REPORT OF THE COMMISSIONER.

ORGANIZATION OF THE COMMISSION.

THE COMMISSIONER'S OFFICE.

INTRODUCTORY.

The annual report of the Commissioner has heretofore been made for the 12 months included in the calendar year.

Since, however, several of the most important branches of the fish cultural work of the Commission, viz, the propagation of cod, lobster, salmon, trout of different species, and whitefish, are continuous throughout the winter, it is necessary, in order to give a complete and comprehensive account of each season's work, that the annual report should be made for the fiscal rather than the calendar year.

This report will therefore cover the operations of the Fish Commission for the 18 months comprised between January 1, 1887, and June 30, 1888. This period has been marked by important changes, as well in the organization and personnel of the Commission, as in its relations to other branches of the Government service.

The Fish Commission from its first establishment in 1871 was continuously under the direction of Professor Baird, until his death at Wood's Holl, Massachusetts, in the summer of 1887. An account of his distinguished services in behalf of the fishery interests will be given in my next report.

Immediately after the death of Professor Baird, at the request of the President, Dr. G. Brown Goode, Assistant Secretary of the Smithsonian Institution, assumed the commissionership, and performed the duties of the office for a period of about 6 months, until the law was modified and the present Commissioner appointed.

The following is a copy of the act amending the law concerning the U. S. Commission of Fish and Fisheries:

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That section four thousand three hundred and ninety-five of the Revised Statutes of the United States be, and the same is hereby, amended to read as follows:

That there shall be appointed by the President, by and with the advice and consent of the Senate, a person of scientific and practical acquaintance with the fish and fisheries to be a Commissioner of Fish and Fisheries, and he shall receive a salary at the

rate of five thousand dollars a year, and he shall be removable at the pleasure of the President. Said Commissioner shall not hold any other office or employment under the authority of the United States or any State.

JOHN G. CARLISLE,
Speaker of the House of Representatives.
JOHN J. INGALLS,
President of the Senate pro tempore.

This act was approved by the President January 20, 1888, and Marshall McDonald was appointed Commissioner.

The report accompanying the act making the Commissioner of Fish and Fisheries a salaried officer of the Government follows herewith:

Mr. DUNN, from the Committee on Merchant Marine and Fisheries, submitted the following

REPORT:

[To accompany bill S. 261.]

The Committee on the Merchant Marine and Fisheries, to whom was referred the bill (S. 261) entitled "An act to amend the law concerning the Commissioner of Fish and Fisheries," have considered the same and report it back to the House without amendment and recommend its passage without delay.

The U. S. Fish Commission was established by act of February 9, 1871, which provided for the appointment by the President, with the consent of the Senate, of a Commissioner of Fish and Fisheries from among the civil officers or employés of the Government, who shall serve without additional salary. The act contemplated simply an investigation "with the view of ascertaining whether any, and what, diminution in the number of the food fishes" had taken place, and also what "protective, prohibitory, or precautionary measures should be adopted, and report upon the same to Congress."

The act of March 3 of the same year, to provide for deficiencies, etc., appropriated $5,000 for the expenses of the inquiry ordered.

Prof. Spencer F. Baird, then Assistant Secretary of the Smithsonian Institute, and an employé of the Government, he having charge of the National Museum, was appointed Commissioner. He prosecuted the inquiries with so much zeal, energy, and ability that the act of 1871 was reënacted, and the deficiency bill of May 18, 1872, made an additional appropriation of $3,500 to continue the inquiry, and $500 for the preparation of illustrations, tables, and report.

So impressed was Congress with the wisdom of Professor Baird's recommendations, based on the investigations he had made into the condition of our fisheries, that the act of June 10, 1872, contained an appropriation of $5,000 to continue those investigations during the fiscal year, and $15,000 was provided "for the introduction of shad into the waters of the Pacific States, the Gulf States, and of the Mississippi Valley; and of salmon, whitefish, and other useful food fishes into the waters of the United States to which they are best adapted." Each succeeding year appropriations have been increased as the work was extended under the wise and successful management of the Commissioner.

The act limiting the appointment of the Commissioner to a detail of some one at the time in the employ of the Government appears to have contemplated only an inquiry occupying perhaps a few summer months.

At the time of the selection of Professor Baird his duties under his salaried position were comparatively light, as he was charged with the administration, under the Secretary, of the Museum, which was in those days contained in the small space which could be allowed in the Smithsonian Building. Under Professor Baird's masterly,

wise, and energetic management, both the Fish Commission and the National Museum have grown to large proportions, so that at his death the work of the Fish Commission had developed from an inquiry in 1871, on an appropriation of $5,000, to the production, transportation, and distribution of over 100,000,000 young fish, and the administration of some sixteen hatching and rearing stations: Two in Maine, at Grand Lake Stream and Bucksport; two in Massachusetts, at Gloucester and Wood's Holl; two in Michigan, at Northville and Alpena; one at Duluth; one on the Columbia River; two in California, on the Sacramento; one on the Susquehanna, at Havre de Grace; one at the mouth of the Potomac; two within the city of Washington; one at Fort Washington, and one at Wytheville, Virginia, besides the administration of scientific investigations and fish hatching done by 3 steam and 1 sailing vessel, and of 3 transporting cars specially designed to transfer fish from one end of the country to the other.

The National Museum has had a corresponding expansion, for in addition to the hall of the Smithsonian which held the collections in 1871, and whose administration cost $20,000, a building covering 3½ acres has been built and equipped, and it has been found necessary to appropriate $168,000 for their care this year.

* * * Although the act of 1871 may have been prudent and a wise measure at the time it was enacted, and although the work of the Fish Commission as well as that of the Museum was well done by him, perhaps at sacrifice of some years of his valuable and honored life, it is to be doubted if, at the time of his appointment as Fish Commissioner, the Smithsonian, the National Museum, and the Fish Commission had been of their present magnitude, Congress would have provided for their conduct being placed even on his broad shoulders, and the work of three assigned to his well trained and cultivated intellect.

The work of the Fish Commission has become so extensive, and the results so important to the country, that it should be made, as this bill proposes, the sole object of the Commissioner—it should occupy all his time. This bill, therefore, while giving the President the greatest latitude in making his choice, takes away the limitation that that choice shall be confined to those who may be otherwise employed by the Government. This bill repeals the provision of the act of 1871, which requires that the now important and all-engrossing duties of the Fish Commissioner shall be performed at the expense of some other Department and some other appropriation.

Under the present law the Commissioner must either hold a sinecure, receive a Government salary, which he does not earn, or he must neglect duties for which he is paid in order that he might perform others for which he is not paid; or, perhaps, as in the case of Professor Baird, devote hours which nature demands for rest and recreation to Government work without compensation. The first two alternatives are neither right nor proper, and the Government is not so impecunious or needy that we should ask for it or accept such gratuitous services.

The rate of salary named in the bill is the same as has been fixed for and paid to the Assistant Commissioner for years.

With a Commissioner charged, as his sole duty, with the work of the Fish Commission there will be no further need for an Assistant Commissioner. The bill therefore does not contemplate any additional expense. The further details of the administration will be looked to when the appropriation bills are made up.

It is best not to encumber the present bill with other matter than the provision for the head of the Commission, as it is of the first importance that a permanent head of the Commission should be provided for at once. As soon as the new Commissioner provided for by this act shall have been appointed and installed he can be called before the committees of the House, and if further legislation be needed it can be predicated on his reports and after a revision of any projects for the prosecution of the work which he may submit.

Originating in an inquiry instituted by Congress "with the view of ascertaining whether any and what diminution in the number of the food fishes of the coast and lakes of the United States has taken place," the Commissioner was directed "should such diminution be ascertained to have taken place" to investigate the causes of the same and report to Congress "whether any and what protective, prohibitory, or precautionary measures should be adopted in the premises."

The fact that there had been a disastrous decline in the annual yield of both the coast and river fisheries of New England was clearly indicated by the investigations into the conditions of these fisheries, which had been conducted by the State authorities of Massachusetts, Rhode Island, and Connecticut.*

The fishery interests that were placed at a disadvantage by the introduction of pounds and traps sought, through their respective legislatures, to secure the enactment of laws prohibiting the use of fixed apparatus for the capture of fish.

The contention before the legislative committees charged with the consideration of the subject developed a great variety of opinions, which naturally grew out of the diversity and antagonism of interests involved, and led to the conviction on the part of those who desired to conserve the paramount public interest without making unfair or invidious discrimination in respect to the conflicting methods pursued, that the basis for rational legislation in respect to the fisheries could only be laid after a careful and comprehensive study of the matter in all its relations from a disinterested standpoint.

It was this informal consensus of opinion that led to the introduction into the House of Representatives by the Hon. H. L. Dawes, then a member from Massachusetts, of the joint resolution for the protection and preservation of the food fishes of the coast of the United States, which became a law on the 9th of February, 1871.

This bill, while responding to the immediate exigency and demand, is prophetic in the completeness with which it makes provision for that evolution of the Fish Commission by which it has come to be the conservator and custodian of an important economic resource for our people—a resource which can not, except in small measure, be appropriated or segregated by individuals, as our lands, our forests, and our mines may be and are, but which must for all time be maintained by the Government for the common use.

The alleged deterioration of the coast and river fisheries of New England having been abundantly confirmed by the investigations of

* The cause assigned by those who complained most of the result was the multiplication of traps and pounds which captured fish of all kinds in great numbers, and as was supposed in greater quantities than the natural fecundity of the fish could make good year by year, especially in view of the fact that these catches were made during the spawning season, thus destroying many of the fertile fish and preventing others from depositing their eggs. (S. F. Baird, Report of the Condition of the Sea Fisheries of the South Coast of New England in 1871 and 1872., p. 8.)

the Commissioner, his attention was next given to an inquiry as to the "causes of this deterioration and the protective, prohibitory, or precautionary measures to be adopted."

Omitting suggested causes, which were beyond the regulation or control of man, the result of the inquiry was to show that the agency of man was the most potential factor in bringing about this deterioration.

The injury was brought about directly by the multiplication of traps and pounds and by the absence of any restriction upon the season or methods of the fishery. Indirectly it was facilitated by the obstruction of streams by means of impassable dams and by the pollution of the waters with substances deleterious to the life of fish and to the maintenance of their natural spawning grounds. There was consequently a serious diminution in the natural reproduction of the shad and also of the herring and other anadromous species, which form a considerable portion of the food of important marine species along the coast.

The remedy for the decadence of the industry was to be found in the proper regulation of the fishing and in systematic and rational methods of propagation. These measures could be based only upon careful study of the methods and conditions of the fisheries and of the environment and habits of the fishes. In order to accomplish its objects the work of the Commission, outside of office administration, is therefore naturally concerned with the inquiry in regard to the food fishes, the study of the methods and conditions of the fisheries, and the conduct of fish-cultural operations. From this distribution of labor arose the divisions of administration, scientific inquiry, fisheries and fish culture.

Fish culture as a means of restoring the fisheries was first undertaken by the U. S. Fish Commission in 1872, being done at the suggestion of the American Fish Culturists Association, which appointed a committee of which Mr. George Shepherd Page was chairman to bring the matter to the attention of Congress. An appropriation of $15,000 for the purpose in question was made by Congress on June 10, 1872, and the Commission took immediate steps to inaugurate this important work, which in its development has come to be the principal agency for maintaining our most important commercial fisheries.

The species propagated in 1872 were as follows: The shad, the Maine salmon, the Rhine salmon, the California salmon, and the whitefish.

The organization outlined above was in effect during Professor Baird's lifetime, although never specifically defined and published by him. Realizing the advantage and necessity of a permanent guide for the operations of the Commission, the Committee on Merchant Marine and Fisheries drafted a bill which was introduced by Mr. Dunn in the House of Representatives April 30, 1888, providing for the reorganization of the Commission of Fish and Fisheries and defining its duties. Although this never became a law the organization proposed has been

adopted and the classification of the work and personnel made in substantial agreement with it. A copy of the bill is herewith given:

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That it shall be the duty of the Commissioner of Fish and Fisheries to continue the systematic investigation of waters of the United States, and of the biological and physical problems they present, with the object of determining the character, abundance, geographical distribution, and economical value of the inhabitants of the waters, both salt and fresh, as also their migrations, and the cause influencing or regulating the same. This investigation is to be conducted on a broad and comprehensive plan, so as to arrive at the life history of all species having economic value, as well as of those species to which they are intimately and essentially related.

SEC. 2. That he will continue the investigation into the history of the methods and apparatus of the fisheries and for the preservation and utilization of fishery products now in use, and will cause careful study to be made of new methods and apparatus introduced from time to time with the object of determining their effect upon production, and furnishing the information upon which to frame intelligent legislation regulating the conduct of the fisheries and improving their methods and apparatus.

SEC. 3. That it shall be the duty of the Commissioner of Fish and Fisheries to provide for the collection of the statistics of the fisheries of the United States, especial reference being had to the fisheries of the Great Lakes and of the New England and North Pacific coasts of the United States, which are of international importance and may influence or become the subject of treaty stipulations. The statistical inquiry hereby authorized and directed shall be comprehensively planned to accomplish the purposes for which it is instituted.

SEC. 4. That it shall be the duty of the Commissioner of Fish and Fisheries to continue the work of artificial propagation of food fishes and other useful inhabitants of the water with a view to their introduction into and establishment in the interior and coast waters, and to the maintenance and improvement of the important commercial fisheries of the coast and interior lakes and rivers. To this end he will, in his annual estimates transmitted to Congress, provide for the maintenance and operation of the existing stations of the Commission, and for the maintenance and operation of such additional permanent and field stations as may be from time to time authorized and directed.

SEC. 5. That the Commissioner of Fish and Fisheries shall appoint such employees as Congress may from time to time provide, with salaries corresponding to those of similar officers in other departments of the Government, and he shall, as Congress may from time to time provide, employ other persons, of expert knowledge, for such time as their services may be needed, including chemists, naturalists, and physicists, for the conduct of the researches and investigations required in the performance of the duties devolved upon this Department, or which may be from time to time authorized and directed by Congress.

PUBLICATIONS.

LIBRARY.

On January 1, 1887, the total number of volumes registered in the library of the U. S. Fish Commission had reached 3,000. Up to June 30, 1888, this number was increased to 3,857. At first the books comprising this collection were kept with those belonging to the Commissioner, Prof. S. F. Baird, in his private office; but in March, 1888, they were transferred to the office of the Commission, at 1443 Massachusetts avenue, and made accessible to all the employés of the Commission.

REPORTS AND BULLETINS.

The Report of the Commissioner for 1885, constituting part XIII of this publication of the Commission, relating to an inquiry into the decrease of food fishes and their propagation in waters of the United States, was published in 1887. Extra copies were issued of the following five papers included in this report: (1) Report on the work of the U. S. Fish Commission steamer *Albatross* for the year ending December 31, 1885, by Lieut. Commander Z. L. Tanner, U. S. Navy, commanding; (2) Report on the thermometers of the U. S. Commission of Fish and Fisheries, by J. H. Kidder, M. D.; (3) Report on the discovery and investigation of fishing grounds, made by the Fish Commission steamer *Albatross* during a cruise along the Atlantic coast and in the Gulf of Mexico, with notes on the Gulf fisheries, by Capt. J. W. Collins; (4) On the development of the cetacea, together with a consideration of the probable homologies of the flukes of Cetaceans and Sirenians, by John A. Ryder; (5) The Annelida Chætopoda, from Eastport, Me., by Prof. H. E. Webster and James E. Benedict.

The Bulletin of the Commission for the year 1886, a publication devoted to matters pertaining to fish-culture and to the apparatus, methods, and relations of the fisheries, was issued in 1887.

ARTICLES IN THE APPENDIX.

In 1885 Professor Baird began to collect information concerning the fisheries of the Great Lakes. He was led to make this investigation principally because of the supposed expansion in the products, value, etc., of the lake fisheries, the intimate relations existing between Canadian fishery enterprises and American markets, and the influence upon these fisheries of artificial propagation by the National and State fish commissions. It was believed that a consideration of the fishery relations between the United States and Canada might be somewhat influenced by a full knowledge of existing conditions in the Lake region. The work was carried on from August to November, 1885, and was under the direction of Mr. R. E. Earll, who was assisted by 6 employés of the Commission. The elaboration of the field notes and the compilation of the review have been delayed for various imperative reasons

until the present time. The labor of compilation devolved upon Dr. Hugh M. Smith and Mr. Merwin-Marie Snell, and the introduction and description of fishing vessels and boats were prepared by Capt. J. W. Collins, assistant in charge of the division of fisheries.

