared by Passed Assistant Engineer George W. Baird, U. S. Navy, of the steamer *Albatross*, and received the approval of Mr. C. W. Copeland, the designer of the vessel, and of Chief Engineer B. F. Isherwood, U. S. Navy, to whom they had been submitted for criticism. Proposals for constructing the boilers were received and opened December 21, as follows:

Name.	Address.	Time required.	Amount.
Slater & Reid	167 Charles street, New York, N. Y.	130 days	\$14,300.00
Atlantic Works	East Boston, Mass.	120 days	19,800.00
John H. Dialogue	Camden, N. J.	Reasonable time	27,000.00
Donald McNeil and John McNeil	Brooklyn, N. Y.	3 months	16,825.00
C. H. De Lamater & Co.	New York, N. Y.	4 months	17,000.00
H. A. Ramsay and H. A. Ramsay, jr.	New York, N. Y.	6 months	18,538.28
Columbinn Iron Works and Dry Dock Company	Baltimore, Md.	120 days	13,439.00
Olivier Reeder, C. M. Reeder, and L. B. Reeder	do	135 days	21,985.00
Pusey & Jones Company	Wilmington, Del.	112 days	19,500.00

The bid of the Columbian Iron Works and Dry Dock Company, of Baltimore, being the lowest, was accepted, and the construction of the boilers was immediately begun.

B.—STEAMER FISH HAWK.

The steamer *Fish Hawk* was at Wood's Holl from January 1 to February 21, when she proceeded to the eastern part of the Gulf of Maine, for the purpose of collecting cod eggs for the Wood's Holl Station, generally making Portsmouth her headquarters. She remained in this region until April 12, when she returned to Wood's Holl, having obtained several million eggs, which were shipped directly as they were taken. While at Portsmouth the last part of February the *Fish Hawk* encountered a severe gale, and slight damage was done to the steamer by two schooners fouling while at anchor. The steam-launch was also sunk and not recovered until the following September.

From April 26 to June 3 the *Fish Hawk* was engaged in shad propagation in the Delaware and Susquehanna Rivers, being stationed most of the time in the vicinity of Gloucester City, N. J. The total number of shad eggs obtained was 34,454,500, of which 21,018,000 were hatched on board. From early in July until August 28 she was engaged most of the time in freighting for the Saint Jerome and Battery Island Stations, and left the last of August for Wood's Holl, visiting on the way the light-ships at Winter Quarter Shoal, Five Fathom Bank, and Sandy Hook, for the purpose of instructing the keepers in the methods of making temperature observations. Returning from Wood's Holl the latter part of October, an unsuccessful search was made in the vicinity of Sandy Hook for the English sole, which had been planted there some years before. The balance of the year the steamer remained in Chesapeake Bay, serving as a freight boat, the crew also assisting at times in the work at the stations. In July the command of the *Fish Hawk* was transferred from Ensign W. J. Maxwell, U. S. Navy, to Mate James A. Smith, who had previously commanded the *Halcyon*.

C.—STEAMER HALCYON.

This steamer, previously called the *Lookout*, was at Battery Station at the beginning of the year, where she remained until March 28, undergoing repairs. Subsequently she made an investigation of the pound and gill-net fisheries in some of the tributaries of the Lower Chesapeake, and from April 27 to May 23 was employed in connection with the work of shad propagation in the Susquehanna and Delaware Rivers. From the close of the shad season until the last of July, and again from the first of November until the end of the year, the *Halcyon* was mainly in Chesapeake Bay, acting as a dispatch boat or freight boat in connection with the stations, or investigating the fisheries. From August 9 to October 25 she was at Wood's Holl, Mass. Mate

James A. Smith, U. S. Navy, who commanded the *Halcyon* during the first half of the year, was transferred to the steamer *Fish Hawk* in July, and was succeeded on the *Halcyon* by Mr. William Hamlen.

D.—SCHOONER GRAMPUS.