The review includes descriptions of the fishing grounds, sketches of the various methods of fishing, of the fishermen, the species of fish captured, the limits of the fishing season, the disposition of the catch, the statistics of the fisheries with reference to the influence of artificial propagation of several important species. Illustrations are given of the principal food fishes, fishing vessels and apparatus, the methods and processes pursued in various important fisheries, and there are maps of the fishing regions, together with charts showing the location of fixed apparatus. The work comprises 328 pages and 44 plates, besides numerous maps, charts, etc., and is the most important contribution to our knowledge of the Great Lake fisheries which has yet appeared.

The report on the work of the steamer *Albatross*, by Lieutenant Commander Tanner, consists chiefly of a narrative of the cruise of the *Albatross* from Norfolk to San Francisco, for the purpose of investigating the fishery resources of the Pacific Coast.

The steamer made upward of forty anchorages during the trip in various harbors of the West Indies, South America, Galapagos Archipelago, Mexico, and California. Shore collections were made at various points, and the dredge and trawl were used when opportunity offered. The scientific staff consisted of Prof. Leslie A. Lee, with Messrs. Thomas Lee and Charles H. Townsend as civilian assistants. The narrative gives a brief sketch of the regions visited, the inhabitants seen, and the collections obtained. Important hydrographic soundings were made during the voyage, and a valuable record of temperatures and specific gravities for the eighteen months ending June 30, 1888. The report is accompanied by four plates.

The report on the construction of the schooner *Grampus*, by Capt. J. W. Collins, the designer of the vessel, gives a complete history of the preparation of this schooner for the investigation of the fishing grounds and fisheries. It furnishes also complete details of the outfit carried by the vessel and the methods employed in conducting investigations.

The report is accompanied by 18 plates, showing interior and exterior views of the *Grampus* and of certain appliances and apparatus used in connection with her work.

The report upon the operations of the U. S. Fish Commission schooner *Grampus* from March 15, 1887, to June 30, 1888, by Capt. J. W. Collins and Capt. D. E. Collins, relates to investigations during the spring of 1887 of the mackerel, halibut, and cod fisheries and of the former habitat of the Great Auk. It contains also notes upon various species of fish and other aquatic animals observed during the cruise of this vessel. It gives important notes concerning the Newfoundland cod fishery, relative

to the vessels, boats, and apparatus employed, and the methods of catching and preserving fish. Another important investigation covered by this report is that of the southern mackerel fishing grounds in the spring of 1888. Incidental to this was the inquiry concerning the pound-net fisheries of Chesapeake Bay. The report is accompanied by numerous temperature records, and is illustrated by 16 plates.

Scientific investigations made on behalf of the Commission by Dr. David Starr Jordan, president of the University of Indiana, Prof. S. A. Forbes, director of the Illinois State Laboratory of Natural History, and Prof. Edwin Linton, of the Washington and Jefferson College, Washington, Pennsylvania, are made the basis of special reports by these authors. Dr. Jordan's contribution is a review of the Labroid fishes of America and Europe, in which he gives a systematic catalogue of all the species of this family of fishes (old wives, wrasses, doncellas, pudianos, parrot fishes, cunner, and tautog) found in the waters of America and Europe, with the synonymy of each species and analytical keys by which the various genera and species may be distinguished. This important monograph is accompanied by eleven plates, showing twelve of the one hundred and fifteen species discussed.

The article by Professor Forbes on "Some Lake Superior Entomostraca," is a valuable contribution to our knowledge of the crustaceans of Lake Superior. It has an important economic relation to some difficult problems of fish-culture in the Great Lake region, since the minute crustaceans treated by Professor Forbes constitute the principal supply of food for the young of several valuable edible species. The paper contains descriptions of several new species and two new varieties of Entomostraca, and is illustrated by four plates.

The notes on the Entozoa of marine fishes of New England, with description of several new species, is the second part of a series of papers by Prof. Edwin Linton, of the Washington and Jefferson College, Washington, Pennsylvania. It comprises 149 pages of text and 15 plates, and relates to forty-two species of Cestod worms, of which twenty-seven are described as new to science, eight of these representing new genera.

These parasites were found in a variety of fishes, but principally in the sharks and rays. This is one of the most important contributions to the subject of fish parasites which has been given to the public.

RELATIONS OF THE COMMISSION.

The Commission has continued to coöperate with the fish commissions of various States and with the fish-culturists of foreign countries in the effort to increase the productiveness of the waters. Every active State fish commission has received at various times from the United States supplies of eggs to be developed in its hatcheries, or of young fish to be distributed in suitable waters. The species allotted to Commonwealths in this way include all of the native *Salmonidæ* reared in establishments of the United States, as well as the species obtained by exchange with foreign governments. The list includes the whitefish, Maine salmon, landlocked salmon, rainbow trout, brown trout, Loch Leven trout, sälbling, brook trout, lake trout, shad, carp, goldfish, and the lobster. Some of these fishes are reared through the coöperation of States with the United States. The station at Bucksport, Maine, for instance, which is engaged in the cultivation of the Penobscot salmon, is operated by the United States and the State of Maine. The Schoodic Station at Grand Lake Stream, Maine, cultivates the landlocked salmon, and is operated on the joint account of the United States, New Hampshire, and Massachusetts. At the Cold Spring Harbor Station, of the New York Fish Commission, the United States is allowed the privilege of hatching and distributing salmon, whitefish, shad, and various kinds of trout. In the transportation of shad to the headwaters of the Delaware River, the Pennsylvania Commission extended the assistance of its messengers. The Michigan Fish Commission donated to the United States about 20,000,000 whitefish eggs out of their supply obtained from Detroit River.

FOREIGN GOVERNMENTS.

The system of international exchanges, which has been so productive of good results heretofore, has been continued and extended. The United States Commission has received living soles from Mr. Thomas J. Moore, of Liverpool, England; Loch Leven trout from Sir James G. Maitland, Howietoun, Scotland; sälbling and brown trout from Herr von Behr and Herr Max von dem Borne, of Germany. Whitefish eggs have been forwarded to England, Germany, and New Zealand; eggs of the landlocked salmon to England, France, and Germany; eggs of the rainbow trout have been shipped to England, France, Germany, Switzerland and Mexico. Brook trout eggs were forwarded to England, as were also eggs of the lake trout. All of these are referred to in detail in the tables of distribution.

RELATIONS WITH OTHER DEPARTMENTS OF THE UNITED STATES GOVERNMENT.

The Commission has continued to receive assistance from the heads of various Departments of the Government, and its operations have been greatly facilitated by means of such aid.

To the *Secretary of the Navy*, Hon. W. C. Whitney, the Commission is under special obligations for details of officers and men to its vessels engaged in the Divisions of Inquiry and Fish-culture, as well as for necessary facilities for outfitting and repairing its vessels in the navy-yards. The *Bureau of Construction and Repair* lent launch No. 55 for the use of the Commission in the shad propagation at Havre de Grace, Maryland. A dredge was lent to the Commission by the *Bureau of Yards and Docks*, and the *Hydrographic Office* furnished the charts required for outfitting the schooner *Grampus*.

The *Treasury Department* has granted the withdrawal of alcohol from bonded warehouses and the free entry of coal for the use of the Fish Commission vessels. The Department has also admitted free of duty a submarine cable for the use of the Commission, galvanized rope required for dredging, and a package of preserved fish from Scotland. The *Bureau of Navigation* has continued to furnish valuable data concerning fishing vessels. The *Light-House Board* on the 9th of November, 1887, granted to the Fish Commission for a hatchery site, a portion of Ten Pound Island, in the harbor of Gloucester, Massachusetts. It has supplied vessels of the Commission with publications of the Board, which are necessary for the navigation of the coast, and has forwarded temperature observations from thirty-three light-houses and ships, covering almost the entire region from Maine to Florida. The *Life-Saving Service* has contributed to the efficiency of the Commission by reporting by telegraph, through the keepers and patrolmen, the stranding of fish and other marine animals in the various precincts. The *Coast and Geodetic Survey* has furnished many necessary charts, time tables, etc.

To the *Secretary of War*, William C. Endicott, the Commission is indebted for the privilege of quartering its employés in the commandant's residence at Fort Washington during the season of shad hatching. The *U. S. Signal Office* has examined and approved a submarine cable, which was imported for the use of the Fish Commission, and has furnished temperature observations from sixteen important and widely separated localities in the United States.

The *U. S. Geological Survey* has lent a boiler and engine for the use of the Fish Commission.

The *Commissioner of Patents* has furnished copies of specifications of patents relating to fishing apparatus and the fisheries.

In the office of the *District Commissioners*, the *Health Officer*, Dr. Smith Townshend, has furnished monthly statistics of the fishes in the markets of Washington.

RELATIONS TO INDIVIDUALS.

Acknowledgment is due to Mr. Marshall E. Morris, of Bridgeport, Connecticut, for the use of his steamer for the oyster investigation in 1887. Mr. S. J. Seneca, of Havre de Grace, Maryland, allowed the Commission to use a part of his counting house, which was fitted up with 100 shad-hatching jars, besides furnishing all the water needed for hatching.

To Capt. L. L. Blake and Purser Adams, of the steamer *W. W. Corcoran*, of Washington, District of Columbia, thanks are due for aid in the shipment of shad eggs; and to Mr. George L. Sheriff, of Washington, District of Columbia, for the free use of his wharf for the Fish Commission launch.

The Commission has received some distinguished visitors from foreign countries on missions of inquiry concerning fisheries and fishery investigations. Count Kmoda, an official of the Japanese Court, was provided with information on the utilization of fish products; and Mr. K. Ito, Superintendent of Fisheries of Japan, was given many facilities for investigating the subjects in which he is interested. In September, 1888, Rev. W. S. Green, of Dublin, Ireland, visited the Wood's Holl Station of the Commission, and obtained many data of practical utility concerning the fisheries.

In the account of the division of scientific inquiry will be found references to persons who were engaged in the laboratory at Wood's Holl, Massachusetts, and in collaborating reports for the Commission.

RELATIONS TO INSTITUTIONS.

On the 6th of January, 1887, Mr. Vinal N. Edwards, of Wood's Holl, on behalf of the Commission, shipped a live seal to the Zoölogical Gardens, Philadelphia, Pennsylvania.

RELATIONS TO TRANSPORTATION COMPANIES.

To the Duluth and Iron Range Railroad Company the Commission is indebted for granting the right of way over its grounds for a water flume, and for the privilege of suspending the same from one of its bridges at Duluth. The Norfolk and Western Railroad Company, at the request of the Commission, has made Wytheville Station a flag station for all local freight trains.

In the work of distribution from January 1, 1887, to June 30, 1888, inclusive, 176,027 miles were traveled by the cars of the Commission and the detached messengers engaged in the service. Of this mileage, free transportation was furnished the Commission cars by railroads of the country, as follows:

Summary showing name of railroad and total number of miles of free transportation furnished the U. S. Fish Commission cars by the railroads from January 1, 1887, to June 30, 1888.

Railroad.	Miles.	Railroad.	Miles.
Canada Southern	459	Missouri Pacific	1,622
Chesapeake and Ohio	104	Mobile and Ohio	40
Chicago, Burlington and Quincy	262	Northern Pacific	2,087
Chicago and Grand Trunk	553	Old Colony	19
Chicago and West Michigan	54	Oregon Railway and Navigation Company	404
Detroit, Bay City and Alpena	630	Rome, Watertown and Ogdensburgh	346
Eastern	216	St. Louis, Iron Mountain and Southern	980
Eureka Springs	26	St. Louis and San Francisco	351
Flint and Pere Marquette	3,561	St. Paul and Duluth	304
Florida Railway Navigation Company	414	South Florida	230
Grand Rapids and Indiana	620	Texas Pacific	738
Illinois Central	425	Utah Central	600
Lake Shore and Michigan Southern	947	Wabash, St. Louis and Pacific	264
Louisville and Nashville	11	Western and Atlantic	170
Maine Central	272	Wisconsin Central	462
Mexican Central	2,448	Total	21,560
Michigan Central	1,941		

DIVISIONS OF THE COMMISSION.

DIVISION OF FISH CULTURE.

For the present the Commissioner has retained immediate and personal direction of the work of artificial propagation and distribution, and to relieve himself as far as practicable from the details of administration has designated an inspector of stations and a superintendent of distribution.

In view of the increasing number of fish-cultural stations and their distribution over all sections of the United States, the services of an inspector will be in constant requisition, to maintain intelligent supervision of the stations and prevent irregularities and abuses.

The increasing production of the stations and the wider area over which the distribution is to be made render the services of a superintendent of distribution equally indispensable for the effective regulation of the car and messenger service.

These offices will constitute an integral part of the permanent organization of the personnel of the Commission, which should as soon as practicable be established by law and the classification of the service and the rates of compensation specifically prescribed.

The effective work of the stations is measured by the number of fish and eggs furnished each season for distribution. This is increasing each year, with a proportionate decrease in the cost of production.

The total production for the fiscal year 1887–'88 is given in the following table, and for convenience of reference is arranged by stations and species.

STATION REPORTS.

Fish and eggs furnished for distribution by the stations for the year ending June 30, 1888.

Stations.	Species.	Eggs.	Fry.	One year old.	More than 1 year old.
Alpena, Mich	Whitefish		18,000,000		
Baird, Cal	Rainbow trout	251,000	78,000	5,000	2,000
Battery, Md	Shad	17,408,000	62,641,000		
Bucksport, Me	Atlantic salmon	924,000			
Carp Ponds, Washington, D. C.	Carp for public waters		38,497		
	Carp for private ponds		131,656		
	Goldfish		5,019		
Central Station, Washington, D. C.	Shad	13,351,000	39,664,000		
	Rainbow trout		20,000		
	Lake trout		20,000		
	Brook trout		20,000		
	Whitefish	2,412,000	500,000		
Cold Spring Harbor, N.Y.	Rainbow trout		23,500		
	Landlocked salmon		34,000		
	Atlantic salmon		459,200		
	Sälbling	7,417			
	Whitefish		800,000		
	Lake trout		85,200		
	Brown trout		54,000		
Fort Washington, Md.*	Shad		1,475,000		
Gloucester, Mass	Codfish	189,432	627,040		
Grand Lake Stream, Me.	Landlocked salmon	345,000			
Northville, Mich	Whitefish	30,000,000			
	Lake trout	547,000			560
	Brook trout	215,000			45
	Rainbow trout	10,000		8,578	10
	Brown trout	5,000		1,000	10
	Loch Leven trout	50,000			
Steamer *Fish Hawk* (Delaware Bay).	Shad	8,336,000	30,851,000		
Wood's Holl, Mass	Codfish		8,843,600		
	Lobsters	196,000			614
	Flounders		220,000		
Wytheville, Va	Brook trout			11,235	6
	Rainbow trout	80,000		18,618	150
	Landlocked salmon		11,400		
	Redeye perch			3,675	30
	Black bass			550	
	Carp		4,521		733
	Goldfish		388		
Total		74,326,849	164,607,054	48,056	4,158

* At this station 70,249,000 shad eggs were taken and transferred to Central Station for hatching and distribution.

GLOUCESTER STATION, MASSACHUSETTS, E. M. ROBINSON, SUPERINTENDENT.

For several years the Commission has prosecuted steadily at the Wood's Holl Station experimental investigations looking to the development of methods and apparatus for hatching the floating eggs of the cod, haddock, and other important commercial species. Prior to 1885 the investigations had not passed the experimental stage, nor were the results obtained very encouraging. Each season, however, some advance to practicable methods was secured, the causes of failure being, one by one, ascertained and eliminated, and the conditions for success established.

In the winter of 1885–'86 Captain Chester, superintendent of the Wood's Holl Station, devised a modification of the McDonald tidal apparatus, by the use of which he succeeded in hatching a very considerable per cent. of the ova of the cod, and made it practicable to undertake extensive and systematic fish-cultural work with all the marine species affording buoyant or floating eggs.

In the winter of 1886–'87, some seven million young codfish were hatched out and turned into the adjacent waters of Vineyard Sound and Buzzard's Bay. The methods for the profitable conduct of fish-cultural operations with the marine species having been determined, it was decided by the Commissioner, Prof. G. Brown Goode, to establish an auxiliary station at some point on the coast of Massachusetts, north of Cape Cod. Gloucester Harbor was finally selected as the location for this station, for the reason that it is conveniently situated with reference to the fishing grounds, which are easily reached either by the vessels of the Commission or by the numerous fishing vessels which go out from Gloucester to the inshore grounds and to Ipswich Bay.

The Light-House Board, responding promptly and courteously to the request of the Commissioner, gave permission to locate the proposed station on Ten Pound Island. Plans were prepared, the site occupied, and arrangements to begin the construction of the station were perfected early in November, 1887. The work was pushed with the utmost dispatch; and, after vexatious delays on account of unfavorable weather, the station was completed and equipped ready for work on January 8, 1888.