The fishing-schooner *Grampus*, which was under construction at Noank, Conn., at the beginning of the year, was completed June 5, and left for Wood's Holl the same day. She is the first of a new type of vessel, designed especially for the offshore fisheries by Capt. J. W. Collins, who superintended her construction and subsequent operations. A description of her principal features and of her merits is given elsewhere in this report. The signal letters G. V. Q. F. were assigned to her by the Bureau of Navigation of the Treasury Department.

The *Grampus* made her first cruise August 12 to the offshore fishing-grounds south of Martha's Vineyard, where a week was spent in a fruitless search for the tilefish. Certain alterations in her fittings, shown to be necessary by this trip, delayed the vessel in port until the last of September, when she began a cruise to the vicinity of Le Have Bank, Roseway Bank, and Seal Island Ground, for the purpose of securing and bringing to the Wood's Holl Station, in her well, living specimens of halibut and other food-fishes, the spawn of which was desired for propagation. Returning to Wood's Holl October 12, a short trip was made to the mackerel fleet operating at the western end of Vineyard Sound, and during most of the remainder of the year she was engaged in fishing for spawning cod, which were carried to the Wood's Holl Station, and in investigating the fisheries of the western part of the Gulf of Maine, Massachusetts Bay, and the Vineyard Sound region.

ASSIGNMENTS OF NAVAL OFFICERS.

The following changes in the assignments of naval officers to the service of the Fish Commission were made during the year:

Lieut. Seaton Schroeder, executive officer and navigator of the steamer *Albatross*, was detached January 2, and was succeeded by Lieut. H. S. Waring.

Ensign W. J. Maxwell assumed command of the steamer *Fish Hawk* January 10, relieving Lieut. L. W. Piepmeyer, but July 24 he was transferred to the steamer *Albatross*, from which he was finally detached August 28.

Ensign W. S. Benton joined the *Albatross* January 13, and Ensign W. S. Hogg on the 16th of the same month.

Mate James A. Smith was detached from the steamer *Halcyon* and took command of the steamer *Fish Hawk* July 31, and August 3 Mate Hugh Kuhl joined the *Fish Hawk* as executive officer. Assistant Engineer S. H. Leonard was detached from the *Fish Hawk* December 18.

8.—COURTESIES AND ASSISTANCE RECEIVED BY THE FISH COMMISSION.

A.—FROM THE UNITED STATES GOVERNMENT.

TREASURY DEPARTMENT.—Secretary's Office.—In planting young cod-fish at Pensacola it was very desirable to have the use of a steamer. The revenue cutter *Forward*, by direction of the honorable Assistant Secretary, C. S. Fairchild, transported the fish and messenger in charge of the shipment to the point selected for depositing the fish.

Bureau of Statistics.—This Bureau has issued circulars and letters of instruction to collectors of customs, at ports where fishing-vessels are documented, with the result of furnishing the Fish Commission much statistical material.

Light-House Board.—The assistance of this Board in securing ocean temperature observations at thirty-five of the principal light-houses and light-ships upon the Atlantic coast has been continued.

Coast and Geodetic Survey.—The Commissioner has received a large supply of maps and charts published by this Survey; especially upon the fitting out of the *Grampus* in May a complete set was furnished for her use.

Life-Saving Service.—The keepers and patrolmen of this service, by direction of Superintendent J. H. Kimball, continue to report the stranding of marine animals upon the sea-coast. Among the specimens thus obtained were the following:

In March Mr. D. M. Ethridge, keeper of the Currituck Inlet Station, forwarded a rare shark, *Hexanchus griseus*, the first of this species seen on the United States coast.

Mr. E. H. Bunkers, Fletcher's Neck Station, Biddeford Pool, Me., sent a specimen of *Argentina silus*, a fish which is extremely rare on our coast, although not uncommon in Norway.

On July 5 Captain Edwards, of the Amagansett Station, forwarded a torpedo, or cramp-fish, to be mounted for exhibition.