The favorable season for work had then passed, and the extremely cold weather that immediately supervened and continued during January and February kept the temperature of the water in the hatchery below the point at which hatching operations can be successfully carried on. A temperature below 30° kills the eggs which have reached a certain stage of development, and when it descends to 28°, both old and young fish succumb and perish.

The season's work was valuable rather for the experience secured by the personnel employed, and the opportunity to study the necessary conditions for success in future operations, than for the material results obtained.

The total number of eggs obtained was 32,449,000; the average loss during incubation was 90 per cent.; the largest percentage of fish obtained from any single lot being 15 per cent.

WOOD'S HOLL STATION, C. G. ATKINS, SUPERINTENDENT.

This station is thoroughly equipped, as well for marine biological research as for the most extensive fish-cultural operations. Reference will be made here only to the fish-cultural work carried on during the year.

The investigations conducted in the biological laboratory by the regular and volunteer scientific assistants engaged in the study of the marine life of the waters adjacent to the station will be referred to under the head of inquiry in respect to food fishes and the fishing grounds.

As heretofore, the most extensive fish-cultural operations were with

The Codfish.

The total number of eggs taken was 30,088,000; the number of fry hatched, 7,822,000, the average percentage of production being 26 and the highest percentage 92½. The heaviest losses were during January, when the temperature of the waters was lowest. It would appear that a temperature of 30° or below is certainly fatal, both to fish and eggs.

The high percentage of production obtained in a number of cases would indicate that, when the necessary conditions of success are precisely ascertained, we may count on as good results with the codfish as with the shad and whitefish.

A number of experiments were made to transfer eggs from Gloucester to Wood's Holl, but without satisfactory results in any case. The young fish obtained were all planted in the waters of Buzzard's Bay and Vineyard Sound, in the vicinity of the station, with the exception of one lot of 894,000, which were delivered to the *Fish Hawk* for transfer to Long Island Sound and Chesapeake Bay.

The Winter Flounder.

An application by Prof. Benjamin Sharp, of the University of Pennsylvania, for material for the study of the embryology of the flat fishes was the occasion of some interesting experiments and observations on the breeding and artificial hatching of the common flounder.

This species was obtained in breeding condition early in February. The eggs were found to be extremely adhesive, and, if permitted, would aggregate in great lumps. The best success was obtained by spreading them thinly on panes of glass and placing them in a current of water. The total number of eggs collected was 1,179,000, from which were produced 320,000 fish, which were placed in the waters of Vineyard Sound.

Lobsters.

Of this species 2,092,000 eggs were taken, from which a consignment of 193,000 was sent to the Pacific coast. The rest were hatched and turned out in waters adjacent to the station.

Other species incubated at the station were as follows: Mackerel, scup, tautog, and sea bass. With each species fair results were obtained, showing that our present methods and apparatus can be applied to these fish when the necessity for their artificial reproduction becomes apparent.

St. Jerome Station, Maryland.

This station is occupied under a lease, which will expire in 1889. It is in the custody of a watchman. No active work has been carried on there during the present year, nor is it proposed to continue such in future. The station will be abandoned on the expiration of the present lease.

The Maine Stations.

The Maine stations are under the direction of Mr. C. G. Atkins as superintendent. During the present season the active direction of the work of the stations has been intrusted to the assistant superintendent, Mr. W. O. Buck, Mr. Atkins being in immediate charge of the Wood's Holl Station, and engaged in a series of investigations having for their object the improvement of methods and apparatus for hatching eggs.

The Schoodic Station.

This station, at Grand Lake Stream, is operated on the joint account of the United States, New Hampshire, and Massachusetts. Its object is the collection of the ova of the landlocked salmon for distribution, with the view to acclimation in other sections of the country where the waters offer favorable conditions. One-third of the eggs taken are reserved and hatched out and the young planted in Grand Lake Stream. The rest are allotted to the contributors to the expenses of the work, the quotas being proportioned to the amounts contributed by each of the participants. Under this arrangement the United States received 345,000, which were distributed as follows:

Iowa State Commission	10,000
Pennsylvania State Commission	10,000
New York State Commission	50,000
Michigan State Commission	50,000
Maine Commission	50,000
Vermont Commission	50,000

These consignments were all received in the very best condition. Ten thousand eggs were sent to Wytheville Station, Virginia, and the same number to Bucksport Station, Maine, to be hatched and held for a year in the rearing ponds before turning out into open waters. A

consignment of 50,000 eggs was sent to the Deutsche Fischerei Verein, in return for consignments of eggs of the European trout, and 10,000 eggs were forwarded to the Department of Agriculture of France, in response to request made through official channels.

BUCKSPORT STATION.

This station has for its object the collection and incubation of the eggs of the Penobscot salmon. When the eggs have reached such development as to permit safe transportation they are forwarded to their various destinations. The allotments are made to New England waters principally, since it is only in this section that we find streams affording suitable conditions. It is thought probable that salmon may be established in the Hudson River, and with this view it is proposed, in coöperation with the New York Commission, to continue the systematic stocking of its headwaters for several years longer. This station, like the Schoodic Station, is operated jointly by the United States and the State of Maine. The quota of eggs received by the United States the present season was 924,000, which were distributed as follows:

New York Commission	500,000
Rhode Island Commission	50,000
New Hampshire Commission	50,000
Vermont Commission	50,000
Massachusetts Commission	50,000
Maine Commission	148,000
Benj. Lincoln, for the Dennis River, Maine	40,000
Reserved for rearing at Craig's Brook Station	36,000

The fry obtained will be liberated in ponds and fed until they have attained a length of several inches before turning out into open waters. It must be confessed that the results obtained from planting the fry of the *Salmonidæ* are often disappointing. On the other hand, the results of stocking with fingerlings are immediate and assured, and it is proposed to extend this work as rapidly as the requisite facilities can be provided at the stations.

BAIRD STATION, LIVINGSTON STONE, SUPERINTENDENT.

This station was established in 1879 for the propagation of the Rainbow Trout (*Salmo irideus*), and from it has been drawn the eggs to furnish a stock of breeders for the Eastern stations. The species is now well established at Northville, Michigan, and Wytheville, Virginia, and in the breeding ponds of various State commissions. We will be able in future to meet all requests for eggs with the product of Eastern stations.

In view of this fact it has not been deemed advisable to continue the Baird Station in active operation. Accordingly, at the end of the season in June, the station was closed, and the serviceable property removed to the salmon station on the McCloud River about 4 miles below.

At first it was contemplated to transfer the magnificent collection of breeding fish to our Eastern stations, but this was found to be impracticable, and instructions were given to plant them in the tributaries of the McCloud River in the vicinity of the station. The number deposited was as follows: 2,000 large breeders, 5,000 yearlings, and 80,000 fry.

The number of eggs obtained during the season was 443,000, which were disposed of as follows:

To R. O. Sweeny, commissioner of fisheries for Minnesota, 38,000.

To Otto Gramm, commissioner of fisheries for Wyoming, 25,000.

To E. Cházari, commissioner of fisheries for Mexico, 33,000.

The latter shipment was made in response to a request of the Mexican Government through our Department of State.

The rest were retained to be hatched at the station.

McCLOUD RIVER STATION, CALIFORNIA, LIVINGSTON STONE, SUPERINTENDENT.

This station has not been in operation since 1883, the building being in charge of a custodian or watchman.

The necessity of artificial propagation with the view of keeping up the salmon fisheries of the McCloud River has become so evident that it was determined to resume work there. Accordingly Mr. Livingston Stone was instructed to have the buildings put in repair and all necessary arrangements made for the operation of the station during the fall and winter of 1888. During the spring of 1888 arrangements were made for placing the usual rack and bridge across the McCloud, to stop the salmon ascending the river and for raising water to the hatching house. In 1881 the original hatching house was carried away by the high water, and to avoid a recurrence of this the present one was built on a higher level, and pumps are used for raising the water for hatching. A 12-foot current wheel was placed in the river to furnish power to run the pumps. A spawning building and other appliances for taking eggs were constructed and made ready, and the hatchery and hatching apparatus put in order for receiving eggs. The work of preparation is progressing favorably, and the station will be ready for efficient work when the spawning season begins in August.

CLACKAMAS STATION, OREGON, LIVINGSTON STONE, SUPERINTENDENT.

Provision was made for the establishment of a salmon hatchery on the Columbia River, its tributaries or their branches, by the sundry civil bill, which became a law March 3, 1887, the sum of $10,000 being appropriated for this purpose. The act further provided "that if in the opinion of the United States Fish Commissioner the existing laws of Oregon and Washington are not sufficient for the protection of salmon in the Columbia River and its tributaries, this appropriation shall not be available until the legislatures of the State of Oregon and Washington Territory shall have enacted such additional legislation as in the

opinion of the Fish Commissioner shall be necessary to protect the salmon from improper capture and destruction."

The then Commissioner of Fisheries, Prof. G. Brown Goode, after satisfying himself that the existing legislation of Washington and Oregon was in substantial compliance with the provisions of the act of appropriation, made arrangements to carry the instructions of Congress into effect.

Accordingly Mr. Livingston Stone, who had previously been in charge of the salmon work on the McCloud River, California, was assigned to duty and instructed to proceed to the Pacific coast and establish a salmon-breeding station somewhere on the Columbia River or its tributaries.

He was instructed if possible to secure the site on the Clackamas River, which was the property of the Washington and Oregon Fish Propagating Company, and then occupied under lease by the State fish commission of Oregon.

This was accomplished after various difficulties and delays, the fish propagating company having generously conveyed their property in fee simple to the United States and the Oregon commissioners surrendering their lease in consideration of reimbursement for expenditures incurred in the construction and equipment of the station.

It is confidently expected that arrangements for transfer and occupation will be completed in time to begin the collection of eggs the ensuing season and thus inaugurate a work which will doubtless in time contribute much to the improvement of the salmon fisheries of the Columbia River.

Michigan Stations, F. N. Clark, Superintendent.

Northville station, Michigan.

The operations at this station during the present season have been conducted, as heretofore, under the immediate direction of Mr. F. N. Clark, and include the propagation and distribution of the whitefish, lake trout, brook trout, California trout, brown trout, and Loch Leven trout.

The results obtained during the season with the different species have been very satisfactory, and this is especially so with reference to the California trout and brook trout.

Whitefish.

The hatching of the eggs of the whitefish at this station has been intermitted during the present year, and it is proposed to confine this work in the future exclusively to the Alpena Station. Of the eggs obtained, however, 30,000,000 were shipped to Northville where they were overhauled, repacked, and forwarded to applicants, 15,000,000 having been sent to the Pennsylvania commission, 10,000,000 to the Minnesota commission, 4,000,000 to Central Station, Washington, District of Co-

lumbia, and 1,000,000 to Fred Mather, Cold Spring Harbor, New York, which were hatched out and deposited in waters of Long Island. Reports received indicate that the eggs reached their destination in splendid condition in every instance.

Lake Trout.

After an intermission of one year the collection of the eggs of this species was resumed the present season, the total number collected being 1,300,000 eggs. The first eggs were taken on October 15, and the season closed about November 20. During the winter 462,000 eggs were forwarded to State fish commissions, 45,000 to the National Fish Culture Association, London, England, and 40,000 to Central Station, Washington, District of Columbia. Of the balance 50,000 fry were hatched out and retained at the station. On December 16, 1887, 560 2-year-old lake trout were planted in Long Lake, Alpena County, Michigan.

Brook Trout.

Very gratifying success has attended the work with this species the present year, the total production of eggs being 274,600, of which 175,000 were forwarded to State commissions and 40,000 to Central Station, Washington, District of Columbia. Of the remainder 45,000 fry were hatched out and retained at the station for future distribution. All of the shipments reached their destination in very good condition.

Rainbow Trout.

The best results received from this species in the history of the station, both in the number of eggs and the percentage of good eggs taken, have been obtained the present season. The total number of eggs taken was about 325,000, of which 225,000 were good. It is the intention to hold and rear as many as possible of this fish until they are able to take care of themselves, when they will be distributed to suitable waters Very few of the eggs, therefore, were shipped the present year, only one lot of 10,000 having been forwarded to the Castalia Club, of Castalia, Ohio. The first eggs were taken on December 8, and the season closed May 4. The total production of fry was 157,000, which were retained at the station. During the season 8,578 one-year-old fish were distributed to open streams, lakes, and applicants for ponds in Michigan, Missouri, Ohio, Indiana, Arkansas, Tennessee, and Kansas, the greater part of the distribution having been done by Fish Commission car No. 1.

Brown Trout.

Of this species 26,763 eggs were taken from fish raised from the original stock of eggs received in the spring of 1883 from Germany. Five thousand of these were forwarded to the Michigan commission, and 18,000 retained at the station. The success with this fish in the fry state has not been very satisfactory, the mortality being considerable during the first 3 months. After this time, however, they feed well and grow rapidly, the loss being almost imperceptible. On December 20, 1887, 500 one-year-old trout were forwarded by car No. 1 to the Michi-

gan Fish Commission, and in January, 1888, a similar number of yearlings were planted in the north branch of Tobacco River, Michigan.

Loch Leven Trout.

This fish promises to become very popular for pond culture, being very hardy, and not likely to be attacked by fungus. During the season 176,730 eggs were taken from 600 fish of this variety. Of this number 50,000 were forwarded to State fish commissions and 85,000 hatched out and retained at the station for future distribution.

ALPENA STATION, MICHIGAN.

Whitefish.

A very fair season's work has been done with this fish, notwithstanding the fact that no eggs have been obtained from Lake Erie, on which we had previously relied for our greatest supply. The collections this year were made in Lakes Huron and Michigan, the eggs for shipment being forwarded to Northville, and those to be hatched out held at this station. Of the 18,000,000 fry hatched out, 15,000,000 were deposited in Lake Huron, 1,000,000 in Lake Michigan and 2,000,000 in Long Lake, Michigan. This station is also under the immediate direction of Mr. F. N. Clark.

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

Rainbow Trout.

The most noteworthy features in the operation of the station during the season were the increase in the production of eggs of the Rainbow trout and the extensive distribution of yearling fish of this species. The total production of eggs for the season was 300,500, as against 220,500 during the previous season. Of the number of eggs produced, 75,700 were lost in incubation, 45,000 forwarded to foreign governments, and 35,000 to the Commissioners of Fisheries of New Hampshire and West Virginia. The total number of fry released in rearing ponds at the station was 99,870. Fifteen hundred and thirty-five yearling trout were distributed to seventeen applicants for ponds in Virginia, North Carolina, and Tennessee, 11,875 to streams in Virginia and North Carolina, and 5,208 were forwarded to Central Station, Washington, District of Columbia, for distribution. There were also supplied to two applicants for ponds in Virginia 150 trout 3 years old.

The following is a summary of production and distribution of eggs and yearlings of this species:

Total number of eggs produced at station		300,500
Total number of eggs received from other stations		15,000
		315,500
Aggregate losses during incubation	75,700	
Number of eggs shipped from the station	80,000	
		155,700
Total number of fry hatched out		159,800
Losses of fry up to time of transfer to rearing ponds		59,930
Total number released in rearing ponds		99,870

DISTRIBUTION.

To the National Fish-culture Association, London, England	eggs..	25,000
To C. S. White, Commissioner of Fisheries, Romney, West Virginia	do...	10,000
E. B. Hodge, Commissioner of Fisheries, Plymouth, New Hampshire	do...	25,000
To the Government of Switzerland	do...	20,000
		80,000
To eighteen applicants for ponds in Virginia, North Carolina, and Tennessee, yearlings		1,535
To streams in Virginia	yearlings ..	6,375
	3 years old..	150
To streams in North Carolina	yearlings..	5,500
To Central Station, Washington, District of Columbia, for distribution	do...	5,208
		18,768

Brook Trout.

The first eggs ever procured from the brook trout at this station were taken in October, 1887. In consequence, however, of heavy mortality in the eggs during incubation and subsequently in the young, only 2,966 fry were saved out of 25,000 eggs collected at the station and 10,700 fry received from Northville, Michigan. These were transferred to rearing ponds at the station. The number of yearlings of this species forwarded from the station during the season was 10,735, as against 3,238 the previous year. Of this number 1,010 yearlings were supplied to nine applicants in Virginia and Tennessee, 7,225 planted in streams of Virginia, and 2,500 forwarded to Central Station, Washington, District of Columbia, for distribution.

Statement of production and distribution.

Number of eggs produced at the station	25,000
Aggregate losses during incubation	16,022
Number of fry produced at station	8,978
Number of fry received from other stations	10,700
	19,678
Losses to time of transfer to rearing ponds	16,712
Released in ponds	2,966

DISTRIBUTION.

To nine applicants in Virginia and Tennessee	yearlings..	1,010
To streams in Virginia	do....	7,225
To Central Station, for distribution	do....	2,500
		10,735

Black Bass.

No arrangements having been made with a view to the production of this species for distribution, such numbers as are required to meet occasionally urgent demands are procured by collection from waters in the vicinity of the hatchery. During the season there were obtained in this manner 550 yearling small mouth black bass, of which 300 were

supplied to three applicants in the State, 200 to streams in Bath County, Virginia, and 50 forwarded to Central Station, Washington, District of Columbia.

Red-eye Perch.

Such distribution of this species as has been made up to this time has also been the result of collections from streams convenient to the station. The total number collected the present year, was 6,628; 3,523 of these were retained at the station, 580 supplied to five applicants for ponds in Virginia, 400 planted in the headwaters of the Shenandoah River, Virginia, 600 in streams in Bath County, Virginia, and 1,525 forwarded to Central Station, Washington, District of Columbia, for distribution.

Lake Trout.

Twenty thousand fry of this species were received on April 6, 1888, from Central Station, Washington, District of Columbia. In this lot there was a loss of 7,873, leaving 12,127 healthy fry, which were released in rearing ponds at the station.

Brown Trout.

On March 23, 1888, there was received from Cold Spring Harbor, New York, a lot of 15,263 eggs of the brown trout, from which not very satisfactory results were obtained. The total number of fry produced was 14,394, there being a loss in incubation of only 869 eggs. There was, however, heavy mortality in the fry, which proved a total loss.

Land-locked Salmon.

One lot of 20,000 eggs of this fish was received on March 1, 1888, from Grand Lake Stream, Maine. The loss of eggs during incubation and the subsequent loss of fry reduced the number to 11,400 fish, which were deposited in the headwaters of the Shenandoah River, Virginia, May 16, 1888.

German Carp.

The total production of this fish at the station was about 600,000. There were also received from the carp ponds, Washington, District of Columbia, during the summer of 1888, 440,000 fry, which were released in rearing ponds. Not very favorable results, however, have been obtained the present year in the attempt to hold and rear this species at the station. During the fall and winter of 1887 4,024 six-months-old carp were furnished to eighty-one applicants and 733 two-year-olds to thirty-eight applicants in Virginia and Tennessee, and 500 planted in streams in Augusta County, Virginia.

Gold Fish.

The total production of this species for the year was 10,000, which were released in rearing ponds at the station. During the fall of 1887 388 gold fish were furnished to seventy-eight applicants in Virginia, Maryland, Alabama, Tennessee, North Carolina, Mississippi, Louisiana, Georgia, and Texas.

Through the courtesy of the management of the Norfolk and Western Railroad Company, the hatchery is now regarded as a flag station for all local freight trains.

FORT WASHINGTON STATION, MARYLAND.

This station was in charge of Mr. S. G. Worth and was operated under about the same general conditions as in the previous year, and the result of the season's work exceeded the most successful preceding season by 21,000,000 eggs, being the largest ever known there.

The hatchery building being very small, it was supplemented early in the season by a 14-foot army hospital tent adjoining, and used for storing needed apparatus and material.

An important feature was the successful operation of the automatic hatching jars with their tops off. The manipulation proved easy and advantageous, as very nearly all the eggs were transferred to Central Station, Washington, before the hatching period was reached. In 1887 there were seven expert spawntakers, while this season there were six and two apprentices, and the increased volume of work was probably due to a more complete organization. New territory was covered in the direction of Alexandria, and a considerable number of eggs were secured in the vicinity of Fort Foote.

The eggs were kept in the jars thirty-six hours before being shipped to Central Station, the line of the young shad being perfectly plain to the naked eye. Daily shipments were made, and, as usual, the eggs were placed on wire trays covered with cheap, loosely woven cotton cloth. The shipments of eggs to Washington during 41 days amounted to 70,249,000 eggs; during 22 days the shipments were 1,000,000 to 3,000,000 eggs daily, and were in charge of Capt. P. T. Yeatman.

The increase over the season of 1887 was more than 33 per cent. The launch *Blue Wing* was an important factor in the prosecution of the work, and her crew made a gain of about 7,000,000 eggs from the gill nets.

Operations began the second week of April and closed June 2, and in that time, the work having been entirely confined to shad, 81,177,000 eggs were taken.

BATTERY ISLAND STATION, MARYLAND, W. DE C. RAVENEL, SUPERINTENDENT.

SEASON OF 1887.

The season opened May 1. Some eggs were taken prior to this date, but owing to the low temperature of the water the development was not normal, and but a small percentage hatched.

Owing to dissatisfaction on the part of the fishermen, the large seine attached to the station was not operated during the season. It was deemed good policy to rely upon the fishermen for our supply of eggs, and the result justified the expectation.

The steamers *Fish Hawk* and *Halcyon* were assigned to work in co operation with the station, and contributed materially to the large results obtained.

On May the 2d the *Fish Hawk* anchored off Bull Mountain, in easy reach of the seines and gillers, where she remained, conducting operations independently, and transferring eggs to the shore station when the collections exceeded the capacity of her hatching apparatus, 1,330,000 eggs being so transferred.

The *Halcyon* worked in connection with the station, making daily trips to the fishing grounds, and transferring the eggs collected to the shore station; 8,402,000 eggs were thus collected. The services of this steamer were also utilized in transferring fry to the Chester, Elk, and Sassafras rivers, the total number transferred aggregating 3,000,000.

The percentage of ripe shad was unusually large this season. On the night of May 7, 4,000,000 eggs were taken, and a much larger number might have been obtained had it been practicable to visit all the nets.

The total number of eggs received at the station during the season was 60,569,000. 918,000 eggs were transferred to car No. 3, and 42,712,000 fry hatched at the station. Of these, 11,850,000 were placed in waters adjacent to the station and 29,882,000 distributed to other waters, as shown by the tables of distribution in the appendix.

SEASON OF 1888.

A programme for the conduct of the shad hatching on the Susquehanna for the season was submitted by Mr. Ravenel, the superintendent, about March 1. The same was approved and an allotment of money made for this work. The work of preparation was commenced immediately.

During the previous season it had been shown that the hatching facilities at the station were inadequate and the apparatus employed cumbrous and unsatisfactory. Automatic hatching jars were substituted for the cones, and a new building, 60 by 30 feet, was equipped with the new jars. A supplementary station was also established at Havre de Grace, equipped with one hundred jars, and having a capacity of ten million eggs at one time, doing away with the risk and inconvenience of transferring fry intended for shipment to distant waters from the station at Battery Island. Few good eggs were obtained prior to April 23. One week afterwards 25,000,000 good eggs had been taken. The station closed June 4, with a total production of 105,315,000 eggs. Of these, 17,400,000 partially developed eggs were transferred to cars Nos. 2 and 3. The remainder yielded 62,641,000 fry, which were distributed as shown in the tables in appendix.

The results this season are far in excess of any previous year, and this in the face of most unfavorable weather during the height of the season.

WASHINGTON CARP PONDS.

The demand for German carp continues from many States, and much interest is manifested in this species. Dr. R. Hessel is in immediate charge of the ponds, which have been under his care for a number of years. The surface area of the series of ponds amounted to a total of 23.50 acres.

The east pond, known as Babcock's Lake, was filled in, in order to strengthen the foundations of the Washington Monument, work being commenced on it about April 1, 1888. By the filling of this pond the Commission suffered a loss of 6½ acres of the above water area, which necessitated the construction of a new pond, and it was determined to establish it near the office on the north side of B street, where there was already a pool, requiring but little excavation, except what was needed to remove a dense growth of vegetation. A 12-inch valve was placed in position to regulate the inflow of water which comes from the foot of Observatory Hill. This pond has a surface area of about 3 acres.

In October, 1887, the regular drawing off of the ponds began, and by December 31 the product of the several ponds was ascertained to be 235,687 German carp, 6,100 Japanese goldfish, and 1,500 tench.

About June 10 Superintendent Hessel had artificial spawning beds prepared for the carp in small ponds, and the ova, after the fish had deposited them, were transferred to large tanks, the result of which was the production of 600,000 fry. Five hundred thousand of these were shipped to the Wytheville, Virginia, Station, and 100,000 were liberated in Aquia Creek, a tributary of the Potomac River.

About the 1st of May, 1888, a large number of shad fry were transferred from Central Station to the West Pond, which is connected with the Potomac, and separated from it by a water gate, where they would not be disturbed by other fish or destructive animals during the natural period of their river life. It was ascertained by observation and by measurement that the young shad grew rapidly until towards the middle of August, when the growth was noticed to be slower; a month later it almost ceased, and from that time on no growth at all was observed.

On October 27 the sluice of the pond containing the fish was opened and about 800,000 young shad, which had attained a growth of from 2½ to 3 inches in a pond of 6¾ acres, were liberated and started on their way to the sea.

CENTRAL STATION, WASHINGTON, D. C.

The work of this station is more general in its nature than that of any other station of the Commission. It includes the hatching of the eggs of *Salmonidæ*, including whitefish, intended for eastern waters; the distribution of fishes of the carp family, bred at the carp ponds, near the Washington Monument, and of fishes of the Mississippi Valley, transferred to eastern waters.

In connection with Fort Washington as an auxiliary station, it is the great hatching and distributing station for Potomac River shad.

It is also a central point for repair and equipment of the vessels of the Commission, and fish cultural and scientific equipment.

It is the aim of the Commission to constitute it also, as rapidly as circumstances will allow, a point for experiment, development, and illustration of the methods of fish culture and of scientific inquiry. This will include the development of aquaria, experimental ponds, etc., as a means of observation and determination of the habits and life histories of fishes, as also models of fish-cultural apparatus, both historical and representative.

During the earlier part of the fiscal year, all work appertaining to the receipt, shipment, and hatching of fry was in charge of Mr. William F. Page; the custody of the property of the station and shipment of carp devolving on Mr. J. E. Brown.

The Commissioner upon assuming office found a partial reorganization necessary, and Mr. William P. Seal was appointed superintendent.

The necessity imposed by Congress of making an exhibit at the Ohio Valley Centennial Exposition, held at Cincinnati, Ohio, compelled the transfer of Mr. Seal to that point to establish and operate an exhibit of aquaria as a part of the general exhibit of the Commission, under the charge of Capt. J. W. Collins, chief of the fisheries division, and Mr. S. G. Worth was made superintendent of Central Station.

The operations of the station are shown in the tabulated statements, which, with the exception of the shad, were prepared by Mr. Page, that of shad having been prepared by Mr. Seal. During the present fiscal year adult fish and fry and eggs, as follows, have been distributed through Central Station: German carp, 225,070; goldfish, 10,037; rock bass, 960; tench, 2,175; rainbow trout, yearlings and adults, 5,026, fry, 20,000; brook trout, adults and yearlings, 2,989, fry, 20,000; lake trout, 20,000; shad fry, 39,664,000; shad eggs, 13,351,000; whitefish eggs, 2,912,000; rainbow trout eggs, 57,632; besides several other kinds of fish in small numbers.

COLD SPRING HARBOR STATION, NEW YORK, FRED MATHER, SUPERINTENDENT.

This station is leased and operated by the New York State Fish Commission, through whose courtesy operations in the hatching and planting of salmon, whitefish, shad, and several varieties of the trout, etc., are conducted each season by the U. S. Fish Commission, under the immediate direction of Mr. Fred Mather, superintendent. During the past year a new hatchery, with complete hatching equipment and increased facilities for efficient work, was constructed by the New York commission, at a cost of about $5,000.

Atlantic Salmon.

In January, 1888, 500,000 eggs of this species were received from Bucksport, Maine, only 300 being dead on arrival. Losses in incuba-

tion, and otherwise, reduced this number to 459,000 fry, of which 439,000 were planted in the tributaries of the Hudson River, and 20,000 on Long Island. There seems to be no doubt of the suitability of these waters for the salmon, and with proper protection, by the enforcement of the State laws now in effect, the success and increase of this species in the waters of the Hudson is assured.

Sälbling.

Twenty-five thousand eggs of this species, in two lots, were received at the station during January and March, 1888, from Herr von dem Borne, Berneuchen, Germany, 10,000 being dead on arrival. Three thousand good eggs were shipped to Mr. E. B. Hodge, commissioner of fisheries, Plymouth, New Hampshire, and 3,000 to the U. S. Fish Commission station at Northville, Michigan. The balance, which were retained at the station, owing to heavy mortality in the eggs and fry, proved almost a total loss; only a small number of fry having been forwarded to the New York hatchery, at Caledonia, New York.

Whitefish.

On March 22, 1888, 1,000,000 whitefish eggs were received from the Northville Station, Michigan. Of this number, 50,000 were lost in incubation, and 150,000 fry escaped into the trout ponds at the station. The remainder, 800,000 fry, were planted in lakes on Long Island, New York.

Lake Trout.

One case containing 90,000 eggs of this species was received on December 28, 1887, from Northville Station, Michigan. The losses during incubation and afterward reduced this number to 85,200 fry, which were planted in lakes in Sullivan, Putnam, Queens, and Warren Counties, in the State of New York.

Brown Trout.

Very satisfactory results have been obtained from the planting of this fish. During the past season two lots of eggs of this species were received from Herr von Behr, of Schmoldow, Germany, and Herr von dem Borne, of Berneuchen, Germany. These were divided equally among the State commissions of New York, Wisconsin, Michigan, Virginia, and Minnesota; 19,000 eggs being forwarded to each. From the allotment to Cold Spring Harbor and 40,000 eggs taken from brood fish at the station, 55,500 fry were produced. One thousand five hundred of these were reserved at the station and the remainder deposited in streams, lakes, etc., in New York State.

Land-Locked Salmon.

In March, 1888, 35,000 eggs of this fish were received from the Grand Lake Stream Station, Maine. The loss in transfer and hatching subsequently amounted to only 1,000, leaving 34,000 fry, which were distributed to lakes and other waters in New York and New Jersey.

Rainbow Trout.

Two lots of eggs of this species were received during the month of March, 1888, from Baird Station, California, 24,000 in all being good on arrival. From this number, in addition to 1,000 eggs taken at the station, 23,500 fry were produced, which were distributed to applicants and deposited in suitable waters in New York State; none of the fry being retained at the hatchery.

Shad.

During the spring of 1888 the experiment was made of shipping shad eggs by express, 5,000,000 having been forwarded in this manner to the Cold Spring Harbor Station. The eggs reached destination in good condition, but the losses in incubation were considerable, only 350,000 fry being produced, which were deposited in the Hudson River at Albany, New York. The mortality in hatching was no doubt attributable to the use of a new pine supply pipe, and not to bad or unhealthy eggs, which were found to be in very good condition on arrival.

NEOSHO STATION.

During the summer of 1887, Mr. Marshall McDonald, acting under instructions from Prof. S. F. Baird, Commissioner, made an exploration of the Ozark region of southwest Missouri, with the object of ascertaining a suitable site for a fish-cultural station, where the propagation of species of fish suited to the streams of Missouri, Arkansas, and Kansas, could be conducted to advantage, and thus adequate provision made for a section of the country too remote from the existing stations of the Commission to be supplied to advantage from them. Mr. McDonald, after completing the investigation, submitted a report to the Acting Commissioner, Dr. J. H. Kidder, recommending the selection of a site in the suburbs of Neosho, Missouri, for reasons fully set forth in the report.

On December 21, 1887, the United States Senate, by resolution, directed the Commissioner of Fisheries "To report to the Senate at as early a day as practicable what measures, if any, had been taken for the selection of a site for, and the location of, a fish-cultural station of the U. S. Fish Commission in the Ozark region of southwest Missouri, with the views and recommendations of the Commissioner and the cost thereof." To this resolution the Acting Commissioner, under date of January 4, 1888, replied as follows, transmitting at the same time a copy of Mr. McDonald's report:

U. S. COMMISSION OF FISH AND FISHERIES,
Washington, D. C. January 4, 1888.

SIR: In compliance with a resolution of the Senate, agreed to on the 21st December, 1887 (a copy of which is appended hereto), I have the honor to report that the availability of the Ozark region in southwestern Missouri for a fish-cultural station was made the subject of a personal investigation last summer by Mr. Marshall McDonald, under instructions from the late Commissioner Baird, modified and extended by Acting Commissioner T. B. Ferguson.

It appears from Mr. McDonald's report of his investigation that the neighborhood of the city of Neosho, in Newton County, Missouri, affords more favorable conditions than any other of the localities examined; and, furthermore, that the Neosho City authorities have guarantied to the United States the free use of some 17 acres of land and of a plentiful supply of excellent water for the purpose above named.