WAR DEPARTMENT.—Permission for using the buildings and grounds at Fort Washington for the purpose of hatching shad was continued.

Signal Office.—During the occupancy of the Wood's Holl Station in July, August, and September, the Signal Office furnished weather predictions and special warnings of approaching storms. Copies of temperature reports made by observers at certain points of interest were also furnished as during preceding years.

Engineer Office.—Col. Peter C. Hains, engineer in charge of Potomac River flats improvements, gave authority to cut sods from the flats for turving about the carp ponds.

NAVY DEPARTMENT.—The officers and crews of the *Albatross*, *Fish Hawk*, and *Halcyon* have been furnished by the Navy Department, and the facilities of various navy-yards, particularly those at Washington and Norfolk, have been extended to the Commission.

During the shad distribution in May and June the Department detailed Mr. H. E. Quinn to assist in the work.

Bureau of Construction and Repair.—The loan of two launches was continued during the present year.

Bureau of Steam Engineering.—By order of Mr. Charles H. Loring, Chief of the Bureau, a lot of engines, tools, etc., which were no longer required by the Department, were lent to the Commission and proved very useful.

Bureau of Yards and Docks.—A dredge and some scows belonging to the Washington navy-yard were lent to the Commission in June.

Hydrographic Office.—Upon the fitting out of the *Grampus* the Hydrographic Office furnished a valuable set of charts for her use in navigation.

Bureau of Navigation.—Commodore J. G. Walker furnished the *Grampus* with the Nautical Almanac, azimuth tables, and other books. He assisted also in procuring her instruments.

Naval Observatory.—Allan D. Brown, Superintendent of the U. S. Naval Observatory, detailed Mr. W. F. Gardiner in July to oversee the work of erecting a time-ball at Wood's Holl Station.

STATE DEPARTMENT.—When it became desirable to have the Roosen apparatus for experiments upon the preservation of bait, the Secretary of State directed the United States consul at Leith, Scotland, to procure and forward a set to the Wood's Holl Station.

In June the Secretary furnished, upon application, a circular letter to all consular officers of the United States in British North America, introducing Capt. J. W. Collins, commanding the schooner *Grampus*, and asking for him such official aid and facilities as might be required during a cruise in Canadian waters. The Secretary also addressed a letter to Sir Lionel Sackville West, requesting him to inform the Marquis of Lansdowne of the proposed scientific expedition of the vessel.

INTERIOR DEPARTMENT.—*Patent Office.*—The Official Gazette of the Patent Office has been supplied as heretofore; also specifications and drawings of various patents relating to fish and fishing apparatus.

Geological Survey.—The Director of the Survey allowed Prof. W. J. McGee to make a reconnaissance of Battery Island, with a view to determining the feasibility of sinking wells at that station.

GOVERNMENT PRINTING OFFICE.—The Government Printer has rendered much aid in advancing the publications of the Commission. Mr. James W. White, foreman of binding, wrapped the Commission's quota of its annual report.

BOTANICAL GARDENS.—Mr. William A. Smith, superintendent, at various times has furnished plants for the use of the Commission.

B.—BY RAILROAD COMPANIES OF THE UNITED STATES.

The distribution of fish and eggs is greatly facilitated by the courtesies of the railroad companies in transporting the cars free or at a re-

duced rate, in granting permission to carry fish and eggs in baggage cars, and to make repairs at their shops.

The Northern Pacific Railroad Company passed a car free from Saint Paul to the Pacific coast and back. The Atchison, Topeka and Santa Fé transported a car without charge with fish for the Southern Pacific region. During the whitefish distribution the Grand Rapids and Indiana Railroad lent the Commission a baggage car, which they transported free.

C.—BY STEAM-SHIP COMPANIES.

The foreign steam-ship companies, without exception, have continued to transport free of charge the fish and eggs which are exchanged between the United States and foreign countries.