Should it be the pleasure of Congress to direct the establishment of a station for fish culture in this locality, the probable cost is estimated to be as follows:

Construction of buildings, ponds, and appliances	$8,000
Maintenance for fiscal year beginning July 1, 1888	5,000
Total	13,000

Very respectfully, your obedient servant,

J. H. KIDDER,
Acting Commissioner.

Hon. JOHN J. INGALLS,
President pro tempore United States Senate.

IN THE SENATE OF THE UNITED STATES,
December 21, 1887.

Resolved, That the Fish Commission is hereby directed to report to the Senate at as early a day as practicable what measures, if any, have been taken for the selection of a site for, and the location of, a fish-cultural station of the U. S. Fish Commission in the Ozark region of southwest Missouri, with the views and recommendations of the Commission and the probable cost thereof.

Attest:

ANSON G. McCOOK,
Secretary.

[Extract.]

Report in reference to the establishment of a fish-cultural station of the U. S. Fish Commission in southwest Missouri, by Marshall McDonald.

The object of a station in the Ozark region is to make adequate provision for stocking the waters of Missouri, Kansas, Arkansas, Texas, New Mexico, Arizona, Louisiana, and West Tennessee with the species of food-fishes adapted to the natural conditions afforded by the waters.

Only a limited area of the extensive section of country under consideration affords waters suitable for acclimation of the trout or other salmonidæ.

Climatal conditions would largely restrict the work of the proposed station to the pond culture of the tench, bass, rock bass, carp, and other species, native or introduced, which are adapted to the warmer waters of this section, and the distribution of the same in very large numbers to the streams, lakes, and ponds of the Southwest.

The necessary conditions to be fulfilled in the establishment of such a station are as follows:

(1) The location should be central, with reference to the section in the interest of which the station is to be operated.

(2) It should be in convenient communication by railroad with all portions of the area over which its operations are to extend.

(3) The water supply for ponds and hatching houses should be practically unlimited, so that there should be no restriction in the free use of water in the most extensive work that it might be expedient to undertake.

(4) The water should be spring water, remaining clear and of even temperature under all circumstances of weather or season, and with such head or fall as to permit a gravity supply to hatchery and ponds; thus eliminating one serious element in the cost of operating a station where circumstances render it necessary to lift the water by pumping.

The conditions thus imposed limited the location to some point in the Ozark Hills, a region abounding in magnificent springs, forming the headwaters of clear streams, which on the one side flow into the Missouri River and on the other into the Arkansas. It is, moreover, traversed through its entire extent from northeast to southwest by the Frisco road, which, with it connections, puts this section into convenient communication with all parts of the Southwest which would draw their supplies of fish from the proposed station.

An exhaustive examination was made of all localities which offered reasonable promise of affording the requisite facilities for a station. Springs affording unlimited supply of water were numerous. Some were excluded by reason of inaccessibility; others, presenting the advantages of convenient location and abundant water supply, were excluded on account of the difficulty or impracticability of controlling the water supply so as to secure sufficient head or fall of water to utilize it for the supply of ponds and hatchery.

The choice of locations was finally restricted to four, viz: The Percy Cave Spring, in the vicinity of Springfield, Missouri; the Jones Spring, immediately on the Gulf road, 4 miles south of Springfield; the Mammoth Springs, Arkansas, just south of the Missouri line, and immediately on the line of railroad leading from Springfield to Memphis, Tennessee, and the magnificent group of springs in the immediate vicinity of Neosho City, Missouri.

The springs in the vicinity of Springfield impressed me most favorably, but careful examination made it evident that the water supply was entirely inadequate to afford the amount required to feed the extensive system of ponds that will be required in the development of the station.

The choice of location lies, therefore, between Mammoth Springs, Arkansas, and the site offered by the city of Neosho. Both stations furnish unlimited water supply, capable of easy control and utilization. Each is advantageously situated, immediately on a line of railroad, and thus affords equal convenience and facilities for distribution. In either case the site for buildings and ponds and the necessary water franchise will be donated to the United States Government free of charge.

The location at Neosho, however, presents the following important advantages:

It is more centrally situated with reference to those sections to which the distribution of fish is to be made, and the station can therefore be more economically operated than the one at Mammoth Springs. The amount of land available for ponds is ample, and lies conveniently for their construction at a moderate expenditure of labor and money.

The ground available for this purpose at the Mammoth Springs location is very limited and lies so unfavorably, that the construction of the series of ponds required can be accomplished only under considerable difficulty and at a very considerable expenditure of money. Indeed, in my judgment it will be impracticable at the Mammoth Springs location by any reasonable expenditure to secure the development of ponds necessary to carry on pond culture on the scale it will be necessary to conduct the operation of the station. For these reasons I respectfully recommend the selection of the site proposed to be donated to the United States Government by the city of Neosho.

Seeking to influence the selection of location by the manifestation of a liberal spirit, the corporate authorities have already voluntarily executed an agreement to convey to the United States Government title to 17 acres of land within the corporate limits of the city, and having upon it a magnificent spring flowing nearly 600 gallons per minute. This supply is ample for all needs, immediate or prospective; but they further agree, if the supply is not ample for all purposes, to guaranty to the United States the franchise of another spring flowing several hundred gallons of water per minute, and to convey it to the ponds and hatchery without charge to the U. S. Fish Commission. We could hardly ask or desire more liberal concessions than have been voluntarily tendered, nor can we probably find another location so advantageously situated for convenient and economical work.

The agreement of the mayor and city council, properly executed and attested, is herewith submitted; also a plat of the tract of land which it is proposed to convey to the use of the U. S. Fish Commission.

The appropriation requisite for the erection of a new station must be specifically made by Congress; and no steps looking to its occupation can properly be undertaken in advance of such action. But assuming from the obvious necessity and importance of such a station in the development of the work of the Commission, and from the active and general interest that the mere suggestion has awakened, that the matter will be brought to the attention of Congress at an early date, I respectfully submit the following estimates of the cost of erecting and operating the station, as follows:

For the construction of hatchery, quarters, inclosures, and ponds..... $8,000
For the conduct of the station for the fiscal year beginning July 1, 1888, salaries, temporary services, maintenance, repairs, etc 5,000

As there is no period of the year in which outside building operations may not be carried on, it is desirable that the appropriation for construction may be made immediately available, the buildings and a sufficent number of ponds for immediate use may be completed early in the summer of 1888, and the station fully equipped for extensive work without any material delay.

M. McDONALD,
In charge of Fish Culture.

On June 9, 1888, the Secretary of the Treasury transmitted to Congress an estimate from the U. S. Commissioner of Fisheries of an appropriation for the establishment and maintenance of a fish-cultural station in the Ozark region of Missouri, as follows:

TREASURY DEPARTMENT, *June* 9, 1888.

SIR: I have the honor to transmit herewith, for the consideration of Congress, copy of a communication from the U. S. Commissioner of Fish and Fisheries of the 8th instant, submitting an estimate for an appropriation of $13,000 for the establishment and maintenance of a fish-cultural station in the Ozark region, in southwest Missouri.

Respectfully yours,

C. S. FAIRCHILD,
Secretary.

The SPEAKER OF THE HOUSE OF REPRESENTATIVES.

U. S. COMMISSION OF FISH AND FISHERIES,
Washington, D. C., June 8, 1888.

SIR: I have the honor to request that you will transmit to Congress, for consideration by the Committee on Appropriations, an estimate for appropriation for the establishment and maintenance of a fish cultural station of the U. S. Fish Commission in the Ozark region, in southwest Missouri, as follows:

Construction of buildings, ponds, and appliances..... $8,000
Maintenance for fiscal year beginning July 1, 1888..... 5,000

13,000

The necessary explanations to accompany estimate are embraced in Senate Miscellaneous Document No. 23, copy of which is respectfully transmitted.

Very respectfully,

M. McDONALD,
Commissioner.

The estimate thus transmitted was provided for in the sundry civil bill, which was pending at the close of the fiscal year 1888.

DULUTH STATION.

Legislation looking to the establishment of a station for hatching whitefish and lake trout in the vicinity of Duluth, Minnesota, was initiated by a petition from the fishermen of Lake Superior, who had "formed themselves into an association to promote their mutual interests, their aims and objects being a better understanding of the fishing laws of the several States, a uniform action among the fishermen concerning the regulation of the size of meshes of all nets, and the enforcement of the laws concerning them, and to secure the artificial propagation of the eggs of both whitefish and lake trout by a fish hatchery." They further pledged themselves to aid, both by their labor and by the use of their fishing plants and men, the work of collecting eggs for propagation. This petition was accompanied by assurances that if the necessary appropriation for the establishment of a hatchery should be made, the people would donate a suitable site with an ample supply of good water.

The petition was forwarded to the Hon. Knute Nelson, Representative from the district in which the city of Duluth is situated, who, after conference with the Commissioner, brought the matter to the attention of the Committee on Appropriations, and secured the introduction of an item into the sundry civil bill appropriating $10,000 "For the establishment of a fish hatchery on Lake Superior at or near Duluth, Minnesota: *Provided*, That the city of Duluth shall furnish without charge a suitable site for said hatchery." This bill became a law August 4, 1886.

Of the several sites available, that offered by the Lakeside Land Company on the Lester River, in the northern suburbs of the city, was after examination found most desirable, and was accepted. The site thus conveyed to the United States in fee simple contains about 6 acres lying on the shore of Lake Superior and bounded on the north by Lester River. In addition to the donation of land for the station, the Lakeside Land Company made a cash contribution of $1,000 towards the expense of introducing a supply of water by gravity from Lester River.

Jurisdiction over the land was ceded to the United States by act of the State legislature, approved March 2, 1887. The validity of title in the lands thus conveyed was duly certified by the Attorney-General on March 10, 1888.

In November, 1887, after personal examination of the ground by the assistant in charge of fish culture, the location of the hatchery building was definitely marked out, and the general plans for the development of the station indicated. Plans and specifications for the hatchery building and for the steam and water distributing plant were prepared during the winter and following spring, and, after due advertisement, the building let to contract on May 21, 1888. Work was in satisfactory progress at the close of the fiscal year, and it is expected to have the station completed and equipped for work the ensuing winter.

STEAMER FISH HAWK.

SEASON OF 1888.

Previous to leaving for the Delaware River, the steamer *Fish Hawk*, commanded by mate James A. Smith, U. S. Navy, was supplied at Baltimore, Maryland, with additional hatching apparatus; two hatching tables were placed on each side of the hatching deck, with a capacity of thirty-seven McDonald automatic jars each, the water supply being furnished by two good-sized wooden tanks, placed on the upper deck; the hatching facilities were thus increased so that about 12,000,000 eggs could be under process of hatching at one time.

Spawn was secured from five haul seines, operated on the New Jersey side of the river below Gloucester City, and from gillers near by. The first eggs were taken May 7, and operations continued until June 5, when orders were received to cease collecting spawn; 48,607,000 shad eggs were collected, of which 1,800,000 were delivered to the New York Fish Commission, 4,397,000 to the Delaware Fish Commission, and 2,139,000 were forwarded to Utah, and hatched en route, on Fish Commission car No. 2, which is equipped with the McDonald closed jar, it being the only hatching jar that can be used on this car, which may be called a traveling hatching station.

Thanks are due the Pennsylvania State Fish Commission for the assistance rendered in transporting fry by messenger to the upper stretches of the Delaware, where the numerous beautiful pools afford protection to the young shad during the period of their river life. Sixteen million eleven thousand fry were deposited in the upper waters of this river, and 14,840,000 were liberated in the vicinity of Gloucester City, New Jersey.

It is worthy of mention here that during the evening of May 29 a violent thunderstorm occurred, lasting from 6 o'clock until midnight. The hatching jars at this time contained 4,481,000 eggs, in apparently excellent condition, with the embryo shad well formed and plainly visible with a glass, scarcely any dead or unfertilized eggs being in the jars. About 8 p. m. it was observed that the majority of the eggs were rapidly turning white. In some jars as many as one-half were dead. There being no perceptible change in the condition of the water, it is reasonable to suppose that the loss, amounting to 1,918,000 eggs, was due to the water being thoroughly charged with electricity, caused by the violent electrical disturbance taking place at the time.

On June 4 William Johnson took from one shad a pan of eggs, which, when placed in a jar, and carefully measured, was found to contain 115,000.

NOTES ON THE SPECIES PROPAGATED AND DISTRIBUTED.

The Sole (*Solea solea*).

May 16, 1888, sixteen English sole were received from Mr. E. G. Blackford, and June 2 twenty more. Thirty-four survived and were fed daily with clams, etc., at the Wood's Holl Station. Mr. Blackford obtained the soles from Mr. Thomas J. Moore, curator of the Free Public Museum, Liverpool, England.

The Flatfish or Winter Flounder (*Pseudopleuronectes americanus*).

This species was found in breeding condition at Wood's Holl, Massachusetts, early in February. The eggs were extremely adhesive, and had a tendency to form in large lumps. They were hatched by spreading them thinly on panes of glass, and placing them in an aquarium of running water. 1,179,000 eggs were taken, and produced 320,000 fish, of which 220,000 were planted in Vineyard Sound.

The Cod (*Gadus morrhua.*)

Spawning cod were procured for the Wood's Holl Station from Nantucket Shoals and Noman's Land; 155 fish were brought from Noman's Land November 14, and 62 fish from the same place November 17. 783 fish arrived from Nantucket Shoals November 17.

From these were obtained all the eggs that were impregnated at the station. Eggs were taken from November 17, 1887, until February 4, 1888. The eggs were stripped into large pans with a moderate allowance of water and milted without much loss of time. They were thoroughly stirred immediately after adding the milt and carried to the hatchery. 30,088,000 eggs were obtained, from which 7,822,000 fry were hatched. The average percentage of production was 26 per cent., and the highest 92½ per cent.

The efforts to transfer the eggs from Gloucester to Wood's Holl were unsatisfactory. For an account of the experiments leading up to the successful hatching of cod at the Gloucester Station see the description of this establishment.

The greatest number of eggs taken in any one day during the season was on January 14, when 7,056,000 were collected.

There is very little variation in the size of cod eggs taken in various places, and from several sizes of fish.

Mr. Robinson finds that 1 gallon of water per minute is exactly the amount that should pass through each cod-hatching box in order to make the siphon work properly; if less goes through the siphon will fail to catch promptly, and if more is used it will not break for some time.

His best results from the tidal hatching box were obtained with the eggs three layers deep, or 350,000 to the box. The jar seems to be objectionable for cod eggs because of lack of aëration. Eggs of the same age in boxes and jars will hatch out at different times. The box will develop them from five to eight days earlier than the jars.

Mr. Robinson has noticed that eggs handled in the ordinary way, and with water of the usual winter temperature, are most delicate between the sixteenth and twentieth days. They are then adhesive and will stick to the sides of the box when the tide begins to ebb, unless one is very careful to keep the sides thoroughly wiped off two or three times a day. Early in the season, when the water is warmer, the eggs become adhesive at the age of five or six days and must be brushed off the sides and lower edge of the jar with a feather.

The slow tidal motion of the box was found to be entirely suitable for the care of the young. When the temperature of the water fell to 30° all the spawning fish died.

The Haddock (*Melanogrammus aeglefinus*).

Not much success was achieved in hatching haddock eggs. Mr. Robinson found them to be larger than those of the cod, and to have a beautiful pinkish color. They measure sixteen eggs to the inch, while the cod measure eighteen.

One lot of haddock eggs taken after the middle of March contained only fifteen and a half to the inch. There are 100,000 fewer eggs in a quart of the haddock than of the cod. A quart of cod eggs number 336,798, and a quart of haddock eggs 236,556.

Haddock eggs are more tender than any other eggs that Mr. Robinson has yet handled. Often on the fourth or fifth day the eggs would all die, with scarcely any loss up to that time. They will float in water which is less dense than that suitable for cod. All the eggs of this species were taken in water of a density of 23½ except 75,000. After the weather seemed to be settled and the water in the tank rose above 33°, the density of the water changed from 27 to 25 and 24½, and as low as 23. This change took place on or about April 1, and interfered greatly with the success of the hatching operations.

Floating eggs.—250,000 floating eggs of undetermined species were brought in the *Grampus* hatching bucket and in pans from Narragansett Bay to Wood's Holl in June, 1888, by Dr. Bean. 150,000 of these were hatched and planted and embryos kept for identification.

The Tautog (*Hiatula onitis*).

The Mackerel (*Scomber scombrus*).

The Scup (*Stenotomus chrysops*).

Fair results were obtained at the Wood's Holl Station in hatching eggs of the last three species, and when it becomes necessary to apply artificial methods to their reproduction the work can be successfully prosecuted.

The Red-eye Perch or Rock Bass (*Ambloplites rupestris*).

6,628 adult fish of this species were collected in the vicinity of Wytheville, for distribution to ponds in Virginia and elsewhere. On March 1, 1887, 20 small individuals were sent to Herr Max von dem Borne, of Berneuchen, Germany. A new station was provided for in 1888, at Neosho, Missouri, for the cultivation of this and allied species for introduction into waters of the Southwest.

The Crappies (*Pomoxys annularis* and *sparoides*).

A new station at Neosho, Missouri, was projected in 1888 for the cultivation of crappies, rock bass, black bass, and tench for waters of the Southwestern States.

The Black Bass (*Micropterus salmoides*).

Yearling fish of this species have been obtained at the Wytheville Station for distribution to applicants and streams, chiefly in Virginia.

A new station was provided for in 1888 at Neosho, Missouri, for the cultivation of black bass and allied species suitable for the streams, lakes, and ponds of the Southwest.

The Sea Bass (*Centropristis nigricans*).

Fair results were obtained at the Wood's Holl station in hatching eggs of this species, and the conditions of its successful incubation were established. Should artificial methods become desirable they can be efficiently applied to the multiplication of this fish.

The White Perch (*Roccus americanus*).

On the 1st of March, 1887, sixteen yearlings of this species were sent from Cold Spring Harbor, New York, to Herr Max von dem Borne, Berneuchen, Germany. Only three of them reached him alive.

The Whitefish (*Coregonus clupeiformis*).

A detailed account of the work with this species is given under the description of the Michigan Stations. 15,000,000 eggs have been shipped to the Pennsylvania fish commission, 10,000,000 to the Minnesota commission, and 1,000,000 to the New York commission. The work in Michigan will hereafter be limited to the Alpena Station.

The first eggs were received from Alpena November 28. Shipments were made during the months of December, January, February, and March. The use of creek water made the season for shipment much longer than formerly. The fry resulting from the allotment to the New York commission were planted in Long Island lakes.

At the close of the fiscal year ending June 30, 1888, work was in progress upon a new station at Duluth, for the propagation of this species.

Whitefish eggs were forwarded to the National Fish Cultural Association, London, to Herr Von Behr, Germany, and to New Zealand. The number sent to London was 45,000.

The European Grayling (*Thymallus thymallus.*)

The New York Fish Commission received 10,000 eggs of the grayling from France in 1887, of which only 300 were good. A few of these were hatched at Cold Spring Harbor, but did not live.

The California Salmon (*Oncorhynchus chouicha.*)

The McCloud River Station, which was not operated from 1883 to 1888, was prepared in the spring of 1888 for work during the approaching season. The necessity of continuing artificial propagation to keep up the salmon fisheries of the McCloud was so evident that steps were

taken to resume the work. Provision was made in 1887 for salmon hatching on the Columbia River, and Mr. Stone was directed to establish a station somewhere on this river or its tributaries. A site was chosen on the Clackamas, and arrangements made for beginning work the ensuing season. Applications have been received up to the present time for several million salmon eggs, from parties on the small coast rivers, who offered to receive and hatch the eggs and distribute the young fish at their own expense.

The Atlantic Salmon (*Salmo salar*).

Eggs of this species are collected and hatched at the Bucksport Station. From there consignments are forwarded to various State commissions who have contributed to the expense of handling them. At this station the plan of rearing salmon until they have reached a length of several inches before turning them out was begun in 1888. See under the Maine Stations for fuller details.

At Craig's Brook there was a great loss of salmon during the summer, probably on account of the low stage of the water. The temperature of the water became high, and on the morning of July 5 an extreme of 72° F. was recorded.

The spawning season began October 25 and ended November 5; 1,184,000 eggs were taken. The average number of eggs per female was 8,691.

The loss up to the final shipment was 7.1 per cent. The average temperature in November, 1887, was 42.3°; in December, 34.8°. In January, 1888, 33.5°; February, 34.5°.

500,000 eggs of this species were received at the Cold Spring Harbor Station, from Bucksport, Maine, and nearly all of them were planted as fry in the Hudson River and Long Island waters. During the months of May and June, of 1888, salmon were caught in the Hudson by shad fishermen. Commissioners Blackford and Burden estimated that over 300 adult salmon were taken from the river between Gravesend Bay and the dam at Troy.

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

An account of the number of eggs of this species taken, and their distribution, will be found under the heading of the Maine Stations.

The salmon made their appearance at Grand Lake Stream early in September, 1887. A trap inclosing several acres of water, of a maximum depth of 20 feet, was made to retain salmon. October 25, the inclosed fish were found to have begun to form ridds. The first eggs were taken October 26. The inclosure was cut several times by muskrats. The total catch of salmon was 154 in excess of that of 1886. The heaviest fish taken was a female weighing 5 pounds 7 ounces; this was caught November 13. In 1887 only one marked fish was seen, and that appeared to have been marked in 1885; none of the fish marked in 1886 were observed.

The cost of fertilized eggs at this station was a little less than 1 cent for four eggs.

The eggs were kept in the hatchery from February 27 until April 2, before they were shipped.

35,000 eggs were received from Grand Lake Stream at the Cold Spring Harbor Station. The fry were deposited in the waters of New York and New Jersey. Eggs of this species were received from Grand Lake Stream, Maine, at the Wytheville Station, where they were hatched and the fry deposited in the Shenandoah River, Virginia.

90,000 eggs were sent to foreign countries in 1887 and 60,000 in 1888; their distribution is recorded elsewhere.

The Rainbow Trout (*Salmo irideus*).

Rainbow trout are reared at Baird Station, California, and also at Northville, Michigan, and Wytheville, Virginia, and by various State commissions. The spawning season of this species at Baird usually closes about May 1, but in 1888 some females continued spawning until the end of May. Eggs were taken from January 1 to April 26, and some large trout continued spawning through May. 468 trout yielded 443,500 eggs, an average of 948 eggs each.

The best results obtained at Northville, Michigan, since the species was brought there, were secured during 1888. The egg-taking season lasted from December 8 to May 4. During the season 8,578 yearling fish were planted in open streams, lakes, and ponds, in Michigan, Missouri, Ohio, Indiana, Arkansas, Tennessee, and Kansas.

During the last fifteen days of the hatching period of the rainbow trout eggs, the loss is less than one-tenth of 1 per cent. The greatest number of eggs taken from a single female was 2,000. This species is very successfully bred at the Wytheville Station, which has become one of the most important distributing points for foreign as well as home applicants.

The prominent feature of the work at this station is the large distribution of yearlings, amounting, in 1888, to 18,618; besides these, 150 3-year-olds were liberated.

Eggs of the rainbow were received at Cold Spring Harbor in March, 1888, from Baird Station, California. These were hatched and distributed in New York waters. The rainbow trout are unsatisfactory breeders at Cold Spring Harbor. From 6 fish less than 2,000 eggs were taken; and of these about $\frac{2}{3}$ were impregnated, a larger proportion than usual. 80,000 eggs were shipped to foreign countries, in exchange, in 1887, and 78,000 in 1888. These are referred to in the tables.

The Brown Trout (*Salmo fario*).

This species was introduced at the Northville Station in 1883. The results obtained with the fry have not been satisfactory during the first 3 months of their lives; after that, the loss is insignificant.

In June of 1888, Mr. Dean caught from the creek, adjacent to the Northville hatchery, a brown trout 22 inches long, and weighing 4

pounds. The greatest number of eggs taken from a single female was 2,375.

Eggs of this species were received from Herr von Behr and Herr von dem Borne, of Germany, in 1888. These were distributed among New York, Wisconsin, Minnesota, Virginia, and Michigan commissions, 19,000 being sent to each of these States from Cold Spring Harbor. The receipts of eggs were as follows:

March 4, 1887, from Herr Max von dem Borne, per steamer *Elbe*	8,000
March 9, 1887, from Herr von Behr, per steamer *Werra*	50,000
March 22, 1887, from Herr Max von dem Borne	50,000
February 22, 1888, from Herr Max von dem Borne	50,000
February 29, 1888, from Herr von Behr	60,000

The Loch Leven Trout (*Salmo levenensis*).

The first Loch Leven trout hatched at Northville were produced in the spring of 1883. The species has proved hardy and well adapted for pond culture.

Further particulars may be learned from the account of the Michigan stations.

48,000 eggs were received, January 12, 1887, from Sir James G. Maitland, Howietoun, Scotland.

The Sälbling (*Salvelinus alpinus*).

25,000 eggs of the sälbling were received at Cold Spring Harbor during January and March of 1888 from Herr von dem Borne. Some of these were shipped to the New Hampshire Commission, some to the New York Commission, and the balance were sent to Northville, Michigan.

February 9, 1887, there were received from Herr Max von dem Borne 20,000 eggs, of which 8,000 were dead. March 9, 1887, 20,000 eggs were obtained from the same source; of these 5,500 were dead. On the same date 20,000 eggs were received from Herr von Behr.

The Brook Trout (*Salvelinus fontinalis*).

This species is reared at Northville, where the work has been very successful, as will be seen by referring to the account of the Michigan stations.

The season's work on brook trout outranks any previous season in the percentage of good eggs from a given number. The eggs were taken from October 13 to November 12.

The highest number of eggs taken from one female was 1,200, and the average number from 786 females was 348 eggs. This species is reared also at Wytheville. The first eggs obtained from the species at this station were secured in October, 1887. The distribution of yearlings from this station in 1888 very much exceeded that of any previous year, aggregating 10,735.

January 15, 1887, 10,000 eggs were shipped to the National Fish Cultural Association, London, England.

The Lake Trout (*Salvelinus namaycush*).

The eggs of this species were taken at Northville from October 15 to November 20. An account of their distribution appears under the discussion of the Michigan Stations.

A notable circumstance in the distribution of this species was a deposit, on December 16, 1887, of 500 two-year-olds in a lake in Alpena County, Michigan. The eggs, for the greater part, were taken in small numbers, very few fish being stripped at a time. This prolonged the spawning season to a greater length than in any preceding season.

90,000 eggs of the lake trout were received at Cold Spring Harbor, December 28, 1887, from Northville. The fry were planted in New York lakes.

The fry in the troughs were fed on the bellies of soft clams (*Mya arenaria*) and they all thrived on this food. The same material has proved suitable for the lake trout in the two attempts made to rear them. When the fry were large enough to eat coarser food they received boiled mussels (*Mytilus edulis*) chopped fine. In former years lake trout were kept until the middle of the summer, when they would gradually grow less in numbers, and by October would all be gone.

The lake trout is kept in rearing ponds at the Wytheville Station. At the close of the fiscal year ending June 30, 1888, work was in progress upon a new station at Duluth, Minnesota, for the propagation of this species.

The Shad (*Clupea sapidissima*).

One of the principal stations for hatching shad is at Fort Washington, Maryland, and details are given in the account of this station. An important departure was effected in the successful operation during 1888 of the automatic hatching jars with their tops off.

During forty-one days 81,177,000 eggs were taken. From the second week of April to June 2, 70,249,000 of these were shipped to Washington from Fort Washington.

At Fort Washington about two-fifths of the shad eggs were obtained from gill nets and three-fifths from seines.

Only 8 per cent. of the eggs taken at Fort Washington were gathered between midnight and noon in 1888; in 1887, 14 per cent., the average of the two seasons being 11 per cent. In 1887, at Fort Washington, the proportion of male to female shad was nearly 3 to 1. In 1888, it was about 2 to 1. The shrinkage from air exposure in shipping shad eggs from Fort Washington to Washington, in 1888, was about 10 per cent. In the season of 1888 the hatchery at Battery Island, near Havre de Grace, Maryland, was equipped with 386 automatic hatching jars and the use of cones was discontinued. 7,000,000 shad eggs were taken in one night, prior to May 1, at Havre de Grace.

A supplementary station was established at Havre de Grace, with a capacity of 10,000,000 eggs at one time. The total production of eggs up to June 4 was 105,315,000.

At Battery Island Station, Maryland, eggs were obtained in 1887 from the fishermen. The steamers *Fish Hawk* and *Halcyon* coöperated with this station. The percentage of ripe shad at Battery Island was unusually large. 60,569,000 were received during the season of 1887. In the season of 1888 the steamer *Fish Hawk* was supplied with two hatching tables on each side of the hatching deck, with a capacity of 37 McDonald automatic jars each. The water supply was furnished by two wooden tanks placed on the upper deck. This increased the capacity of the steamer to the amount of 12,000,000 eggs at one time.

The first shad eggs were collected May 7 by the steamer *Fish Hawk*, in Delaware River near Gloucester. The last eggs were taken June 5. A single shad from Delaware River, on June 4, yielded 115,000 eggs. The temperature of the water did not exceed 65° until May 30, and, as a consequence, the period of incubation was retarded to 7 days.

On May 29, a violent thunderstorm on Delaware River destroyed 1,918,000 eggs which were nearly developed in the jars.

Three times during the season of 1888 heavy rains produced freshets in the Susquehanna, which ran off the fish for several days, and high winds prevailed throughout. The last freshet, occurring on May 31, practically closed the work, only 340,000 eggs having been taken in June. As soon as the water became clear fish were caught in abundance and continued plentiful until the end of the fishing season. The catch of shad was heavy, both in the bay and up the river, many gillers getting over 6,000 during the season.

The experiment of shipping shad eggs by express was tried in the spring of 1888; 5,000,000 were forwarded in good condition to Cold Spring Harbor, New York. There was great mortality in hatching these eggs in spring water at Cold Spring Harbor. This was attributed to the use of pine water pipes, which had not been thoroughly soaked. All the other eggs hatched remarkably well and shad have always hatched well in spring water before. 2,139,000 eggs were forwarded to Utah on car No. 2 and hatched on the way.

On May 15, 1887, a shipment of 1,184,000 eggs was placed in car No. 3 under the care of Mr. S. G. Worth for hatching on the way to Albany, New York. The eggs reached their destination on the 16th, and 30,000 were hatched on arrival. The remainder were hatched in the car by connecting the feed pipes with the city water works, the last of them having been liberated on the 18th. The loss in hatching was 20 per cent., due chiefly, in Mr. Worth's opinion, to the low temperature of the water in the engine tenders. The successful working of hatching apparatus on cars Nos. 2 and 3 enabled us to relieve the hatcheries of over 2,000,000 eggs per car each trip, the loss in transit being little greater than at the hatcheries.

The number of shad fry distributed from April 26 to June 9, the commencement and close of the season of 1888, was the largest since the organization of the Commission. The total number of eggs col-

lected was 235,099,000, of which there were lost during incubation at hatcheries and in transportation 81,208,700, the total number of fish and eggs distributed being 153,890,300. The number of eggs collected and of fish and eggs distributed by stations is shown in the tables of distribution in the appendix.

Summary by river basins of shad fry distributed during 1888.

River basin.	Total number shad deposited.
Tributaries of Narragansett Bay	1,764,000
Tributaries of North Atlantic coast	3,404,000
Hudson River and tributaries	4,040,000
Hudson River and tributaries, from eggs hatched at Cold Spring Harbor, New York	160,000
Delaware Bay and tributaries	34,159,000
Delaware Bay and tributaries, from eggs hatched at Wilmington, Delaware	3,560,800
Chesapeake Bay and tributaries	84,136,000
Tributaries of South Atlantic coast	3,921,500
Tributaries of Gulf of Mexico	16,820,000
Inland waters (Salt Lake, Utah)	1,925,000
Total	153,890,300

The Carp (*Cyprinus carpio*).

The pond area devoted to this species in the Washington carp ponds up to 1888 amounted to 23½ acres, but this was reduced to 17 acres by the filling of Babcock Lake. A new pond of 3 acres was established; 235,687 carp were collected during 1887, and in 1888, 600,000 fry were produced. Gravid carp were placed in the ponds May 15, 17, 18, and 19, 1888, water temperature 65° to 68°, increasing within a few days to 72° to 73°, when the fish began to deposit their eggs in great numbers upon the roots and lower branches of water plants. On the night of May 25, and subsequently, a sudden fall in temperature stopped the development of eggs, and killed many of them; the number of young fish hatched out decreased so greatly that it was necessary to restock the ponds. In breeding ponds of about 40 by 60 feet and 1½ feet deep it is easy to hatch out more young carp than the water will nourish. The pond may be completely filled with young carp, but within a few days thousands of them will perish by hunger for the want of natural food.

They will not take artificial food during the first three or four weeks, but live upon algæ and animalculæ. 6,000 carp were produced at the Wytheville Station and 440,000 fry were received during the summer of 1888 and released in the rearing ponds at Wytheville. The results were not very favorable. During the summer of 1887, water snakes killed a great many young carp in the west pond at Washington, District of Columbia; 40 fish were found in the stomach of a snake 3½ feet long. Mr. Hessel thinks the water snake one of the most destructive enemies of young fish.

On December 14, 1887, 5,000 carp were sent to the City of Mexico.