Messrs. Glidden and Curtis, of Boston, furnished transportation for a Fish Commission naturalist, Mr. Charles H. Townsend, from New York to Swan Island, on board the schooner *Mosquito*.

D.—COURTESIES FROM FOREIGN COUNTRIES.

Australia.—Mr. F. Abbott, of the botanical gardens, Hobart, Tasmania, in September sent some seeds of hardy Eucalyptus, and offered to send those of *Nymphæa gigantea*, for the plant collections at the carp ponds.

England.—During the year, 61 soles were brought over alive from Liverpool in the White Star steamer *Britannic* and placed in large tanks at Wood's Holl, to be kept for breeding purposes.

Germany.—On January 28, were received from the German Fishery Association 50,000 eggs of a small whitefish (*Coregonus albula*); these were forwarded to Bucksport, for hatching and planting in Maine waters. On February 4, 50,000 additional eggs were received, and the good ones sent to Northville for lakes in Michigan and adjacent States.

During March, 1886, 104,000 eggs of the brown trout (*Salmo fario*) were received. The good ones, 35,000 in number, were sent to Northville, Wytheville, and Cold Spring Harbor. On April 16, 50,000 eggs were obtained from Max von dem Borne, of Berneuchen; these were forwarded to Northville, Mich.; Madison, Wis.; and Cold Spring Harbor, N. Y.

During March, 1887, 58,000 eggs of the brown trout were received from Max von dem Borne, and 50,000 from the German Fishery Association.

On February 9, 1887, 20,000 eggs of the saibling (*Salvelinus alpinus*) were received from Berneuchen. On March 9 another consignment of 40,000 eggs arrived, one-half of them from Max von dem Borne, the other from the German Fishery Association.

Scotland.—On January 14, 1887, the Cold Spring Harbor Station received 48,000 eggs of the Loch Leven trout (*Salmo levenensis*), from Sir J. B. Gibson Maitland, proprietor of the Howietoun Fishery at Stirling.

9.—COURTESIES AND ASSISTANCE RENDERED BY THE FISH COMMISSION.

England.—Shipments to England were made to the National Fish Culture Association, South Kensington, London. On January 15 and 29, 1886, two lots of whitefish eggs, each of 1,000,000, were forwarded by the Cunard steamer *Aurania*. On January 15, 1887, 1,500,000 eggs of the same species, followed on February 19 by 1,000,000, were shipped through Mr. E. G. Blackford, of New York. Few of these, however, arrived in good condition.

50,000 lake-trout eggs were sent by the *Aurania* on January 15, 1886, and arrived in excellent order.

10,000 brook-trout eggs were carried by the Cunarder *Servia*, January 29, 1886, and 10,000 were forwarded through Mr. Blackford on January 15, 1887.

10,000 eggs of the landlocked salmon were taken March 16, 1886, by the White Star Line steamer *Germanic*. On March 5, 1887, Mr. E. G. Blackford assisted in sending 25,000 eggs of the same species. Both of these shipments were successful.

10,000 eggs of the rainbow trout were sent from Wytheville during the fiscal year 1886-'87.

France.—During the fiscal year 1886-'87, 5,000 eggs of the rainbow trout were sent to France from the Wytheville Station. On April 6, 1887, 25,000 eggs of this trout from the Northville Station were sent to Mr. E. G. Blackford for shipment to France.

25,000 eggs of the landlocked salmon, from Grand Lake Stream Station, were shipped on April 1, 1887, to Léon d'Halloy, vice-president of the Lower Seine Fish Commission.

Germany.—In April, 1886, an unsuccessful attempt was made to transport shad to the Danube River.

On March 20, 1886, 20,000 landlocked salmon eggs were sent to von dem Borne for the Fischerei Verein. 30,000 eggs of this species were forwarded on March 5, 1887, through Mr. E. G. Blackford, to von Behr for the same association, and 10,000 to Max von dem Borne for his establishment at Berneuchen.