The Goldfish (*Carassius auratus*).

10,000 goldfish were hatched at Wytheville, and released in the rearing ponds. The account of the distribution is given in the sketch of the station.

The Tench (*Tinca tinca*).

This European species has been under cultivation in Washington, District of Columbia, for several years. In 1888 provision was made for rearing it at the new station of Neosho, Missouri, for introduction into the Southwestern States.

The Sturgeons (*Acipenser spp*).

June 11, the steamer *Fish Hawk* went to Delaware City, Delaware, to make some experiments with sturgeon spawn, with a view to determining what apparatus and conditions are necessary to hatch the eggs successfully. The vessel remained at this place until the end of the month, and during that time diligent search was daily made among the sturgeon fishing boats, to find fish suitable for the purpose, but not one could be found.

In May and June, 1888, Dr. John A. Ryder, professor of biology in the University of Pennsylvania, investigated the sturgeon of the Delaware River, and a monograph resulting from his studies will appear in the Bulletin for that year.

The Lobster (*Homarus americanus*).

Lobster eggs were collected from May 16 to May 31, 1888. None hatched until June 2, when they began to hatch rapidly.

When the lobsters were crowded in tubs in carrying them from Lobsterville in the launch, the time of the voyage being two hours, only a few of their eggs hatched; but when towed in the dory live-car the eggs nearly all hatched. 2,092,000 lobster eggs were collected at Wood's Holl, of which 193,000 were sent to the Pacific coast. An account of this transfer is given below.

TRANSPLANTING OF LOBSTERS TO THE PACIFIC COAST OF THE UNITED STATES.

The inhabitants of the Pacific coast have long desired to add the American lobster (*Homarus americanus*) to the food supply of their region, and they have from time to time urged the Government to attempt its transfer to the Pacific Ocean. The State of California has contributed to the accomplishment of this object, both independently and with the help of the U. S. Fish Commission.

The effect of the more equable temperature of the water and the interrelations of the indigenous fauna with the introduced lobster can be determined only by experience; but it is believed that the species will adapt itself to its new surroundings and prove a valuable addition to the already large stock of edible crustacea.

The first attempt to transfer the lobster was made in June, 1873, and was unsuccessful. The second shipment, in June, 1874, resulted in the

planting of only four lobsters out of one hundred and fifty, with which the messengers started.

In June, 1879, the third attempt was made under the supervision of Mr. L. Stone, and twenty-two lobsters were taken to the Pacific with the loss of a single individual. These were all females, and, although they carried a large number of eggs, it is not known that they accomplished the purpose of the transfer.

The determination of the best methods of shipping lobsters long distances overland has been a difficult problem, but was simplified by the introduction of cars built specially for transporting live fish. The experiments made by the late Capt. H. C. Chester at Wood's Holl, Massachusetts, in 1886, demonstrated the practicability of carrying them safely with a limited supply of sea water, at a low temperature, in a packing of rock weed (*Fucus*) and his methods were applied in the fourth trial in June, 1888, by Mr. J. F. Ellis, in charge of the Fish Commission Car No. 3, with the efficient help of Mr. R. S. Johnson, Mr. Trenholm, and Mr. John Jansen. This party left Wood's Holl, Massachusetts, June 14, 1888, with 614 lobsters, of which 360 were females, eight of them having eggs attached to their swimmerets. The length of the lobsters ranged from 8 inches to about 12 inches. 150,000 loose eggs, cut from the swimmerets, were carried in the ice box on twelve cloth-bottom trays, combined into one package, and sprinkled with salt water twice daily during the trip. The eight egg-bearing lobsters died on the way and 46,000 eggs were taken from them and added to the stock on the trays.

The lobsters were placed between layers of moist rock-weed in coverless wooden trays, with bottoms consisting of five or six narrow slats, the trays measuring 22 inches in length, 17 inches in width, 6 inches in depth, and holding about 6 lobsters each. These crates were placed in the fish-transportation tanks, or refrigerators, under the floor of the car. The temperature of the carrying tanks was controlled as far as possible by the use of ice. Coarse salt was provided in large quantity for making a freezing mixture with the ice and to make a brine for use upon the lobsters if the supply of sea water became exhausted. Complete details of the methods followed in this transfer will be found in a report by Mr. Rathbun in the Bulletin of the Fish Commission for 1888. The car reached Sacramento, June 22, and was dispatched to Monterey June 23, where 162 lobsters were deposited in the sea and the remaining 170 placed in floating boxes in the bay for deposit later. The loose eggs were put into hatching boxes June 24 and began hatching slowly June 28. The embryos were not liberated up to the time of closing this report. By this effort 332 lobsters and many eggs were carried across the continent in good condition and the requirements of successful transfer pretty thoroughly established. Still more favorable results are to be expected by making shipments in the spring or autumn, when the temperature will present less difficulty and the lobsters are in the most healthy state.

METHODS AND RESULTS.

REARING SHAD IN PONDS.

The experiments in rearing shad in confinement date back 4 years. In 1885 and 1886 the fry were placed in ponds containing young carp and a great many perch. The favorable results of these experiments, under most unpromising conditions, encouraged further investigation. As it was possible for shad to find their way into our ponds through the water supply, or by the drainage outlets from the river, I determined, in 1887, to renew the experiments under such conditions that the shad found in the ponds would certainly be accepted as the result of the stocking with fry. To this end I had a pond prepared at our Wytheville station, the same being fed by water drawn from Tate's Run, a small stream passing through the hatchery grounds. In June of that year I sent by messenger from Washington to Wytheville 40,000 shad fry, which were placed in the pond and left until the following October, when the pond was drawn, and we obtained, by count and estimate, 5,000 shad from 3½ to 4½ inches in length, or about 12½ per cent. of the number placed in the pond originally. The conditions were by no means favorable, for about 2,000 young carp 4 inches long were taken out with the shad, and the pond swarmed with cyprinoids which came in with the water supply. These fish are active and predaceous, and doubtless destroyed large numbers of the shad.

The experiment of the present season at Washington was carefully planned to exclude unfavorable conditions. The pond selected contained about 6 acres; it was thoroughly drained, and the bottom lay exposed to the frosts for some time; quicklime was used in the trenches to kill any eels or perch that might be in the mud; roots of hardy aquatic plants were planted in patches over the bottom, and then the pond was allowed to fill during the winter from the rains.

With the opening of the spring the vegetation grew up finely, and patches of green showed at numerous points. About 2,500,000 of fry were placed in the pond, and during the mild summer evenings, when the young shad were schooling at the surface and jumping after the flies, it looked as if a silver rain were falling on the water. Early in November, when the gates were opened to let the shad pass out into the river, it was a sight worth going to see; they were hours passing out in solid column, and a hand net dipped at random in the outlet conduit would bring up two or three hundred. We can of course only estimate numbers; every fry placed in the pond seemed to have a representative from 2½ to 3 inches in length. Dr. Hessel, the superintendent, estimates the proportion of survivals at over 60 per cent. I am certainly within limits in placing it at 30 per cent. The following account of the preparation of the pond and the feeding habits of the shad is from Dr. Hessel's report.

In May, 1888, shad fry were liberated in one of the carp ponds and suc-

cessfully reared on the supply of natural food. The pond in which young shad were reared was prepared by planting vegetation favorable to the growth of small crustacea such as *Daphnia*, *Cypris*, and *Cyclops*, upon which the young shad feed. The plants introduced were *Potamogeton*, *Natans*, *Gramineus*, *Crispus pectinatus*, and also bushy *Myriophyllum* of different varieties.

A *Nelumbium*, which was growing in the pond intended for shad, was found to be unfavorable to the experiment and it was removed. *Vallisneria* and *Polygonum amphibium* were added to the plants in the pond.

Shad fry were introduced April 26, 28, and 30; May 1, 2, 3, 4, and 6. On May 3 the fry were seen in water 3 to 4 inches deep, on sandy bottom, feeding upon minute crustacea. From May 3 to May 7, a raw north wind drove the animalculæ into deeper water, where the shad followed them and were lost from sight. Dr. Hessel began measuring the fish May 20, continuing at intervals of from five to fifteen days until October 10. The growth of the shad diminished towards the middle of August. The *Cyclops*, *Cypris*, etc., although very abundant in the pond, were too small to satisfy their appetite and the larger *Gammarus pulex* was not present. In order to determine whether or not the young shad would eat the fry of other fish, Dr. Hessel made the following experiment:

At those points of the pond mostly frequented by shad I placed, about June 20, from 80 to 100 carp, ten days old. The young shad were then about 3 centimetres long, and the carp about 6 millimetres (or one-fourth of an inch).

The shad at once attacked the carp, and ate them up. I can not say that it is the nature of the shad to eat other fish; but in this case it may have been the want of crustacea of proper size which compelled them to eat the carp fry, and it does not necessarily follow that they do so in open waters of rivers and the ocean. I am satisfied, however, that they do this in inclosed waters, from the following fact:

In 1886 a few cans of shad fry from the U. S. Fish Commission were deposited in the same point, in order to test the practicability of raising shad in the pond. The shad grew rapidly. In May the carp in the pond spawned and after the eggs were hatched an abundant supply of young carp was observed. The carp fry gradually disappeared and when the pond was drawn off, instead of 120,000 young carp which were expected, only 25,000 were taken out. At the same time, we found about 12,000 young shad 6 or 7 inches in length, which was three or four times the average size of the shad raised this year.

They accomplished this abnormal growth at the expense of the young carp which they had devoured.

October 27, 1887, about 800,000 young, of 2½ to 3 inches, were liberated and entered the Potomac.

This method is capable of general application as a means of stocking our rivers. I would select low meadows along the tidal portions of streams, which are bare at low water; by dikes I would exclude the tide water and allow the ponds to fill by seepage or surface drainage.

Ponds of several hundred acres area may be constructed at moderate expense. Each season I would stock these ponds with fry, and in the fall open the sluice gates and let the shad pass out into the rivers. Pur-

suing this method, with our capacity for producing fry, we could turn out each season into the Atlantic rivers 100,000,000 shad from 3 to 4 inches in length. The system of rearing ponds with a supply of natural food will, I am sure, be adopted in the end both for the production of shad and the various *Salmonidæ*.

SOME RESULTS OF ARTIFICIAL PROPAGATION.

PROPAGATION OF SHAD.

Since 1875 the U. S. Fish Commission has been engaged in the artificial propagation of the shad.

Prior to 1880 the immediate object and motive of the work was the production of fry, with a view to their introduction and acclimation in those river basins of the United States in which the species is not indigenous.

The fisheries census of 1880 and special investigations made under the immediate direction of the U. S. Commissioner of Fish and Fisheries revealed plainly the fact that there was a rapid decline in the productiveness and value of the shad fisheries in the Atlantic coast rivers, and that this decline was the inevitable result of adverse conditions, which were apparently beyond direct regulation or control by the General Government.

The Fish Commission could offer but one hope, namely, the artificial propagation and distribution of the young. Would these means be adequate; could we, by rescuing from waste the eggs taken from the shad captured in the nets of the fishermen, and destined for the market—by impregnating, hatching, and returning them to their native waters—arrest this decline, and, in the face of adverse conditions, determine a steady and progressive improvement in one of our most important fishery industries?

This was the definite problem to the solution of which the Commission addressed itself. Systematic development and extension of the shad-hatching operations of the Commission were undertaken with the definite purpose of testing the value of artificial propagation as a chief reliance in maintaining an important fishery, in the face of most unfavorable conditions, and—in a field which nature had abandoned as hopeless—determining a steady increase in value and production.

In 1880 the aggregate catch of shad in Atlantic coast waters, from Connecticut to North Carolina, was 4,140,968. The fisheries were steadily declining and there was a general and well-founded apprehension of their ultimate extinction. The work of stocking the streams was steadily prosecuted, increasing numbers of fry being planted each year, the total plant in 1888 aggregating 153,890,300 fry.

In 1885 a careful census of the shad fisheries of the region indicated was taken. The result of this was encouraging, since it showed an

aggregate increase in the shad fisheries of 1885 over 1880 of 1,032,963 shad, representing 4,131,852 pounds of increased food supply and an increased money value of $206,592. Like returns were obtained for 1886, 1887, and 1888.

These are summarized in the following table:

Aggregate catch of shad in Atlantic rivers from Connecticut to North Carolina for 1880, 1885, 1886, 1887, *and* 1888.

Year.	Number taken in salt and brackish waters.	Number taken in the rivers.	Total catch.	Increase over 1880.
				Per cent.
1880...	2,549,544	1,591,424	4,140,968	.....
1885...	3,267,497	1,906,434	5,172,931	25
1886...	3,098,768	2,485,000	5,584,368	34
1887...	3,813,744	2,901,661	6,715,405	62
1888...	5,010,101	2,650,373	7,660,474	85

By reference to this it will be seen that there has been a steady increase in the productiveness and value of our shad fisheries.

In 1885 the percentage of increase over 1880 was 25 per cent.; in 1886 the percentage of increase over 1880 was 34 per cent.; in 1887 the percentage of increase over 1880 was 62 per cent.; in 1888 the percentage of increase over 1880 was 85 per cent., the money value of the increase of 1888 over 1880 aggregating $704,101.

The significance of this result as measuring the value of the work of the Commission in the improvement of our fisheries will be better appreciated when it is understood how unfavorable to natural reproduction are the existing conditions under which the shad fisheries are prosecuted. Dams and other obstructions in the rivers exclude the shad from their natural spawning ground and vastly curtail the area of the feeding grounds for the young fish during their river life.

With this contraction of the area of spawning grounds the possibilities of natural reproduction in the rivers are diminished *pro tanto*, for in all our streams the larger area of favorable spawning and feeding grounds lies above the insurmountable obstructions.

In the lower reaches of our rivers, which are still accessible to the shad, the restricted spawning grounds are industriously and assiduously swept with drift net and seine, and innumerable fyke nets and pounds effectually bar all approaches, so that natural reproduction is in great measure impracticable even for the shad that find their way into the rivers and to the vicinity of their spawning grounds.

More serious than all, however, has been the transfer of the shad fisheries to the estuaries of the rivers and the substitution of the pound net for gill net and seine. In consequence of this change in the location of the fishing grounds the larger proportion of the shad captured

are now taken in salt or brackish waters, in which natural reproduction can not be accomplished.

Indeed, so small is the proportion of the seasonal runs of shad, which succeed in making their way into and up our rivers and reaching their spawning grounds, that natural reproduction has ceased to be a material factor in influencing the conditions affecting our shad fisheries.

The increased production of this fishery is to be attributed to the fish-cultural work of the United States and State Fish Commissions. The increased value of this fishery is a measure of the economic value of this work to the people of the country.

INTRODUCTION AND ACCLIMATION OF NEW SPECIES.

Experiments in acclimation have always constituted an important feature of the work of the Commission.

These have been directed as well to extending the area of distribution of our most valuable indigenous species as to the introduction from other countries of species promising important additions to our economic resources.

The Shad (*Clupea sapidissima*).

The introduction of the shad into the waters of the Pacific coast, and its multiplication there so as to become an important acquisition to the food resources of that region, is a remarkable illustration of the valuable results to be expected from well directed efforts in acclimation.

Several plants were made in the Sacramento River at Tehama, as follows:

In 1871	12,000
In 1873	35,000
In 1876	99,000
In 1878	150,000
In 1880	250,000

From these slender colonies, aggregating less than 1 per cent. of the number now annually planted on our Atlantic slope rivers, the shad have multiplied and distributed themselves along 2,000 miles of coast from the Golden Gate of California to Vancouver Island in British Columbia. They are abundant in some of the rivers, common in most of them, and occasional ones may be found everywhere in the estuaries and bays of this long coast line.

Prior to our experiments on the west coast it was a dictum of fish culture that fish planted in a river would return to it when mature for the purpose of spawning. The result of these experiments has been to demonstrate that this *instinct of nativity*, should it really exist, is in this case dominated by other influences, which have dispersed the shad planted in the Sacramento widely beyond the limits which we had assigned to them, and in the most unexpected direction.

The cause is probably to be sought in the genial influences of the

Japan current, which brings the warmth of equatorial Asia to temper the extremes of Arctic climate on the southern shores of the Alaskan Peninsula, and thence sweeping to the south, carries tropical heats to the latitude of San Francisco. Repelled on the one hand by the low temperature of the great rivers and fringe of coast waters, and solicited on the other by the equable and higher temperature of the Japan current, the shad have become true nomads, and have broken the bounds of the hydrographic area to which we had supposed they would be restricted. Following the track of the Asiatic current, and finding more congenial temperature as they progress, it is not unreasonable to expect that some colonies will eventually reach the coast of Asia, and establish themselves in its great rivers.

DIVISION OF SCIENTIFIC INQUIRY.