In January, 1886, two shipments of whitefish eggs, each containing 1,000,000, were made from Northville to the Deutsche Fischerei Verein, Germany. These were repacked at Cold Spring Harbor. A third consignment of 1,000,000 from the same station was reshipped by Mr. Blackford March 10 in the original packages, modified only by replacing some of the packing with ice. On January 22, 1887, again 1,000,000 whitefish eggs were sent from Northville to Mr. Blackford, to be forwarded to Germany.

At Cold Spring Harbor 50,000 lake-trout eggs, which had come from Northville, were reshipped on January 18, 1886, per steamer *Fulda*, to the Fischerei Verein.

On February 22, 1886, 25,000 brook-trout eggs, from Northville, were repacked at Cold Spring Harbor, and sent to the Verein per steamer *Eider*.

On February 19, 1886, 25,000 rainbow-trout eggs, from Wytheville, were shipped to the Fischerei Verein on the steamer *Hermann*. 10,000 eggs of this species were sent to Max von dem Borne on January 24, 1887. 30,000 eggs were sent from Wytheville February 7 and 14, 1887, to Herr von Behr.

Attempts to convey sunfish, red-eye, and white perch in 1886 and 1887 to Max von dem Borne have been described in the systematic account of these species.

Mexico.—By request of the minister of Mexico, 25,000 lake-trout eggs were sent from Northville, January 18, 1886, to Estévan Cházari, of the City of Mexico.

New Zealand.—On February 5, 1886, there were sent from the Northville Station 1,000,000 whitefish eggs to Mr. Charles B. Buckland, of San Francisco, destined for Sir Julius Vogel, Wellington, New Zealand. Owing to want of care in transportation this shipment was a failure.

On January 5, 1887, there were forwarded from Northville 1,500,000 whitefish eggs to Mr. Charles B. Buckland, acting resident agent for the New Zealand Government at San Francisco, to be forwarded to New Zealand. These eggs were taken by the steamer *Alameda* and their safe arrival was acknowledged February 26 by Mr. W. J. M. Larnach, minister of marine. About one-half of the eggs were placed alive in the hatcheries.

Switzerland.—1,000,000 whitefish eggs and 50,000 eggs of the lake trout were sent to Switzerland January 13, 1886, per steamer *Amerique*, via Havre. On February 2, 10,000 brook-trout eggs were forwarded. On February 15 Col. Emil Frey announced the safe arrival of the whitefish and lake-trout eggs, and their distribution to the hatcheries at Zurich, Zug, Geneva, Locarno, Interlaken, Lucerne, Brassus, Saint Moritz, Stanz, and Chur.

Assistance rendered by steamer Albatross.—Note has been made, under the heading of the steamer *Albatross*, of the services rendered on March 30 by the officers and crew of that vessel in saving part of the town of Key West, Fla., from a destructive fire.

On the 19th of July, as the steamer *Albatross* was returning to Wood's Holl from a dredging trip, the steam-collier *Panther*, belonging to the Philadelphia and Reading Railroad Company, was discovered aground off Naushon, and was assisted from her perilous position.

10.—PUBLIC EXHIBITIONS OF THE METHODS AND RESULTS OF THE COMMISSION.

At the exposition held at Louisville, Ky., during this year, a few of the appliances of the Fish Commission were displayed in connection

with the exhibit made by the National Museum. The Commission was also represented at the Nebraska State fair, in Lincoln, Nebr., by numerous articles of interest, furnished at the request of Mr. W. L. May, a member of the Nebraska State fish commission. The method of hatching whitefish eggs in the McDonald jars was exhibited, in April, at the exposition building in Chicago, under the direction of Mr. J. F. Ellis, 3,000,000 eggs of the whitefish having been sent from the Northville Station for that purpose. A similar exhibition, with respect to both whitefish and brook-trout eggs, was made in December at an industrial exposition held at Wilmington, Del., Dr. E. G. Shortlidge having charge of the apparatus.

11.—VISITS FROM REPRESENTATIVES OF FOREIGN GOVERNMENTS.

A visit was received in September from Mr. Kadzutka Ito, commissioner of fisheries for the island of Yezzo, under the Japanese Government. Mr. Ito was commissioned by his Government to study the fishing industries of the United States and the methods and results of the U. S. Fish Commission. He is a graduate of the Imperial College of Agriculture at Sappora, and has been for several years chief of the bureau of fisheries in the Department of the Hokkaido; he is also an officer of the bureau of colonization. While in the United States he inspected nearly all of the stations of the Fish Commission and the principal fishery centers. He remained in this country nine months.

Dr. Filip Trybom, of the Swedish commission of fisheries, who arrived in the United States in 1885, continued his studies in this country until November, 1886, visiting the principal fishing ports and the hatching stations of both the Atlantic and Pacific coasts and of the Great Lakes.

12.—DEATHS DURING THE YEAR.

Notice of Capt. Hubbard C. Chester.—During this year the Fish Commission lost one of its most valued members, Capt. Hubbard C. Chester, who died July 19, at the age of fifty-two years. A native of the fishing town of Noank, near New London, Conn., Captain Chester, at an early age, entered the whaling service, in which he gained rapid promotion and received that thorough disciplining which, with his natural tastes and great energy, specially fitted him as an associate of Captain Hall in his Arctic expedition. The services which he rendered as executive officer of the steamer *Polaris*, and his successful rescue of the unfortunate party which drifted to sea on the detached ice-floe, have gained him well-merited fame.

Captain Chester joined the Fish Commission in 1874, soon after his return from the *Polaris* expedition, and has taken part in nearly all of its branches of service. On the smaller steamers, before the *Albatross* was built, he was generally in charge of the dredging operations, and

also participated during two or three seasons in the shad operations on the Susquehanna and Potomac Rivers. He assisted in preparing and installing the exhibits of the Fish Commission and National Museum at the Centennial Exposition at Philadelphia in 1876, and in 1883 had charge of packing the large collections sent by the Fish Commission to the London Fisheries Exhibition and their subsequent installation. In 1885 he was made the first superintendent of the Wood's Holl Station, which was then permanently organized, and continued to fill this position until June of this year, when his final illness unfitted him for active service. Captain Chester was a member of the party which conducted the experimental work of cod hatching at Gloucester, Mass., during the winter of 1878-'79, when by unwise exposure he contracted a serious lung trouble, from which he never fully recovered. He also took part in the subsequent experiments of the same nature at Wood's Holl, and during the winter of 1885-'86 was in charge of the work. The Commission is indebted to him for important improvements in the methods of hatching cod and lobster eggs and in the dredging appliances.

Notice of Capt. Nathaniel E. Atwood.—It is very appropriate that mention should be made in this connection of the important services rendered to science and to the fishery industries of New England by Capt. N. E. Atwood, of Provincetown, Mass., who died November 7, 1886, in his eightieth year. His warm devotion to the interests of the Fish Commission, and his frequent contributions to its fund of information, made him an honored associate in its work, and his loss will be deeply felt by those who enjoyed his friendship. Starting life as a fisherman in 1816, when only nine years of age, he continued actively in this vocation for half a century, at the end of which time he turned his attention to the curing of fish in his native town. In 1857 he was elected to the State house of representatives, and subsequently to the State senate, in which he served as a member of the committee on fisheries. Captain Atwood was an accurate observer of natural phenomena, and possessed a wonderfully retentive memory, lacking only the necessary training to fit him as an accomplished naturalist. He gave valuable assistance to Dr. D. Humphreys Storer in the preparation of his monograph on the fishes of Massachusetts, begun in 1843, and was afterwards a constant helper of Prof. Louis Agassiz in his ichthyological studies. The Fish Commission is indebted to Captain Atwood for most of its information respecting the history of the important fisheries of Cape Cod, and in many other directions it has had the benefit of his varied experiences.