Preparations for the cruise to the Pacific coast detained the steamer *Albatross* in port from the first of January until the middle of September, 1887. During this period new boilers were constructed and put in place, necessitating several changes in the arrangement of the rooms adjoining the scientific quarters. The ship was also thoroughly overhauled and the equipment brought up to its full complement. It had been intended that the steamer should spend the summer of 1887 in making further explorations on the Atlantic fishing grounds, but the delays in completing her repairs rendered this impossible. In April, however, she proceeded to Fortress Monroe and supplied the United States steamer *Thetis*, then about to leave for the North Pacific and Arctic Oceans, with a dredging outfit, comprising several beam trawls, dredges and towing nets, dredge rope, and the necessary appliances and alcohol for preserving specimens. This material was furnished at the request of her commander, Lieut. William Emory, U. S. Navy, who has planned to carry on extensive investigations respecting the fisheries and marine zoölogy of the coasts that he will visit. Lieutenant Emory and several of his officers were given a short dredging trip on board the *Albatross* in order to instruct them in the methods of using the apparatus. September 14 the *Albatross* left Baltimore and put to sea, bound for Wood's Holl, Massachusetts. About 3 days were spent on the way in dredging and making observations along the inner edge of the Gulf Stream in depths of 102 to 1,276 fathoms. This cruise was taken as a trial trip for the purpose of testing the new boilers, which gave entire satisfaction. A month was occupied at Wood's Holl in putting the ship to rights and in making final arrangements, after which she returned to Washington to await orders for the voyage to the west coast. Coal and other supplies were subsequently obtained at Norfolk, from which port the *Albatross* sailed for San Francisco November 21. Lieut. Commander Z. L. Tanner, U. S. Navy, was in command of the steamer, while the civilian scientific staff was in charge of Prof. Leslie A. Lee, of Bowdoin College, assisted by Mr. Thomas Lee, Mr. Charles H. Townsend, and Mr. Dennis Cole.

The reasons for dispatching the *Albatross* to the Pacific coast of the United States have been stated in previous reports. It was considered that the benefits received by the Atlantic fisheries from the investigations of the Fish Commission were sufficiently important to warrant the extension of the work to the western coast, where the off-shore fishing grounds had never been studied or developed, although known to be extensive and valuable. Demands for information respecting their location, characteristics, and productiveness had frequently been made upon the Commissioner, and the late Professor Baird had carefully matured his plans with a view to instituting the desired inquiries, but his sudden death left their fulfillment to his successor. The transfer of the *Albatross* to the Pacific coast was sanctioned by the act of Congress, approved August 4, 1886, which provided for the necessary alterations in her machinery and for the additional expenses of the voyage to San Francisco. In accordance with the arrangements made by Professor Baird, instructions were given to carry on a limited amount of exploring work during the cruise around South America, as it was thought that valuable information might be obtained respecting the distribution of some of the oceanic fishes which frequent the coasts of the United States. It was also considered important to take advantage of the opportunity to study the methods of fishing practiced on the South American coast. Occasional dredgings, chiefly in moderate depths of water, were made during the progress of the cruise, together with the customary physical observations and surface towings. At coaling ports the scientific assistants were principally occupied in collecting and studying the local fishes, and in obtaining data bearing upon the fishery methods and statistics. The fish markets were visited and complete series of the species offered for sale were secured and forwarded to Washington. The places where opportunities occurred for this kind of work were as follows: The Island of St. Lucia in the West Indies, Bahia, Montevideo, Sandy Point, Lota, Panama, Acapulco, and La Paz, the last two being located on the west coast of Mexico. Dredging work and hydrographic observations were carried on through the entire length of the Straits of Magellan, a comparatively unknown region zoölogically, and a short stop was made at the Galapagos Islands, off the coast of Ecuador. At the latter place a number of specimens of the edible land tortoise peculiar to those islands were secured and carried alive to San Francisco. It was intended to plant them on one of the islands off the coast of Florida, in the hope that they might become acclimated on our own coast, but, unfortunately, they barely survived the journey across the continent. Collections of shore fishes were obtained by seining at several localities on the outer coast of Lower California, and a few dredge hauls were made off California, one of the latter containing a new species of edible flounder, which appears to occur in considerable abundance.

The scientific and practical results of this cruise can not fail to be of great importance. The greater part of the collections obtained has

been apportioned among prominent specialists in the several groups for study and their reports are awaited with interest. The general scientific results will be discussed by Prof. Leslie A. Lee; the narrative of the cruise by Lieutenant-Commander Tanner will be found in the appendix to this volume. The *Albatross* arrived at San Francisco the middle of May, 1888, the time previously determined upon, and preparations were immediately begun for the first cruise to the Alaskan fishing grounds, on which she started July 4.

The great extent of the western seacoast of the United States with its varied climate will make it possible to utilize nearly the entire year in carrying on the investigations of the steamer *Albatross*. The exploration of the Alaskan cod and halibut grounds, which reach well up into Bering Sea, must necessarily be limited to the summer months, while the winter is best adapted to the work along the coast of Southern California. The hydrography of this entire region is comparatively little known outside of the harbors and shore waters, and it will, therefore, be of great importance to conduct extensive series of soundings, in order to determine the position and extent of the fishing banks, a work not generally necessary on the Atlantic coast. The study of their resources and their physical and biological characteristics can, however, be made conjointly with the same, and it is expected that results of much value to the fishermen will be obtained before the close of the next fiscal year.

During the year and a half ending June 30, 1888, the steamer *Fish Hawk* was employed but little in this branch of inquiry. From August 9 to September 6, 1887, however, she was stationed at Wood's Holl, Massachusetts, and rendered some assistance in the investigations in that region, making several dredging trips to Vineyard Sound, Buzzard's Bay, and the shallow waters off Martha's Vineyard and Nantucket.

Within the period covered by this report the schooner *Grampus* has made several important explorations and has demonstrated her utility for this class of work. From the latter part of April until the last of May, 1887, while in command of Capt. D. E. Collins and with Dr. T. H. Bean as naturalist, she was engaged in cruising on the early mackerel grounds between Cape Hatteras, North Carolina, and Cape Cod, Massachusetts, for the purpose of studying the schools of mackerel as they approach the coast, and their subsequent movements with relation to temperature, the abundance of food, etc. The schooner was well equipped with the necessary scientific and fishing appliances, and succeeded in obtaining many valuable observations which have been published in the Fish Commission Bulletin for this year. A part of the time she kept company with the fishing fleet, and at others was cruising independently with the view of ascertaining whether the mackerel could be found in advance of the fishing centers or in other directions. During the first part of the season the mackerel were scarce and small. Sea birds,

cetaceans, and the various other marine forms, which generally accompany the schools and indicate their position and size, were less abundant than usual. Bad weather also prevailed most of the time and this undoubtedly interfered with the schooling of the fish at the surface. Most of the schools sighted, even during the latter part of the cruise, were too deep in the water to be reached by seining, and it is probable that a large proportion of the fish passed northward unobserved. They also appeared to move nearer the land than has generally been recorded.

During the following summer, beginning the first part of July, the *Grampus* extended its researches respecting the distribution and abundance of mackerel along the coasts of the British Province as far north as Labrador. She was then in charge of Capt. J. W. Collins. The principal object of the trip was to verify the recent reports concerning the appearance of mackerel off the northeast coast of Newfoundland. Following the coast of Nova Scotia as far as Canso, the *Grampus* entered the Gulf of St. Lawrence, and sailed as far north as the Magdalen Islands. Thence she proceeded to St. John's, Newfoundland, and along the outer side of Newfoundland to the Straits of Belle Isle. No mackerel were observed at any point; but many natural history specimens and physical observations were obtained. Mr. F. A. Lucas and Mr. William Palmer, of the U. S. National Museum, accompanied the schooner as naturalists, and in addition to the regular work of the cruise they were allowed to land and make shore collections at the different harbors visited.

The work begun in the spring of 1887 was continued by the *Grampus* during April, May, and June, 1888, Capt. D. E. Collins being again in command, and Dr. T. H. Bean acting as naturalist. The cruising ground was the same as in the previous year. Only small schools of mackerel were encountered, and those not until late in May. Low water temperatures prevailed during the early part of the season, and the mackerel food was found to be abundant only in streaks or scattered patches. Over 250,000 floating fish eggs taken in the surface nets were carried to Wood's Holl and hatched, the embryos being preserved for identification. Should these eggs prove to belong to useful species, it will probably be expedient to make a practice of collecting and hatching them on a large scale. A few days in May were occupied in investigating the reproduction of the menhaden in lower Chesapeake Bay. The experiment of carrying living mackerel in the schooner's well proved successful, and it will therefore be possible to undertake the reproduction of this species at one of the coast stations of the Commission.

Dr. T. H. Bean spent the summer of 1887 in collecting and in studying the habits of fishes in the vicinity of Great Egg Harbor Bay, New Jersey, chiefly for the purpose of determining the changes that have taken place in the fish fauna of the New Jersey coast during the past

thirty-three years, Professor Baird having made a careful investigation of the same region in 1854. The latter obtained sixty-seven species, of which eleven were not found by Dr. Bean, who succeeded, however, in securing ninety species, thirty-five of which were additions to the list published by Professor Baird. The total number of species now recorded from this region is one hundred and one.

The Wood's Holl laboratory was occupied as usual during the summer of 1887 in the interest of scientific inquiry. Professor Baird was present up to the time of his death, August 19, but as he was seldom able to give personal attention to the conduct of the work, his duties were assumed by the Acting Commissioner, Mr. T. B. Ferguson. The biological laboratory was in charge of Prof. A. E. Verrill, of Yale College, assisted by Mr. Richard Rathbun. Those in attendance during the summer were as follows: Prof. S. I. Smith, of Yale College; Prof. Leslie A. Lee, of Bowdoin College; Mr. Sanderson Smith, of New York; Prof. Edwin Linton, of Washington and Jefferson College, assisted in his work by Mrs. Linton as artist; Prof. B. F. Koons, of the Storrs Agricultural School; Mr. J. H. Blake, of Cambridge, as artist; Mr. Thomas Lee, and Mr. Peter Parker, 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 U. S. National Museum. Dr. J. H. Kidder was in charge of the physical and chemical laboratory, and Mr. William P. Seal of the aquaria. Tables in the laboratory were assigned to Mr. S. Watase, of Johns Hopkins University, and Mr. Miyabe, of Harvard University. Dr. Osler, of Philadelphia, was also present for a short time. Mr. V. N. Edwards, who is permanently employed at the station, acted as general field assistant. The attention of the party was divided between the care and study of the collections brought in by the steamers *Fish Hawk* and *Albatross* and the investigation of the local fauna and fisheries. As above explained, the *Albatross* made only one trip in connection with the Wood's Holl Station, but the short cruises of the *Fish Hawk* in the neighboring waters furnished considerable material. Seines were constantly in use along the shores of Vineyard Sound and Buzzard's Bay, and many fishes were secured in the fish traps of the vicinity.

The taking of temperature observations at the principal light-houses, light-ships, and signal stations along both seacoasts of the United States and on many of the interior lakes and rivers, as described in previous reports, was continued during the entire year, through the courtesy of the Light-House Board and the Chief Signal Officer. The preparation of reports covering the investigations of the steamers and field parties of the Commission has been intrusted to the same personnel as last year. Among the collaborators in this department may be mentioned Prof. A. E. Verrill, and Prof. S. I. Smith, of Yale College; President David S. Jordan, of the University of Indiana; Dr. T. H. Bean, Dr. J. H. Kidder, and Mr. Richard Rathbun, of Washington;

Prof. Leslie A. Lee, of Bowdoin College; Prof. Edwin Linton, of Washington and Jefferson College; and Mr. Sanderson Smith, of New York.

DIVISION OF FISHERIES.

In reorganizing the work of the Commission I felt that the importance of the fisheries demanded the creation of a division which should consider their commercial side in all its bearings. In 1885 the collection of fishery statistics was begun by Professor Baird, with Mr. R. E. Earll in charge of the work. In 1887 Prof. G. Brown Goode, who was appointed Commissioner after the death of Professor Baird, established a division of statistics, with Mr. Earll at its head. This arrangement continued until in May, 1888, when Mr. Earll tendered his resignation from the Commission. I then decided to carry into effect my system of reorganization, by creating a Division of Fisheries, and on May 24, 1888, appointed Capt. J. W. Collins in charge, with instructions to organize and carry on its work. The full accomplishment of this plan was delayed, however, by the necessity of detaching Captain Collins for the preparation and management of the Commission's exhibit at the Centennial Exposition of the Ohio Valley and Central States, held at Cincinnati, Ohio. A temporary organization of the division was effected and the work of securing information concerning the fisheries begun.

In the beginning of 1887 the office force engaged in collecting statistics of the fisheries included R. Edward Earll, assistant in charge; Dr. H. M. Smith, M. M. Snell, and W. H. Abbott, clerks.

Mr. H. R. Center was added to this personnel in November, 1887. During the interval between the resignation of Mr. Earll and the appointment of Captain Collins Dr. H. M. Smith assumed charge of the office.

Mr. W. A. Wilcox acted as a local agent of the Commission until December, 1887, when he was directed to obtain special information in Maine and Massachusetts, for the use of the International Fisheries Commission. After completing this work he was assigned to office duty in Washington until again detailed, in the latter part of June, 1888, for field work in Massachusetts. About the same time Mr. Luther Maddocks was ordered to Maine for similar duty.

The routine work has included the preparation of reports and reference files on the fisheries, based on materials received from the following sources:

Daily reports from the Boston Fish Bureau.

Daily reports from the American Fish Bureau, Gloucester, Massachusetts.

Weekly reports from Capt. S. J. Martin, on the Gloucester fisheries.

Reports from field agents of the Commission.

Newspaper articles on the fisheries, fish culture, fish protection, etc.

Correspondence with New England vessel owners and masters.

Reports from and correspondence with collectors of customs.

Correspondence with Treasury Department officials.

The circular issued by the Treasury Department to the collectors of customs is one of the most valuable means of obtaining information concerning the statistics of fisheries. 3,445 of these reports were forwarded to the Commissioner in the calendar year of 1886, 2,535 in the first half of 1887, and 5,436 during the fiscal year ended June 30, 1888. They are increasing in value every year and have been of great assistance in preparing the compilations elsewhere mentioned.

From the materials above mentioned tables can be prepared at short notice, showing in detail almost every aspect of the vessel fisheries for the food fish of any State or section. The reports, however, do not include the shore fisheries and those devoted to the whale, seal, and walrus.

The division has conducted an extensive correspondence in order to obtain these data. To the Executive Departments, the committees of Congress, and the International Fisheries Commission much information has been furnished on matters concerning the fishery relations between the United States and Canada.

From January 1, 1887, to June 30, 1888, 888 letters were written and sent from the office, besides 2,000 cyclostyle forms to collectors of customs and vessel owners, filled out to suit individual cases, numerous replies to private parties seeking information, and letters to field agents relative to their work.

In response to requests received from the Department of State, the International Fisheries Commission, the Congressional committees on Fisheries and Foreign Affairs, and from other Departments of the Government, and private individuals, twenty-four tables and statistical statements were prepared. These include lists of American vessels whose fishing operations were inconvenienced by the Canadian government; American vessels entering British North American ports and fishing grounds; fishery products imported from and bait exported to Canada; American vessels fishing on offshore grounds, including references to the fishing centers, baiting localities, and average catch; statistics of special fisheries, as the halibut, cod, mackerel, and menhaden; accounts of the fisheries of special ports, as Philadelphia and Camden; and statements of the number and nationality of New England fishermen and the value of the fisheries.

At the request of the International Fisheries Commission Captain Collins furnished "some reasons why the fishermen of Nova Scotia prefer to use salt clams (*Mya arenaria*) for bait in the Bank hand-line cod fisheries." For the use of the same Commission, and at the instance of the Department of State, he prepared four large colored maps covering the region between Cape Hatteras and Labrador, at the intersection of the fifty-third parallel of north latitude, and showing graphically the geographical distribution of the marine fishes most important for food and bait, the areas of greatest abundance, the principal fishing ports and baiting stations, and various other facts bearing on the fishery relations between the United States and Canada.

ASSIGNMENT OF DUTIES.

The work of the Division of Scientific Inquiry has been directed by Mr. Richard Rathbun, who has been intimately associated with this branch of the service since 1874. Systematic investigations of various problems having either direct or ultimate economic importance have been projected or are now in progress under his supervision, and promise results alike valuable to science and its economic applications.

The work of the Division of Fisheries has been directed by Capt. J. W. Collins.

The Commissioner retains charge, for the present, of the Division of Fish Culture.

MARSHALL MCDONALD,
Commissioner.

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