13.—PUBLICATIONS BY THE FISH COMMISSION DURING 1886.

Annual Reports.—The annual report of the Commissioner for 1883, of which only the press-work and binding remained to be done January 1, was not received from the Printing Office until August 11. Most of the report for 1884 was also in type at the beginning of the

Year, and the bound volumes were ready for distribution by the middle of December.

Quarto Reports.—Considerable progress was made with the quarto reports relating to the fisheries and fishery industries of the United States, which were ordered printed by an act of Congress passed in 1882. These reports have been prepared by Prof. G. Brown Goode and a staff of associates, under the joint co-operation of the Commissioner of Fisheries and the Superintendent of the Tenth Census. The "Geographical Review of the Fisheries," which, after being put in type, was transferred to the Department of the Interior, in 1885, for publication as a volume of the Census Report, was returned to the Commission during the current year, and will form Section II of the Quarto series. Only the press-work and binding remain to be done. The account of the fishing grounds of North America and of the ocean temperatures of the Atlantic coast, now constituting Section III, and the report upon the fishermen, forming Section IV, are also in type. Section V, in which the History and Methods of the Fisheries are discussed, was nearly ready for the Printer at the close of the year.

Bulletin.—The printing of the Bulletin for the current year (Volume VI) was begun early in February. Signatures were mailed to correspondents March 30, July 23, October 22, and December 20.

Pamphlets.—The following publications, mostly extracted from the Annual Reports for 1883, 1884, and 1885, have been issued during the year for separate distribution :

96. TANNER, Z. L. Report on the work of the U. S. Fish Commission steamer *Albatross* for the year ending December 31, 1883. (From Report 1883, pp. 117-236.)
97. STONE, LIVINGSTON. Explorations on the Columbia River from the head of Clarke's Fork to the Pacific Ocean, made in the summer of 1883, with reference to the selection of a suitable place for establishing a salmon-breeding station. (From Report 1883, pp. 237-258.)
98. ATWATER, W. O. Contributions to the knowledge of the chemical composition and nutritive values of American food-fishes and invertebrates. (From Report 1883, pp. 433-499.)
99. VERRILL, A. E. Results of the explorations made by the steamer *Albatross* off the northern coast of the United States in 1883. (From Report 1883, pp. 503-699.)
100. BUSH, KATHARINE, J. List of deep-water mollusca dredged by the U. S. Fish Commission steamer *Fish Hawk* in 1880, 1881, and 1882, with their range in depth. (From Report 1883, pp. 701-727.)
101. EISEN, GUSTAV. Oligochaetological researches. (From Report 1883, pp. 879-964.)
102. SEAL, WILLIAM P. The Aqua-vivarium as an aid to biological research. (From Report 1883, pp. 965-969.)
103. BENCKE, B. Utilizing water by fish-culture. (From Report 1883, pp. 1101-1142.)
104. RYDER, JOHN A. An exposition of the principles of a rational system of oyster culture, together with an account of a new and practical method of obtaining oyster spat on a scale of commercial importance. (From Report 1885, pp. 381-423.)
105. SMITH, SIDNEY I. Report on the Decapod Crustacea of the *Albatross* dredgings off the east coast of the United States during the summer and autumn of 1884. (From Report 1885, pp. 605-705.)

106. RYDER, JOHN A. On the development of Osseous Fishes, including marine and fresh-water forms. (From Report 1883, pp. 489-604.)
107. TANNER, Z. L. Report on the construction and outfit of the U. S. Fish Commission steamer *Albatross*. (From Report 1883, pp. 3-116.)
108. BAIRD, SPENCER F. Report of the Commissioner for 1884. A. Inquiry into the decrease of food-fishes. B. The propagation of food-fishes in the waters of the United States. (From Report 1884, pp. xiii-lxxi.)
109. BAIRD, G. W. Specifications for building the new boilers, etc., of the steamer *Albatross*, 1886. (Printed by R. Beresford, Washington, D. C.)
110. TANNER, Z. L. Report on the work of the U. S. Fish Commission steamer *Albatross* for the year ending December 31, 1884. (From Report 1884, pp. 3-112.)
111. NICKLAS, CARL. Pond culture. (From Report 1884, pp. 467-655.)
112. SMILEY, CHARLES W. Some results of carp culture in the United States. (From Report 1884, pp. 657-890.)
113. FEWKES, J. WALTER. Report on the medusæ collected by the U. S. Fish Commission steamer *Albatross* in the region of the Gulf Stream, 1883-'84. (From Report 1884, pp. 927-980.)
114. RYDER, JOHN A. On the origin of heterocercy and the evolution of the fins and fin-rays of fishes. (From Report 1884, pp. 981-1107.)

14.—DIGEST OF THE APPENDICES WHICH ACCOMPANY THIS REPORT.

The appendices which accompany this report consist of thirty-two papers, all of which have a more or less direct bearing upon the work of the Fish Commission. A large proportion, moreover, relate to the work accomplished at the stations of the Commission and by the vessels in its service during the current year. Several of the longer papers will be published in pamphlet form for separate distribution. The arrangement of the appendices is as follows:

A.—THE FISHERIES.

This appendix consists of a comprehensive report by the Commissioner, Prof. Spencer F. Baird, upon the Sea Fisheries of Eastern North America. The paper was mostly prepared in 1877 and 1878, but was withheld from year to year for revision and completion, until it became evident that the author's declining health would prevent his giving the subject further attention. It is an important contribution to the literature of the American fisheries, and shows much careful research and thoughtful study.

B.—SCIENTIFIC INVESTIGATION.

Four papers are included in this appendix, two relating to fishes and two to marine invertebrates. The first is by Prof. D. S. Jordan and Mr. D. K. Goss, his assistant, upon the flounders and soles of America and Europe; the second is by Professor Jordan and Mr. C. H. Eigenmann, upon the Scænidæ (drum-fishes, etc.), of the same region. The former is illustrated by 23 figures the latter by 12 figures. Prof. Edwin Linton reports upon the Entozoa, or intestinal worms of the marine fishes of New England, and Mr. J. Walter Fewkes, upon the medusæ collected by the steamer *Albatross* during its cruise to the Gulf Stream in the winter of 1885-'86.

C.—FISH CULTURE.

This appendix contains a single paper by Messrs. Bettoni and Vinciguerra, of Italy, upon the fish-cultural establishments of Central Europe.

D.—REPORTS OF VESSELS AND STATIONS.

This appendix consists of twenty-two reports, covering the principal field operations of the Commission during the current year. They relate to the steamers *Albatross*, *Fish Hawk*, and *Halcyon*; the schooner *Grampus*, and the fish-cultural stations at Bucksport and Grand Lake Stream, Me.; Wood's Holl, Mass.; Cold Spring Harbor, N. Y.; Battery Island, Saint Jerome, and Fort Washington, Md.; Washington, D. C.; Wytheville, Va.; Northville and Alpena, Mich.; McCloud River, Cal.

E.—MISCELLANEOUS.

The first paper in this appendix is a compilation, by Mr. Sanderson Smith, of the data necessary for locating and defining all the dredging stations made in the North Atlantic Ocean, adjacent to the coasts of North America, by the vessels of the Fish Commission, the Coast and Geodetic Survey, and the various expeditions sent out by European governments. It is accompanied by several charts, showing the positions of the dredging stations. Following it are translations of two papers, one from the Russian, by Professor Kostytscheff, on the chemical composition of fish products, the other from the French, by Dr. Mauriac, on cases of poisoning produced by spoiled codfish, and a compilation of the Norwegian fishery statistics for 1885.